STATE BOARD OF TECHNICAL EDUCATION & TRAINING::AP, VIJAYAWADA

DIPLOMA IN CIVIL ENGINEERING

III SEMESTER

SURVEYING-II PRACTICE & PLOTING (C-308)

(AS PER C-20 CURRICULUM)

1.0 INTRODUCTION

The Curriculum of Technical Education should invariably provide for knowledge, attitudes and skills required by the technicians /technologists in the country. In this context the laboratory courses form a vital portion in the entire curriculum of technician education. The laboratory courses shall therefore be so designed and delivered that they help the students acquire attitudes and motor skills that are essential to function effectively as technicians/technologists.

The planning, organization and implementation of lab courses need a detailed description of tasks to be performed by the students. Well thought out instructional objectives to a large extent give these descriptions. The analysis of tasks (by identifying the activities the students are expected to do) help prepare the objectives meticulously. In other words the objectives would be clearer, when the task analysis is done to spell out the sub tasks for each objective.

A survey of the practices currently followed in the technical/technician education shows an urgent need to plug in gaps in instructional procedures. The reasons for these gaps are ambiguity in the minds of the teachers regarding tasks to be performed, levels of competency to be achieved by the students and the weightage to be allocated for each task. This aids in scientific design of instructional plan (optimizing the resources, budgeting the time & content).

The task analysis, teaching points and the structured scheme of evaluation are very important in focusing the instruction on specific skill of desired outcome and in evaluating the same. The Instruction and evaluation in Laboratory courses are different from that of cognitive lessons in the sense that adequate importance and hence weightage needs to be given for all three domains of learning viz. cognitive, psychomotor and affective. Since both training and evaluation of traits of affective domain are practically difficult, a few traits (called values) most relevant and essential to occupations/professions after the Course may be identified for the purpose. It is imperative to integrate these values during instruction and evaluation and also overtly notify the same to the students.

A technician, in addition to performing a skill needs to prepare a report of testing that includes the description of procedure, details of measurements made, reasoning based inferences and so on.,. The current practice of record writing has failed to achieve this purpose as most of the time students end up with making copies of available material.

Therefore, for sensitizing the need for the changes in laboratory instruction, the present hand book has been prepared to meet the above requirements. As such the hand book comprises four parts that intend to :

- Present task analysis, teaching points which can be used for effective design of instruction
- provide a scheme of evaluation with rationally allocated weightage to each significant skill component
- offer a set of questions designed at different levels of competencies for assessment enabling the teacher to set the question paper with balanced levels of competencies
- present preset worksheets that cultivate the habit of systematic recording of observations and writing the technical report.
- Provide all important data related to particular laboratory activity at one point in the form of annexure

1.1. STRUCTURE OF THE BOOK

The hand book is presented in four parts viz., Laboratory sheets, Worksheet, Experimental Methodology and Annexure. The description of each part is given in the following sections

Part I. Laboratory Sheet

The information provided in this part is useful for the teacher for designing the instruction, planning & organization of the experiment and for scientific evaluation of the students. The major features of the Laboratory sheet are further explained below.

1. **Objective**
   It indicates the **Task** to be performed and completed by the student during the specified duration of time.

2. **Task Analysis**
   It is the process of identifying the component activities (sub tasks) to be carried out by the student in order to achieve the stipulated objective. As the task analysis aim at fitting the instructional objectives into various classes of behaviour, it would help the teacher to determine any particular type of behaviour the student has learnt / failed to perform.

   The task analysis would help the teacher in identifying the specific activities to be performed by the students. This could also be used as some kind of check list to compare with activities planned for the laboratory. Further it would give clue to the teacher to make students think originally & act independently. It includes both psychomotor learning and the related cognitive information and hence the task analysis is presented as Knowledge and skill parts.

   A. Knowledge Part: That includes the cognitive aspects of the task.

   B. Skill Part: That includes Psychomotor & Affective aspects of the task.

3. **Teaching Points:**

   This includes the points based on the SKILL identified with suggested duration for each point and total duration which helps the teacher for the time and content budgeting during instruction.

4. **Need and Scope:**
   The purpose, application and scope of the task to be performed are normally included in this sub section.

5. **Planning and Organisation:**

   It lists actions to be taken to perform various activities and hence useful in planning the instruction and organizing the resources and equipment

6. **Scheme of Valuation:**
   The information provided in this section helps the teacher to devise a tool for rational measurement assessment of the competencies accomplished by the student.

Part II. Work Sheet

It is designed for the student, where in the student enters his personal data of identification, details of the experiment, stepwise procedure, observations made during experiment, a sample calculation, free hand typical graph, graph from experimental data and inference with discussion.

Part III. Experimental Methodology

This section furnishes information with regard to standard procedure to conduct the experiment along with the description of equipment/apparatus and the basic theory/concept involved in the conduct of the experiment. Thus this section is very useful for both teacher and student as well to conduct the experiment systematically. Thus this section is presented in four sub section as described below:

- **Description**

It gives the detailed description of apparatus / tools / equipment / materials to be used for the task.

- **Theory / Concept**

It gives the concept of the task to be performed with formulae and units.

- **Procedure**

It provides the idea of step wise procedure to perform the task.

- **Observation and Calculation**

It includes sample observation, sample graph, sample calculation for reference

Part IV. Annexure

All important and useful information that may help in accomplishment of tasks like conversion tables for units, technical & scientific data like material properities, standard trend or characteristic curves (graphs) etc are compiled and presented at one place in this section.

1.2. WHO IS TO USE AND HOW TO USE.

The hand book is so designed that it can be beneficially used by different sections of the technical education viz., the teacher, the student, the examiner and the administrator convenient to individual's requirements. A few uses of this hand book each stakeholder could make is outlined in the following sections.

1. Teacher

A. The **laboratory sheet** is designed keeping the teacher in mind for the teacher has key responsibility of imparting the skills to the student and hence the information given in the lab sheets may be useful for planning & organizing the experimental set up and designing an effective instruction. Thus the teacher may

Plan and organize as per *section 4*,

Instruct the students as per *section 2***,**

Demonstrate each sub task as per *section1.B*.and

Evaluate the students as per *section 5***,** according to the level of competency.

Values: The values in a person are an important personality trait that needs to be nurtured in the learning environment. Further it is also a driving component in any individual to deliver the best and hence this component is also included in the evaluation. However only five key dimensions, that are important in the teaching-learning environment, are taken into consideration for nurturing and evaluation. A little information about these five dimensions is given below as a guideline for the teacher while assessing students.

1. Co-operation: It is the voluntary arrangement in which two or more students engage in a mutually beneficial exchange, instead of competition. Cooperation can happen where resources adequate for both students exist or are created by their interaction.

2. Co-ordination: It is the unification, integration, synchronization of the effect of group members so as provide unity of action in the pursuit of common goals. It is an integral element and required in each & every function and at each & every stage & therefore it cannot be separated.

3. Communication; Communication skill is the set of skills that enables a student to convey information so that it is received and understood.

4. Sharing: A part or portion belonging to, distributed to, contributed by, owed by a person or a group **Or** To participate in, use, enjoy or experience jointly or in turns.

5. Leadership: Students with the following leadership qualities are almost always the ones that rise above the crowd.

1. Trustworthiness: This refers to integrity.

2. Inspiration: Guides, leads and inspiring others to want to participate in the process of moving towards the vision.

3. Self awareness: It is the individual awareness of him or her self – their abilities and the impact that they have on others.

4. Acceptance of responsibility: True leaders are accepting responsibility for all that comes their way and taking ownership and responsibilities for getting things back on track. Blaming, justifying and excuse making just is not in their responsibility.

B. The **Experimental methodology** is designed for both teacher and student. The teacher can refer the experimental methodology for the details of equipment/apparatus/ materials/tools, procedure to be followed, observations to be made, graphs to be drawn and calculations to be done for the task to be performed

2. Student

The Worksheet is designed keeping in view the needs, deficiencies and the adolescent characteristics of the student for student.

The students submit the filled in work sheet given by the teacher on the day of experiment after referring to experimental methodology and listening to instructions of teacher. The design of the worksheet is made user friendly and the contents are so logically sequenced that the student finds it easy to understand and develop the skill of recording and report writing skill. It also helps the student to actively participate in skill learning. More importantly the student gets immediate meaningful feedback of his performance since the competency wise assessment is done and that too on the same day.

3. Examiner

The examiner may find this hand book very useful as Laboratory sheets and Scheme of evaluation provides information with regard to various competencies (skills) the students is expected to acquire during the course of study and the relative weightages of each competency. This information helps him to design a well balance question paper/measurement tool for assessment

PERFORMING TEMPORARY ADJUSTMENTS FOR A THEODOLITE

OBJECTIVE

To perform series of tasks involved in Temporary adjustments of a theodolite

EQUIPMENT/APPARATUS

- Theodolite
- Tripod
- Levelling staff .

TASK ANALYSIS

A.KNOWLEDGE

- Parts of theodolite
- knowledge on fundamental lines of theodolite.
- rotating foot screws.
- use of clampscrews and tangent screws
- focusing eye piece and objective.
- using plumb bob

B.SKILLS

Category of Skill	Sub task
1. Handling of apparatus	• Lifting the telescope from the box • spreading the legs of tripod • fixing the theodolite to the tripod • operating foot screws • removing the lid from objective glass • rotating clamp screws and tangent screws
2. Manipulation of apparatus	• centering the instrument exactly over station using plumbob • rotating the telescope parallel to bubble tube • bringing the bubble to the center of bubble tube using appropriate foot screws • moving eyepiece in and out for focusing • directing the telescope towards the staff • focusing the objective glass
3. Precise operation /activity	• rotating telescope 180 degrees to check bubble remains central or not • focusing the eyepiece until cross hairs are distinctly visible • focusing the objective glass to bring image clearly in the plane of crosshairs • elimination of parallax

- **TEACHING POINTS**

S. No	Teaching points	Suggestive Duration (min.)
1.	Parts of theodolite	4
2.	Fundamental lines of theodolite and their basic relation	
3.	Why temporary adjustments are needed	
4.	Steps involved in performing temporary adjustments	5
5.	Explanation of focusing of eye piece and objective	
6.	Parallax elimination	6
7.	Intercepting object through crosshairs	
8	Precautions	
	A .Procedural precautions A. Care should be taken in direction of rotation of footscrews B. care should be taken not to rotate telescope with both clamp screws fixed C. Proper care should be taken centering will not get disturbed while levelling .	
	B. Safety precautions • Care should be taken that staff or ranging rods to not touch electric items and wires	
	Total	15

- **NEED AND SCOPE OF THE EXPERIMENT**

The theodolite is one of the most precise survey instruments and is suitable for measurement of angles(horizontal and vertical), prolonging a straight line, measurements of bearings, traversing etc. Experiments involving theodolite requires performing temporary adjustments at each and every setup of the instrument

- **PLANNING AND ORGANIZATION**

Action	Activity
Check for	• functioning of foot screws. • bubble tube sluggishness. • check for permanent adjustments • check whether the clamp screws are tightened or loosened • legs and adjusting screws of tripod
For Instructions	Read the teaching points carefully.

- **SCHEME OF EVALUATION**

Category of skill	Sub Task	Weight with competency level individually	Awarded (50)
1. Handling of apparatus	• fixing the theodolite to the tripod • operating foot screws appropriately	10	
2.Manipulation of apparatus	• centering the instrument exactly over station using plumbob • rotating the telescope parallel /perpendicular to the bubble tube • bringing bubble to the center of bubble tube using approproiate foot screws	15	

3.Precise Operation/Activity	• focusing the eyepiece until crosshairs are distinctly visible • focusing the object glass to bring image clearly in the plane of crosshairs • elimination of parallax and sighting the staff	20	
4. Values	• Co-operation • Co-ordination • Communication • Sharing • Leadership	5	
Total		50	

ASSESSMENT QUESTIONS (Only suggestive)

- Perform temporary adjustments of theodolite.

VIVA QUESTIONS

(Only suggestive. The teacher may add questions depending upon the Context of examination)

- What is centering?
- Differences between temporary and permanent adjustments?
- When do we go for permanent adjustments?
- Explain use of any 5 parts of theodolite?
- What is focusing ?
- What happens if focusing is not done properly?
- What is the use of plumbbo?
- What is transiting?
- What is swinging?

MEASUREMENT OF HORIZONTAL ANGLE USING THEODOLITE

OBJECTIVE

To perform the task of measuring the horizontal angle between two accessible points using theodolite.

EQUIPMENT/APPARATUS/RESOURSES

1. Theodolite
2. Ranging rods
3. pegs
4. Tripod stand
5. Plumb bob

1. TASK ANALYSIS

A. KNOWLEDGE

- Purpose of Theodolite Instrument
- Operating theodolite
- Transiting of telescope
- Set the vernier to zero
- Reading vernier and Main scale readings, Least count of vernier.
- Face left and face right of the theodolite
- Unit conversions
- Identifying the two accessible points.
- Purpose of plumb bob
- Temporary adjustments of theodolite.
- Fixing the theodolite to the tripod stand.

B.SKILLS

Category of Skill	Sub task
1. Handling of apparatus	• Using Ranging rods, fixing them at points A and B. • Using peg, fixing ‘A’ at point ‘O’. • Setting up of theodolite. • Using plumb bob, making the instrument level. • Using Theodolite, taking the readings on both verniers. • For theodolite, performing temporary adjustments.
2.Manipulation of apparatus	• Focusing the telescope to the points ‘A’ and ‘B’. • Bisecting the points ‘A’ and ‘B’ using tangent screw. • Checking for instrument level after rotation of telescope from ‘A’ to ‘B’. • Noting down the readings of main scale and vernier scale from the instrument. • Changing the face of the telescope.

3. Precise operation /activity	• Convert all measurements into single unit. • Observing the readings on the vernier scale and main scale. • Noting the readings in the field book. • Calculating horizontal angle.

2. TEACHING POINTS

S. No.	Teaching points	Suggestive Duration (Min.)
1.	Description about Theodolite A. Purpose of theodolite B. Types of theodolites C. Components of theodolite D. Functions of components of theodolite E. Applications of theodolite F. Temporary adjustments of theodolite	8
2.	What is a horizontal angle? Methods to find the horizontal angle?	
3.	Readings on main scale and vernier scale of the Theodolite	
4.	Conversion of angles into minutes and seconds	2
5.	Tabulating the observed readings	5
6.	Calculating the horizontal angle	
7.	Precautions	
	A. Procedural precautions • Clamping and loosening the screws of the theodolite. • After rotating the telescope to 180^0, temporary adjustments must be checked. • Readings from the vernier should be taken carefully. **B. Safety measures** • Transporting the theodolite from lab to the field safely. • Lifting and placing of the theodolite from the box and in to the box gently. • Fixing of ranging rods in the ground safely.	

	Total	15

3. NEED AND SCOPE OF THE EXPERIMENT

Horizontal angle:

These angles are used to determine the bearings and directions in surveys and for setting out all types of structure.

Horizontal angle can also be measured using magnetic compass, but the theodolite is more precise than the magnetic compass. Magnetic compass measures the angle upto an accuracy of 30’, but a theodolite can measure upto an accuracy of 20” or 10”.

4. PLANNING AND ORGANIZATION

Action	Activity
Check for	1. Working condition of theodolite. 2. Working condition of ranging rods. 3. Working condition of plumb bob.
For design of Instructions	Read the teaching points carefully.

5. SCHEME OF EVALUATION

Category of skill	**Sub Task**	**Weight with competency level individually**	**Awarded (50)**
1. Handling of apparatus	A. Fixing of theodolite to the tripod stand. B. Checking for centering of instrument using plumb bob. C. Making temporary adjustments of the instrument.	A: 2 B: 3 C: 5 Total: 10	

<table>
<tr>
<td>2.Manipulation
Of apparatus</td>
<td>A. Focusing the telescope to the points ‘A’ and ‘B’.
B. Bisecting the points ‘A’ and ‘B’.
C. Reading vernier scale and main scale of the theodolite.
D. Changing the face of the telescope</td>
<td><table><tr><td>A</td><td>B</td><td>C</td><td>D</td><td>tot</td></tr><tr><td>2</td><td>5</td><td>5</td><td>3</td><td>15</td></tr></table></td>
<td></td>
</tr>
<tr>
<td>3.Precise
Operation/Activity</td>
<td>A. Convert all measurements into single unit
B. Observing the readings on vernier scale and main scale of the thedolite.
C. Noting the readings in field book.
D. Calculating the horizontal angle.</td>
<td><table><tr><td>A</td><td>2</td></tr><tr><td>B</td><td>8</td></tr><tr><td>C</td><td>2</td></tr><tr><td>D</td><td>8</td></tr><tr><td>Tot</td><td>20</td></tr></table></td>
<td></td>
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<tr>
<td>4. Values</td>
<td>A. Co-operation
B. Co-ordination
C. Communication
D. Sharing
E. Leadership</td>
<td>5</td>
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<tr>
<td colspan="2">Total</td>
<td>50</td>
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</tr>
</table>

6. **ASSESSMENT QUESTIONS** (Only suggestive)

1. Note down the readings on main scale and vernier scale of the theodlite.
2. Tabulate observations in the field book.
3. Determine the horizontal angle between two accessible points.

7. VIVA QUESTIONS

(Only suggestive) The teacher may add questions depending upon the Context of examination

1. What is a horizontal angle?
2. what is transiting in a theodolite?
3. What are the uses of a theodolite?
4. How a theodolite can be levelled using foot screws?
5. What is the least count of vernier in the theodolite?

MEASUREMENT OF HORIZENTAL ANGLES BY REPETITION METHOD

OBJECTIVE

To Measure the horizontal angle by repetition method.

EQUIPMENT/APPARATUS/RESOURCES

1. Transit theodolite with tripod
2. Ranging rods
3. Arrows

TASK ANALYSIS

A.KNOWLEDGE

- Identifying the parts of Theodolite.
- Knowledge on operating the Theodolite.
- Measurement of horizontal angles.
- Reading the angles on both Vernier and main scales.
- Recording the angles on field book.

B.SKILLS

Category of Skill	Sub task
1. Handling of Apparatus	• Lifting the Theodolite from the box. • Fixing the instrument on tripod. • Removing the instrument from tripod. • Placing the Theodolite in to the box properly.
2. Manipulation of Apparatus	• Identifying the component parts of the Theodolite. • Making temporary adjustments. • Rotating eye piece to view cross hairs clearly. • Maintaining the verticality of the ranging rods over the stations. • Noting the readings on main scale & Vernier scale.
3. Precise operation /activity	• Centring the instrument over the given station. • .Levelling the bubble by adjusting the foot screws. • Bisecting the ranging rods accurately. • Calculating the angles from the observations.

2. TEACHING POINTS

S. No	Teaching points	Suggestive Duration (min.)
1.	Purpose of Repetition method.	2

2.	Explanation of set up the instrument and other tools on field	3
3.	Operation of theodolite for taking readings.	4
4.	Note down the readings in the field book.	2
5.	Calculation of readings.	4
6.	Precautions	
	A. Procedural precautions • Care should be taken while fixing the Theodolite on tripod. • Care should be taken while taking readings on main scale and Vernier scale. • Get the connections checked by the concerned staff member. • Care should be taken while placing the Theodolite in box properly.	
	B. Safety precautions • Ensure that should have to maintain the First aid kit and should have to wear Hat and Safety shoes.	
	Total	15

3. NEED AND SCOPE OF THE EXPERIMENT

This method is generally used for accurate and precise works. In this method the same angle is obtained by dividing the accumulated readings by the number of repetitions.

4. PLANNING AND ORGANIZATION

Action	Activity
Check for	1. Working condition of Theodolite. 2. Checking the telescope and cross hairs of Theodolite. 3. Checking the legs and screws of tripod. 4. Checking the bubble centring.
For design of Instruction	Read the teaching points carefully.

5. SCHEME OF EVALUATION

Category of skill	Sub Task	Weight with competency level individually	Awarded (50)
1. Handling of apparatus	A. Lifting the Theodolite from the box. B. Fixing the instrument on tripod. C. Removing the instrument from tripod. D. Placing the Theodolite in to the box properly	A: 2, B: 3, C: 2, D: 3, Tot: 10	

<table>
<tr>
<td>2.Manipulation of apparatus</td>
<td>A. Identifying the component parts of the Theodolite.
B. Making temporary adjustments.
C. Rotating eye piece to view cross hairs clearly.
D. Maintaining the verticality of the ranging rods over the stations.
E. Noting the readings on main scale & Vernier scale</td>
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<td></td>
</tr>
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<td>3.Precise Operation/Activity</td>
<td>A. Centring the instrument over the given station.
B. Levelling the bubble by adjusting the foot screws.
C. Bisecting the ranging rods accurately.
D. Calculating the angles from the observations.</td>
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B. Co-ordination
C. Communication
D. Sharing
E. Leadership</td>
<td><table><tr><td></td></tr><tr><td>5</td></tr></table></td>
<td></td>
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<tr>
<td colspan="2">Total</td>
<td>50</td>
<td></td>
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</table>

6. ASSESSMENT QUESTIONS (Only suggestive)

1. Tabulate observations made for the experiment.
2. Precision of measurement of horizontal angles by repetition.

7. VIVA QUESTIONS

(Only suggestive. The teacher may add questions depending upon the Context of examination)

1. What is the purpose of repetition method?
2. What is the least count of theodolite?
3. Define face left and face right of theodolite?
4. How to make bubble centre?

5. How to view cross hairs clearly?
6. How to bisect the ranging rods?

MEASUREMENT OF HORIZONTAL ANGLE USING THEODOLITE

OBJECTIVE

To perform the task of measuring the horizontal angle between two accessible points using theodolite.

EQUIPMENT/APPARATUS/RESOURSES

1. Theodolite
2. Ranging rods
3. pegs
4. Tripod stand
5. Plumb bob

1. TASK ANALYSIS

A. KNOWLEDGE

- Purpose of Theodolite Instrument
- Operating theodolite
- Transiting of telescope
- Set the vernier to zero
- Reading vernier and Main scale readings, Least count of vernier.
- Face left and face right of the theodolite
- Unit conversions
- Identifying the two accessible points.
- Purpose of plumb bob
- Temporary adjustments of theodolite.
- Fixing the theodolite to the tripod stand.

B.SKILLS

Category of Skill	Sub task
1. Handling of apparatus	• Using Ranging rods, fixing them at points A and B. • Using peg, fixing 'A' at point 'O'. • Setting up of theodolite. • Using plumb bob, making the instrument level. • Using Theodolite, taking the readings on both verniers. • For theodolite, performing temporary adjustments.
2.Manipulation of apparatus	• Focusing the telescope to the points 'A' and 'B'. • Bisecting the points 'A' and 'B' using tangent screw. • Checking for instrument level after rotation of telescope from 'A' to 'B'. • Noting down the readings of main scale and vernier scale from the instrument. • Changing the face of the telescope.

3. Precise operation /activity	• Convert all measurements into single unit. • Observing the readings on the vernier scale and main scale. • Noting the readings in the field book. • Calculating horizontal angle.

2. TEACHING POINTS

S. No.	Teaching points	Suggestive Duration (Min.)
1.	Description about Theodolite A. Purpose of theodolite B. Types of theodolites C. Components of theodolite D. Functions of components of theodolite E. Applications of theodolite F. Temporary adjustments of theodolite	8
2.	What is a horizontal angle? Methods to find the horizontal angle?	
3.	Readings on main scale and vernier scale of the Theodolite	
4.	Conversion of angles into minutes and seconds	2
5.	Tabulating the observed readings	5
6.	Calculating the horizontal angle	
7.	Precautions	

	A. Procedural precautions • Clamping and loosening the screws of the theodolite. • After rotating the telescope to 180^0, temporary adjustments must be checked. • Readings from the vernier should be taken carefully. **B. Safety measures** • Transporting the theodolite from lab to the field safely. • Lifting and placing of the theodolite from the box and in to the box gently. • Fixing of ranging rods in the ground safely.	
	Total	15

3. NEED AND SCOPE OF THE EXPERIMENT

Horizontal angle:

These angles are used to determine the bearings and directions in surveys and for setting out all types of structure.

Horizontal angle can also be measured using magnetic compass, but the theodolite is more precise than the magnetic compass. Magnetic compass measures the angle upto an accuracy of 30', but a theodolite can measure upto an accuracy of 20" or 10".

4. PLANNING AND ORGANIZATION

Action	Activity
Check for	1. Working condition of theodolite. 2. Working condition of ranging rods. 3. Working condition of plumb bob.
For design of Instructions	Read the teaching points carefully.

5. SCHEME OF EVALUATION

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(50)</th></tr>
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B. Checking for centering of instrument using plumb bob.
C. Making temporary adjustments of the instrument.</td><td><table><tr><td>A</td><td>2</td></tr><tr><td>B</td><td>3</td></tr><tr><td>C</td><td>5</td></tr><tr><td>Total</td><td>10</td></tr></table></td><td></td></tr>
<tr><td>2.Manipulation Of apparatus</td><td>A. Focusing the telescope to the points ‘A’ and ‘B’.
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6. ASSESSMENT QUESTIONS (Only suggestive)

1. Note down the readings on main scale and vernier scale of the theodlite.
2. Tabulate observations in the field book.
3. Determine the horizontal angle between two accessible points.

7. VIVA QUESTIONS

(Only suggestive) The teacher may add questions depending upon the Context of examination

1. What is a horizontal angle?
2. what is transiting in a theodolite?
3. What are the uses of a theodolite?
4. How a theodolite can be levelled using foot screws?
5. What is the least count of vernier in the theodolite?

MEASUREMENT OF HORIZENTAL ANGLES BY REPETITION METHOD

OBJECTIVE

To Measure the horizontal angle by repetition method.

EQUIPMENT/APPARATUS/RESOURCES

1. Transit theodolite with tripod
2. Ranging rods
3. Arrows

TASK ANALYSIS

A.KNOWLEDGE

- Identifying the parts of Theodolite.
- Knowledge on operating the Theodolite.
- Measurement of horizontal angles.
- Reading the angles on both Vernier and main scales.
- Recording the angles on field book.

B.SKILLS

Category of Skill	Sub task
1. Handling of Apparatus	• Lifting the Theodolite from the box. • Fixing the instrument on tripod. • Removing the instrument from tripod. • Placing the Theodolite in to the box properly.
2. Manipulation of Apparatus	• Identifying the component parts of the Theodolite. • Making temporary adjustments. • Rotating eye piece to view cross hairs clearly. • Maintaining the verticality of the ranging rods over the stations. • Noting the readings on main scale & Vernier scale.
3. Precise operation /activity	• Centring the instrument over the given station. • .Levelling the bubble by adjusting the foot screws. • Bisecting the ranging rods accurately. • Calculating the angles from the observations.

2. TEACHING POINTS

<table>
<tr><th>S. No</th><th>Teaching points</th><th>Suggestive Duration (min.)</th></tr>
<tr><td>1.</td><td>Purpose of Repetition method.</td><td>2</td></tr>
<tr><td>2.</td><td>Explanation of set up the instrument and other tools on field</td><td>3</td></tr>
<tr><td>3.</td><td>Operation of theodolite for taking readings.</td><td>4</td></tr>
<tr><td>4.</td><td>Note down the readings in the field book.</td><td>2</td></tr>
<tr><td>5.</td><td>Calculation of readings.</td><td rowspan="4">4</td></tr>
<tr><td>6.</td><td>Precautions</td></tr>
<tr><td></td><td>A. Procedural precautions
• Care should be taken while fixing the Theodolite on tripod.
• Care should be taken while taking readings on main scale and Vernier scale.
• Get the connections checked by the concerned staff member.
• Care should be taken while placing the Theodolite in box properly.</td></tr>
<tr><td></td><td>B. Safety precautions
• Ensure that should have to maintain the First aid kit and should have to wear Hat and Safety shoes.</td></tr>
<tr><td colspan="2" align="right">Total</td><td>15</td></tr>
</table>

3. NEED AND SCOPE OF THE EXPERIMENT

This method is generally used for accurate and precise works. In this method the same angle is obtained by dividing the accumulated readings by the number of repetitions.

4. PLANNING AND ORGANIZATION

Action	Activity
Check for	1. Working condition of Theodolite. 2. Checking the telescope and cross hairs of Theodolite. 3. Checking the legs and screws of tripod. 4. Checking the bubble centring.
For design of Instruction	Read the teaching points carefully.

5. SCHEME OF EVALUATION

<table>
<tr><th>Category of skill</th><th>Sub Task</th><th>Weight with competency level individually</th><th>Awarded
(50)</th></tr>
<tr><td>1. Handling of apparatus</td><td>A. Lifting the Theodolite from the box.
B. Fixing the instrument on tripod.
C. Removing the instrument from tripod.
D. Placing the Theodolite in to the box properly</td><td><table><tr><td>A</td><td>B</td><td>C</td><td>D</td><td>Tot</td></tr><tr><td>2</td><td>3</td><td>2</td><td>3</td><td>10</td></tr></table></td><td></td></tr>
<tr><td>2.Manipulation of apparatus</td><td>A. Identifying the component parts of the Theodolite.
B. Making temporary adjustments.
C. Rotating eye piece to view cross hairs clearly.
D. Maintaining the verticality of the ranging rods over the stations.
E. Noting the readings on main scale & Vernier scale</td><td><table><tr><td>A</td><td>B</td><td>C</td><td>D</td><td>E</td><td>Tot</td></tr><tr><td>3</td><td>5</td><td>2</td><td>5</td><td>5</td><td>20</td></tr></table></td><td></td></tr>
<tr><td>3.Precise Operation/Activity</td><td>A. Centring the instrument over the given station.
B. Levelling the bubble by adjusting the foot screws.
C. Bisecting the ranging rods accurately.
D. Calculating the angles from the observations.</td><td><table><tr><td>A</td><td>B</td><td>C</td><td>D</td><td>Tot</td></tr><tr><td>2</td><td>5</td><td>3</td><td>5</td><td>15</td></tr></table></td><td></td></tr>
<tr><td>4. Values</td><td>A. Co-operation
B. Co-ordination
C. Communication
D. Sharing
E. Leadership</td><td><table><tr><td></td></tr><tr><td>5</td></tr></table></td><td></td></tr>
<tr><td colspan="2">Total</td><td>50</td><td></td></tr>
</table>

6. ASSESSMENT QUESTIONS (Only suggestive)

1. Tabulate observations made for the experiment.
2. Precision of measurement of horizontal angles by repetition.

7. VIVA QUESTIONS

(Only suggestive. The teacher may add questions depending upon the Context of examination)

1. What is the purpose of repetition method?
2. What is the least count of theodolite?
3. Define face left and face right of theodolite?
4. How to make bubble centre?
5. How to view cross hairs clearly?
6. How to bisect the ranging rods?

MEASUREMENT OF HORIZONTAL ANGLE BY REITERATION METHOD

OBJECTIVE

To Measure the horizontal angle by Reiteration method.

EQUIPMENT/APPARATUS/RESOURCES

1. Transit theodolite with tripod
2. Ranging rods
3. Arrows

TASK ANALYSIS

A.KNOWLEDGE

- Identifying the parts of Theodolite.
- Knowledge on operating the Theodolite.
- Measurement of horizontal angles.
- Reading the angles on both Vernier and main scales.
- Recording the angles on field book.

B.SKILLS

Category of Skill	Sub task
1. Handling of Apparatus	• Lifting the Theodolite from the box. • Fixing the instrument on tripod. • Removing the instrument from tripod. • Placing the Theodolite in to the box properly.
2. Manipulation of Apparatus	• Identifying the component parts of the Theodolite. • Making temporary adjustments. • Rotating eye piece to view cross hairs clearly. • Maintaining the verticality of the ranging rods over the stations. • Noting the readings on main scale & Vernier scale.
3. Precise operation /activity	• Centring the instrument over the given station. • .Levelling the bubble by adjusting the foot screws. • Bisecting the ranging rods accurately. • Calculating the angles from the observations.

2. TEACHING POINTS

S. No	Teaching points	Suggestive Duration (min.)
1.	Purpose of Reiteration method.	2
2.	Explanation of set up the instrument and other tools on field	3
3.	Operation of theodolite for taking readings.	4
4.	Note down the readings in the field book.	2
5.	Calculation of readings.	4
6.	Precautions	
	A. Procedural precautions • Care should be taken while fixing the Theodolite on tripod. • Care should be taken while taking readings on main scale and Vernier scale. • Get the connections checked by the concerned staff member. • Care should be taken while placing the Theodolite in box properly.	
	B. Safety precautions • Ensure that should have to maintain the First aid kit and should have to wear Hat and Safety shoes.	
	Total	15

3. NEED AND SCOPE OF THE EXPERIMENT

This method is generally used for accurate and precise works. In this method Several angles are measured successively and finally the horizon is closed. Closing the horizon is the process of measuring the angles around a point to obtain a check on their sum which should be equal to 360^0.

4. PLANNING AND ORGANIZATION

Action	Activity
Check for	1. Working condition of Theodolite. 2. Checking the telescope and cross hairs of Theodolite. 3. Checking the legs and screws of tripod. 4. Checking the bubble centring.
For design of Instruction	Read the teaching points carefully.

5. SCHEME OF EVALUATION

<table>
<tr><th>Category of skill</th><th>Sub Task</th><th>Weight with competency level individually</th><th>Awarded
(50)</th></tr>
<tr><td>1. Handling of apparatus</td><td>A. Lifting the Theodolite from the box.
B. Fixing the instrument on tripod.
C. Removing the instrument from tripod.
D. Placing the Theodolite in to the box properly</td><td><table><tr><td>A</td><td>B</td><td>C</td><td>D</td><td>Tot</td></tr><tr><td>2</td><td>3</td><td>2</td><td>3</td><td>10</td></tr></table></td><td></td></tr>
<tr><td>2.Manipulation of apparatus</td><td>A. Identifying the component parts of the Theodolite.
B. Making temporary adjustments.
C. Rotating eye piece to view cross hairs clearly.
D. Maintaining the verticality of the ranging rods over the stations.
E. Noting the readings on main scale & Vernier scale</td><td><table><tr><td>A</td><td>B</td><td>C</td><td>D</td><td>E</td><td>Tot</td></tr><tr><td>3</td><td>5</td><td>2</td><td>5</td><td>5</td><td>20</td></tr></table></td><td></td></tr>
<tr><td>3.Precise Operation/Activity</td><td>A. Centring the instrument over the given station.
B. Levelling the bubble by adjusting the foot screws.
C. Bisecting the ranging rods accurately.
D. Calculating the angles from the observations.</td><td><table><tr><td>A</td><td>B</td><td>C</td><td>D</td><td>Tot</td></tr><tr><td>2</td><td>5</td><td>3</td><td>5</td><td>15</td></tr></table></td><td></td></tr>
<tr><td>4. Values</td><td>A. Co-operation
B. Co-ordination
C. Communication
D. Sharing
E. Leadership</td><td><table><tr><td></td></tr><tr><td>5</td></tr></table></td><td></td></tr>
<tr><td colspan="2">Total</td><td>50</td><td></td></tr>
</table>

6. **ASSESSMENT QUESTIONS** (Only suggestive)

1. Tabulate observations made for the experiment.
2. Precision of measurement of horizontal angles by reiteraition.

7. VIVA QUESTIONS

(Few questions were given here. The teacher may add questions depending upon the Context of examination)

1. What is the purpose of reiteration method?
2. What is the least count of theodolite?
3. Define face left and face right of theodolite?
4. How to make bubble centre?
5. How to view cross hairs clearly?
6. How to bisect the ranging rods?

MEASUREMENT OF VERTICAL ANGLES

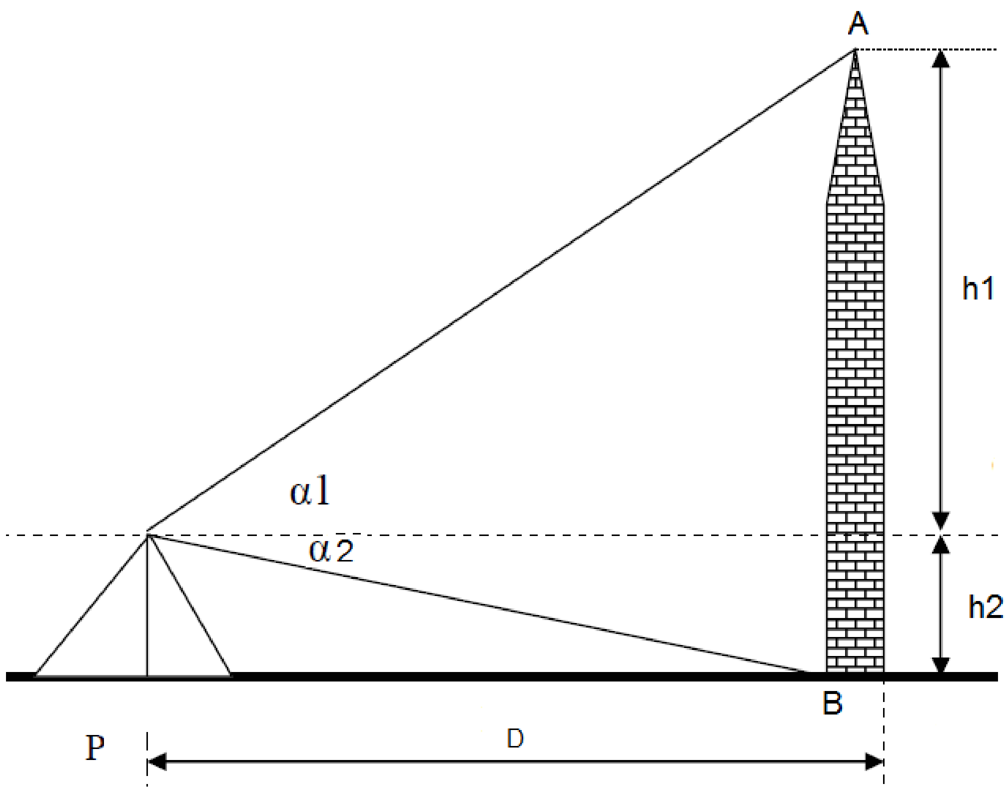
A) OBJECTIVE:

Perform the set of tasks in determining the height of an object by measuring vertical angles.

B) PROCEDURE

1) Set up the tripod, and theodolite at a convenient point nearer to the object whose height is to be determine
2) Perform the temporary adjustments, and eliminate the parallax
3) Using the tape or chain measure the distance between theodolite and the object
4) Set the zero reading in C and D verniers for face left observation
5) Measure the angle of elevation by pointing the telescope to the top of the object
6) Set the zero reading in C and D verniers for face left observation
7) Measure the angle of depression by pointing the telescope to the top of the object
8) Set the zero reading in C and D verniers for face right observation
9) Measure the angle of elevation by pointing the telescope to the top of the object
10) Set the zero reading in C and D verniers for face right observation
11) Measure the angle of depression by pointing the telescope to the top of the object

C) SKETCH:



D) OBSERVATIONS AND TABULATIONS:

Distance between Theodolite and Object D = 20.20 mts

S. No.	Inst. Station	Sight to	Face of observation	Vernier C ° ' "	Vernier D ° ' "	Mean of C & D Angle ° ' "	Average Vertical Angle ° ' "	Remarks
1	P	A	Left	28°10' 20"	0°10' 00"	28°10' 15"	28°10' 22.5"	Angle of Elevation (+α1)
2	P	A	Right	28°10' 20"	0°10' 40"	28°10' 30"		Angle of Elevation (+α1)
3	P	B	Left	18°10' 40"	0°10' 20"	18°10' 30"	18°10' 27.5"	Angle of Depression (-α2)
4	P	B	Right	18°10' 20"	0°10' 10"	18°10' 25"		Angle of Depression (-α2)

E) SPECIMEN CALCULATION:

Distance between Theodolite and Object D = 20.2 m

Calculate the height h1 = D X tan α1 = 20.2 X tan 28°10' 22.5" = 10.818 m

Calculate the height h2 = D X tan α2 = 20.2 X tan 18°10' 27.5" = 6.631 m

Calculate the height of the object 'AB' = (h1 + h2) m

= (10.818 + 6.631) m

= 17.449 m

F) RESULT:

Average Angle of elevation = 28°10' 22.5"

Average angle of depression = 18°10' 27.5"

Height of the object AB = 17.449 m

G) INFERENCE:

PROLONG A GIVEN SURVEY LINE BY DOUBLE TRANSITING METHOD

OBJECTIVE :

To perform prolonging of a given survey line by double transiting method.

EQUIPMENT/APPARATUS/RESOURSES:

1. Theodolite,
2. Tripod,
3. Plumb bob,
4. Ranging rods,
5. Tape

1. TASK ANALYSIS

A. KNOWLEDGE

- Level the tripod
- Lifting the tripod from box
- Fixing of Theodolite on tripod
- Identifying parts of theodolite
- Centering theodolite
- Levelling the bubble tube
- Reading the vernier scale and main scale reading
- Focusing telescope
- Exactly bisecting the object

B.SKILLS

Category of Skill	Sub task
1. Handling of apparatus	A. Lifting the instrument from box B. Fixing the tripod over station C. Fixing theodolite on tripod D. Approximate leveling of tripod with legs
2.Manipulation of apparatus	• Centering by using plumb bob • Operating clamp screws and tangential screws • Swinging the instrument
3. Precise operation /activity	• Centering the instrument • Levelling the instrument by operating foot screws • Focusing telescope by operating focusing screw • Transiting the theodolite by operating clamp screws • Fixing of ranging rods on newly established stations.

2. TEACHING POINTS

S. No.	Teaching points	Suggestive Duration (Min.)
1.	Fixing of the instrument	5
2.	Centering the instrument	
3.	Levelling the instrument	
4.	Focusing telescope	
5.	Operating clamp screws to tighten the lower and upper plates	4
6.	Swinging and transiting the instrument	6
7.	Fixing ranging rods	
8.	Precautions	
	A. Procedural precautions • Care should be taken while lifting the instrument • Care should be taken while fixing the instrument • Proper care should be taken while operating clamp screws • care should be taken while focusing • Proper care should be taken in fixing the rods on survey line. • Precautions for taking care of instrument while changing the instrument station.	
	Total	15

3. NEED AND SCOPE OF THE EXPERIMENT

This experimental procedure will be helpful when chaining is not applicable due to site conditions. With this method we can complete the prolonging of a given survey line fastly and with accuracy.

4. PLANNING AND ORGANIZATION

Action	Activity
Check for	1. Working condition of theodolite and tripod. 2. Functioning of clamps. 3. Fixing of lower plate and upper plate by clamp screws 4. Temporary adjustments 5. Exact focusing of object 6. Fixing of rods on new point along survey line 7. Precautions for taking care of instrument while changing the instrument station.
For design of Instruction	Read the teaching points carefully.

5. SCHEME OF EVALUATION:

Category of skill	Sub Task	Weight with competency level individually	Awarded (50)
1. Handling of apparatus	A. Lifting the instrument from box B. Fixing the tripod over station C. Fixing theodolite on tripod D. Approximate leveling of tripod with legs	A 1 B 1 C 1 D 2 Total 5	
2.Manipulation Of apparatus	A. Centering by using plumb bob B. Operating clamp screws and tangential screws C. Swinging the instrument	A B C Tot 2 5 3 10	
3.Precise Operation/Activity	A. Centering the instrument B. Levelling the instrument by operating foot screws C. Focusing telescope by operating focusing screw D. Transiting the theodolite by operating clamp screws E. Fixing of ranging rods on newly established stations.	A 5 B 5 C 5 D 10 E 5 Tot 30	

4. Values	A. Co-operation B. Co-ordination C. Communication D. Sharing E. Leadership	5	
Total		50	

6. ASSESSMENT QUESTIONS(Only suggestive)

1. Describe the Operation of foot screws for levelling
2. Explain the precautions to be taken while shifting the instrument.
3. Explain Transiting from face left to face right

LABORATORY SHEET 3.

Prolong a given survey line by double transiting method

7. VIVA QUESTIONS

(Only suggestive) The teacher may add questions depending upon the Context of examination

1. Purpose of theodolite?
2. What is the principle of theodolite?
3. What is double transiting method?
4. What is transiting?
5. What is swinging?
6. Which Plate is fixed to not to change the readings?
7. What is swinging?
8. What is face left?
9. What is face right?
10. Which screw is operated to focus the telescope?

DETERMINATION OF HORIZONTAL DISTANCE BETWEEN TWO INACCESSIBLE POINTS BY USING THEODOLITE

OBJECTIVE

To Perform Theodolite surveying to determine the horizontal distance between two inaccessible points.

EQUIPMENT/APPARATUS/RESOURSES

1. Theodolite,
2. Ranging rod,
3. Pegs,
4. Tape,
5. Plumb-bob

1. TASK ANALYSIS

A. KNOWLEDGE

- Setting up of tripod.
- Proper using of plumb-bob.
- Centering the theodolite over the instrument station.
- Levelling the theodolite/centering of bubble.
- Focusing the eye piece.
- Focusing the object.
- Releasing of clamps to rotate the telescope.
- Reading the horizontal plate angles in theodolite.
- Measuring the horizontal distance using tape.

B.SKILLS

Category of Skill	Sub task
1. Handling of apparatus	• Using tape to measure the horizontal distance. • Using plumb bob to centering the theodolite • Adjusting tripod legs to required line of sight • Rotating foot screws to levelling the theodolite • Eliminating parallax error by focusing.
2.Manipulation of apparatus	• Maintaining Centre of the bubble tube of the theodolite • Releasing of clamps to rotate the telescope • Setting horizontal plate angle to zero
3. Precise operation /activity	• Convert all measurements into single unit • Noting down the horizontal angle accurately • Drawing plot in proto type. • Applying sine and cosine rules. • Calculating the horizontal distance.

C.TEACHING POINTS

S. No.	Teaching points	Suggestive Duration (Min.)
1.	Description about theodolite A. Importance of theodolite B. Types of theodolite C. Uses of theodolite	5
2.	Selecting the stations to measure angles	
3.	Setting up of theodolite and making temporary adjustments	
4.	Releasing of clamps to rotate the telescope	4
5.	Measuring horizontal angle in theodolite	6
6.	Calculating horizontal distance by applying sine and cosine rules	
7.	Precautions	
	A. Procedural precautions • Care should be taken in releasing clamps. • Horizontal angle should be noted very carefully and accurately. Proper care should be taken in applying sine and cosine rules to triangles to calculating horizontal distance.	
	Total	15

3. NEED AND SCOPE OF THE EXPERIMENT

The horizontal distance between two inaccessible points cannot be measured directly.by using compass we can measure but it should be limited.so to get the accurate results we will use theodolite to measure the horizontal distance between two inaccessible points.

Suppose that you can measure the distance between A and B and the angles from A and B to two inaccessible points P and For example, A and B might be on a straight road in a valley and P and Q might be two visible mountain peaks. Then you can calculate the distance between C and D using the law of sines and cosines.

4. PLANNING AND ORGANIZATION

Action	Activity
Check for	1. Working condition of tripod. 2. Functioning of theodolite. 3. Centering of theodolite. 4. Levelling of theodolite. 5. Elimination of parallax.

5. SCHEME OF EVALUATION

<table>
<tr><th>Category of skill</th><th>Sub Task</th><th>Weight with competency level individually</th><th>Awarded
(50)</th></tr>
<tr><td>1. Handling of apparatus</td><td>A. Using tape to measure the horizontal distance.
B. Using plumb bob to centering the theodolite.
C. Adjusting tripod legs to required line of sight.
D. Rotating foot screws to levelling the theodolite.
E. Eliminating parallax error by focusing.</td><td><table><tr><td>A</td><td>1</td></tr><tr><td>B</td><td>3</td></tr><tr><td>C</td><td>3</td></tr><tr><td>D</td><td>2</td></tr><tr><td>E</td><td>1</td></tr><tr><td>Total</td><td>10</td></tr></table></td><td></td></tr>
<tr><td>2.Manipulation of apparatus</td><td>A. Maintaining Centre of the bubble tube of the theodolite.
B. Releasing of clamps to rotate the telescope.
C. Setting horizontal plate angle to zero.</td><td><table><tr><td>A</td><td>B</td><td>C</td><td>Tot</td></tr><tr><td>5</td><td>5</td><td>5</td><td>15</td></tr></table></td><td></td></tr>
<tr><td>3.Precise Operation/Activity</td><td>A. Convert all measurements into single unit
B. Noting down the horizontal angle accurately
C. Drawing plot in proto type.
D. Applying sine and cosine rules.
E. Calculating the horizontal distance.</td><td><table><tr><td>A</td><td>2</td></tr><tr><td>B</td><td>5</td></tr><tr><td>C</td><td>5</td></tr><tr><td>D</td><td>3</td></tr><tr><td>E</td><td>5</td></tr><tr><td>Total</td><td>20</td></tr></table></td><td></td></tr>
<tr><td>4. Values</td><td>A. Co-operation
B. Co-ordination
C. Communication
D. Sharing
E. Leadership</td><td><table><tr><td></td></tr><tr><td>5</td></tr></table></td><td></td></tr>
<tr><td colspan="2">Total</td><td>50</td><td></td></tr>
</table>

6. ASSESSMENT QUESTIONS (Only suggestive)

1. Note down horizontal angle plate readings accurately.
2. Drawing the plot in rough and applying the sine and cosine rules to triangles.
3. Calculating the inaccessible horizontal distance.

7. VIVA QUESTIONS

(Only suggestive. The teacher may add questions depending upon the Context of examination)

1. What are the uses of a theodolite?
2. Why a type of theodolite is called a transit theodolite?
3. What are the temporary adjustments of a theodolite?
4. Name different types of theodolite.
5. What are the fundamental parts of a theodolite?
6. What is the difference between level and theodolite?
7. What is meant by size of a theodolite? What's it?
8. What is face left, face right observation in a theodolite?

Measurement Of Magnetic Bearing Of Survey Line

OBJECTIVE

To perform the measurement of magnetic bearing of survey line

EQUIPMENTS/INSTRUMENTS/RESOURSES

1. Vernier transit Theodolite(20”)-01No
2. Measuring Tape (30m)-01No
3. Ranging rods (3m)-02Nos,
4. Arrows(40cm)-01Nos
5. Pegs -02 Nos,

1. TASK ANALYSIS

A. KNOWLEDGE

- Component parts of theodolite
- Component parts of trough compass
- Centering the theodolite
- Temporary adjustments of theodolite
- Use of ranging rod
- Reading the horizontal angle in theodolite
- Plotting the survey line
-

B.SKILLS

Category of Skill	Sub task
1. Handling of Instruments	• Pick the theodolite from box • Fixing the theodolite on tripod • Releasing lockingnob of trough compass • Erecting the pegs on survey line
2.Manipulation of Instruments	• Setting up of theodolite over the tripod • Approximate levelling by the tripod • Centering of instrument over a station • Levelling the theodolite • Focussing the eye piece • Focussing the the objective • Fixing the trough compass to the theodolite • Loosen the lower clamp and trough compass needle and swing the telescope until magnetic needle on N-S graduation on trough compass
3. Precise operation /activity	• Average Reading on vernier A and Veriner B • Magnetic bearing should be read on both the face (face left and face right) • Compare and average both face left and face right observations.

LABORATORY SHEET 4.9 a

Measure the bearing of survey line

2. TEACHING POINTS

S. No.	Teaching points	Suggestive Duration (Min.)
1.	Component parts of theodolite	
2.	Temporary adjustments of theodolite • Approximate levelling by the tripod • Centering of instrument over a station • Levelling the theodolite • Focussing the eye piece • Focussing the the objective	5
3.	Fixing the trough compass to the theodolite	
4.	Reading the vernier scale readings	4
5.	Recording the observations table form	
6.	Average the face left and face right observations	
7.	Precautions	
	A. Procedural precautions • Care should be taken in operating clamping screws. • Booking observation carefully • Care should be taken while placing the instrument in box	6
	Total	15

3. NEED AND SCOPE OF THE EXPERIMENT

Theodolite

- So far we have been measuring horizontal angles by using a Compass with respect to meridian, which is less accurate and also it is not possible to measure vertical angles with a Compass.
- So when the objects are at a considerable distance or situated at a considerable elevation or depression ,it becomes necessary to measure horizontal and vertical angles more precisely. So these measurements are taken by an instrument known as a theodolite**.**

Trough compass

- The trough compass is used for marking the magnetic north line on the drawing sheet of the plane table. In this case, the magnetic needle point to 0° - 0° of the graduated scale and a line drawn parallel to the edge of the trough compass is along the magnetic meridian.

Bearing of survey line

- The **bearing** of a point is the number of degrees in the angle measured in a clockwise direction from the north **line** to the **line** joining the centre of the compass with the point. A **bearing** is used to represent the direction of one point relative to another point

4. PLANNING AND ORGANIZATION

Action	Activity
Check for	1. Field conditions 2. Physical condition of ranging rods 3. Working condition of theodolite 4. Presence of objects causing local attraction
For design of Instruction	Read the teaching points carefully.

LABOATORY SHEET 4.9

Measure the bearing of survey line

5. SCHEME OF EVALUATION

<table>
<tr><th>Category of skill</th><th>Sub Task</th><th>Weight with competency level individually</th><th>Awarded

(50)</th></tr>
<tr><td>1. Handling of apparatus</td><td>A. Pick the theodolite from box
B. Fixing the theodolite on tripod
C. Releasing lockingnob of trough compass
D. Erecting the pegs on survey line</td><td><table><tr><td>A</td><td>1</td></tr><tr><td>B</td><td>2</td></tr><tr><td>C</td><td>1</td></tr><tr><td>D</td><td>1</td></tr><tr><td>Total</td><td>5</td></tr></table></td><td></td></tr>
<tr><td>2.Manipulation Of apparatus</td><td>A. Setting up of theodolite over the tripod
B. Approximate levelling by the tripod
C. Centering of instrument over a station
D. Levelling the theodolite
E. Focussing the eye piece
F. Focussing the the objective
G. Fixing the trough compass to the theodolite
H. Loosen the lower clamp and trough compass needle and swing the telescope until magnetic needle on N-S graduation on trough compass</td><td><table><tr><td>A</td><td>3</td></tr><tr><td>B</td><td>3</td></tr><tr><td>C</td><td>6</td></tr><tr><td>D</td><td>6</td></tr><tr><td>E</td><td>2</td></tr><tr><td>F</td><td>2</td></tr><tr><td>G</td><td>3</td></tr><tr><td>H</td><td>5</td></tr><tr><td>Total</td><td>30</td></tr></table></td><td></td></tr>
<tr><td>3.Precise Operation/Activity</td><td>A. Average Reading on vernier A and Veriner B
B. Magnetic bearing should be read on both the face (face left and face right)
C. Compare and average both face left and face right observations</td><td><table><tr><td>A</td><td>5</td></tr><tr><td>B</td><td>2</td></tr><tr><td>C</td><td>3</td></tr><tr><td>Total</td><td>10</td></tr></table></td><td></td></tr>
</table>

4. Values	A. Co-operation B. Co-ordination C. Communication D. Sharing E. Leadership	5	
Total		50	

LABORATORY SHEET 4.9

Measure the bearing of survey line

6. ASSESSMENT QUESTIONS (Only suggestive)

1. Identify the component parts of theodolite.
2. Establish the survey line on the field and measure the magnetic bearing of survey line.
3. Note down the observation in standard format

7. VIVA QUESTIONS

(Only suggestive) The teacher may add questions depending upon the Context of examination

1. What is the use of trough compass
2. Difference between true bearing and magnetic bearing
3. How to orient telescope to north direction
4. How to read vernier readings
5. What is the use of vernier A and vernier B
6. What is centering of instrument

Perform the task of theodolite traversing (closed), to Compute latitudes and departures, and the area of closed traverse.

OBJECTIVE

Perform the task of theodolite traversing (closed), to Compute latitudes and departures, and the area of closed traverse.

EQUIPMENT/APPARATUS/RESOURSES

1. Theodolite 1 no.,
2. Magnetic compasss 01 no.,
3. Pegs (suitable nos)
4. Plumb Bob 01 no.,
5. Tripod stand 01 no.,
6. Ranging rods (minimum 3nos)
7. Measuring tape 01 no

1. TASK ANALYSIS:

A. KNOWLEDGE

- *Lifting the Theodolite from Box / case*,
- *Fixing the Theodolite to Tripod*,
- *Fixing the Tripod on ground*,
- *Hold/fix the ranging staff*,
- *Leveling the instrument*
- *Focusing the Objective Lens*,
- *Focusing the Eye-piece*,
- *Bisect the ranging rod through* Theodolite
- *Observing the horizontal vernier readings*
- *Noting the (observed) reading (mean reading) in work sheet*,
- *Measuring the distance between given (two) points*,

B. SKILLS:

Category of Skill	Sub task
1. Handling of apparatus	• Fixing the Tripod on ground. • Lifting the theodolite from Box / case. • Fixing the theodolite to Tripod. • Fitting magnetic compass to theodolite • Measuring linear measurements • Hold/fix the ranging rods • Measuring horizontal angle (magnetic bearing)
2.Manipulation of apparatus	• Observing the reading of horizontal main scale and vernier readings through theodolite. • Measuring the distance between given (two) points.

3. Precise operation /activity	• Focusing the Objective Lens. • Focusing the Eye-piece. • Leveling the instrument • Noting the (observed) reading (magnetic bearing) in work sheet

LABORATORY SHEET 4,10

Perform the task of theodolite traversing (closed), to Compute latitudes and departures, and the area of closed traverse.

2. TEACHING POINTS

S. No.	Teaching points	Suggestive Duration (Min.)
1.	Description about Theodolite A. Importance of Theodolite	1
	B. Parts Theodolite	1
	C. Applications of Theodolite	1
2.	What is traversing, methods of traversing and importance of theodolite traversing	1
3.	observation and recording of readings of linear measurements and magnetic bearing in field book	1
4.	How to check the closure error in traverse	1
5.	How to balance the traverse by bow ditch method	3
6.	How to calculate area of closed traverse by co-ordinates method	3
7.	Precautions	

	A. Procedural precautions • Care should be taken in operating the objective and eye piece of Theodolite. • Care should be taken to avoids local attraction due to magnetic compass. • Exact bisecting of the ranging rods by using horizontal screws • Properly measure the distance between the given two points without sag, bends, etc. • Care should be taken while taking main scale readings in Vernier A and Vernier coincidence in Vernier B • Checking the lower and upper clamp screws while taking readings without any slippage	3
	Total	15

LABORATORY SHEET 4,10

Perform the task of theodolite traversing (closed), to Compute latitudes and departures, and the area of closed traverse.

2. NEED AND SCOPE OF THE EXPERIMENT

It is a convenient ,rapid method for establishing horizontal control particularly when the line of sight are short due to heavily built up areas where triangulation are not applicable.

The purpose include:

1. Property surveys to locate or establish boundaries
2. Supplementary horizontal control for topographic mapping surveys
3. Location and construction layout surveys

4. PLANNING AND ORGANIZATION

Action	Activity
Check for	1. Working condition of Theodolite. 2. Tripod Legs 3. Magnetic compass working conditions
For design of Instruction	Read the teaching points carefully.

Perform the task of theodolite traversing (closed), to Compute latitudes and departures, and the area of closed traverse.

5. SCHEME OF EVALUATION

Category of skill	Sub Task	Weight with competency level individually	Awarded (50)
1. Handling of apparatus	A. Fixing the Tripod on ground. B. Lifting the Theodolite Level from Box / case. C. Fixing the Theodolite to Tripod and magnetic compass to theodolite D. Hold/fix the ranging rod	A 1 B 2 C 4 D 3 Total 10	
2.Manipulation Of apparatus	A. Observing the reading from verniers through Theodolite B. Measuring the distance between given (two) points C. Exact bisection of object (ranging rod) using horizontal focusing screws	A 1 B 1 C 3 Total 10	
3.Precise Operation / Activity	A. Focusing the Objective Lens B. Focusing the Eye-piece C. Leveling the instrument D. Measuring the linear distances. E. Observing the horizontal plate main scale readings and Vernier scale readings F. Fitting magnetic compass , fixing ranging rods , pegs . To form closed traverse	A 3 B 3 C 5 D 4 E 5 F 5 Total 25	
4. Values	A. Co-operation B. Co-ordination C. Communication D. Sharing E. Leadership	A 1 B 1 C 1 D 1 E 1 Total 5	
	Total	50	

Perform the task of theodolite traversing (closed), to Compute latitudes and departures, and the area of closed traverse.

6. ASSESSMENT QUESTIONS (suggestive only)

(this is for Formative Assessment only)

1. What is theodolite traversing?
2. What is the necessity of theodolite traversing?
3. How to calculate the magnitude and direction of error of closure?
4. What are the various methods of traversing ?
5. What are methods of balance the traversing?
6. What are methods to calculate the area of closed traverse?
7. How to calculate area of closed traverse by co-ordinate method?
8. What are independent co-ordinates?
9. How to balance the traverse by using bow ditch rule?

7. VIVA QUESTIONS (suggestive only)

(this is for Summative Assessment)

The teacher may add questions depending upon the Context of examination

1. What is traversing?
2. Define traverse?
3. What is the necessity of theodolite traversing?
4. State the temporary adjustments of theodolite?
5. What are methods of traversing?
6. List types of traverse?
7. What is error of closure?
8. What the various methods of balancing the traverse?
9. What are methods to calculate area of closed traverse?
10. What is the meant by face left and face right observation
11. What is meant by latitude and departure?
12. What is total departure?

DETERMINATION OF HORIZONTAL AND VERTICAL DISTANCE OF AN OBJECT WHOSE BASE IS ACCESSIBLE

OBJECTIVE

To Determine the Horizontal and Vertical Distance of an object whose base is accessible

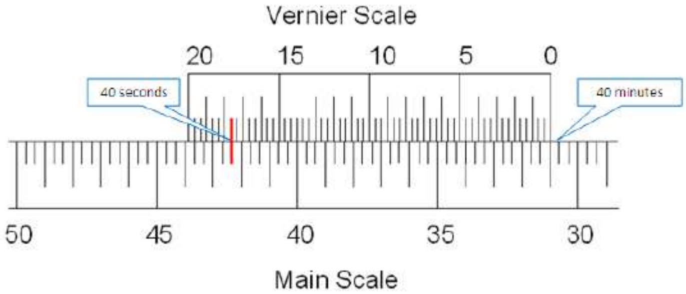
EQUIPMENT/APPARATUS/RESOURSES

1. Transit Theodolite
2. Tripod
3. Plumb bob
4. Tape
5. Leveling Staff
6. Pegs.

1. TASK ANALYSIS

A. KNOWLEDGE

- Fixing Theodolite to tripod
- Leveling the instrument
- Elimination of Paralax
    - Focusing the Eye piece
    - Focusing the object
- Bisecting the point with cross hairs
- Reading the Main scale and Vernier scale
- Transiting theodolite



	°	'	"
Main Scale	30	40	
Vernier Scale		17	40
Reading	**30**	**57**	**40**

B.SKILLS

Category of Skill	Sub task
1. Handling of Instrument	**1. SETTING UP:** • Centering a theodolite over a station • Moving tripod legs radially or circumferentially. **2. LEVELING UP:** • Levelling the instrument accurately with the help of foot screws **3. ELIMINATION OF PARALLAX:** • Focussing the eye-piece • Focussing the object
2.Manipulation of apparatus	• Reading the Main scale and vernier scale • Operating Lower clamp screw and tangent screw • Operating upper clamp and tangent screw • Transiting the Telescope • Swinging the Telescope
3. Precise operation /activity	• Entering the face left and face right readings in tabular form • Calculating average vertical angle • Calculating vertical distance

	• Calculating RL of top and bottom of an object

2. TEACHING POINTS

S. No.	Teaching points	Suggestive Duration (Min.)
1.	Description about Theodolite A. Setting up and leveling the instrument B. Importance of Horizontal Angles and vertical angles C. Applications of angles	5
2.	How to set up the instrument over a station	
3.	Leveling the instrument using foot screws	
4.	Face left and face right operations	6
5.	Reading the main scale and vernier scale and measuring the angle	
6.	Calculating horizontal distance and vertical distance	
7.	Calculating RL of top and bottom of an object	
8.	Precautions	4
	A. Procedural precautions • Care should be taken in while fixing the instrument over tripod • Reading of main scale and vernier scale without Parallax error • Proper Care should be taken while Transiting and swinging the telescope • Proper care should be taken in calculating average angles and calculating the horizontal and vertical distances.	
	Total	15

3. NEED AND SCOPE OF THE EXPERIMENT

HORIZONTAL AND VERTICAL DISTANCES:

This method is useful for determining the horizontal distances, heights of buildings, towers etc. and RLs of top and bottom of buildings towers etc., accurately.

4. PLANNING AND ORGANIZATION

Action	Activity
Check for	1. Working condition of Theodolite, tripod and leveling staff. 2. Functioning of foot screws of Theodolote. 3. Functioning of Bubble tube, eye piece and focusing screw.
For design of Instruction	Read the teaching points carefully.

5. SCHEME OF EVALUATION

<table>
<tr><th>Category of skill</th><th>Sub Task</th><th>Weight with competency level individually</th><th>Awarded

(50)</th></tr>
<tr><td>1. Handling of apparatus</td><td>A. Fixing the Theodolite over a tripod
B. Centering a theodolite over a station
C. Levelling the instrument accurately with the help of foot screws
D. D.Focussing the eye-piece
E. Focussing the object</td><td><table><tr><td>A</td><td>1</td></tr><tr><td>B</td><td>2</td></tr><tr><td>C</td><td>4</td></tr><tr><td>D</td><td>2</td></tr><tr><td>E</td><td>1</td></tr><tr><td>Total</td><td>10</td></tr></table></td><td></td></tr>
<tr><td>2.Manipulation Of apparatus</td><td>A. Reading the Main scale and vernier scale
B. Operating Lower clamp screw and tangent screw and upper clamp and tangent screw
C. Transiting and Swinging the Telescope</td><td><table><tr><td>A</td><td>B</td><td>C</td><td>Tot</td></tr><tr><td>5</td><td>5</td><td>5</td><td>15</td></tr></table></td><td></td></tr>
<tr><td>3.Precise Operation/Activity</td><td>A. Entering the face left and face right readings in tabular form
B. Calculating the average horizontal angle
C. Calculating horizontal distance
D. Calculating vertical distance
E. Calculating RL</td><td><table><tr><td>A</td><td>6</td></tr><tr><td>B</td><td>4</td></tr><tr><td>C</td><td>4</td></tr><tr><td>D</td><td>3</td></tr><tr><td>E</td><td>3</td></tr><tr><td>Tot</td><td>20</td></tr></table></td><td></td></tr>
<tr><td>4. Values</td><td>A. Co-operation
B. Co-ordination
C. Communication
D. Sharing
E. Leadership</td><td>5</td><td></td></tr>
<tr><td colspan="2">Total</td><td>50</td><td></td></tr>
</table>

6. ASSESSMENT QUESTIONS (Only suggestive)

1. Note down the face left and face right readings in tabular form
2. Enter Vertical angles and Calculate the average vertical angle
3. Determine vertical distance and RL of the top and bottom of the object.

7. VIVA QUESTIONS

(Only suggestive) The teacher may add questions depending upon the Context of examination

1. What are the temporary adjustments of theodolite?
2. Why both Verniers are read in theodolite?
3. What is the purpose of using theodolite primarily?
4. What is transiting in theodolite surveying?
5. What is swinging in theodolite surveying?
6. What is the principle of theodolite?
7. Where are the cross hairs in the telescope placed?
8. What happens to the sensitivity of bubble tube if the temperature increases?
9. What is the least count of vernier of transit theodolote?
10. For survey in India which is MSL ?

DETERMINATION OF HORIZONTAL AND VERTICAL DISTANCE OF AN OBJECT WHOSE BASE IS INACCESSIBLE WHEN THE TWO INSTRUMENT STATIONS AND THE OBJECT ARE IN THE SAME VERTICAL PLANE.

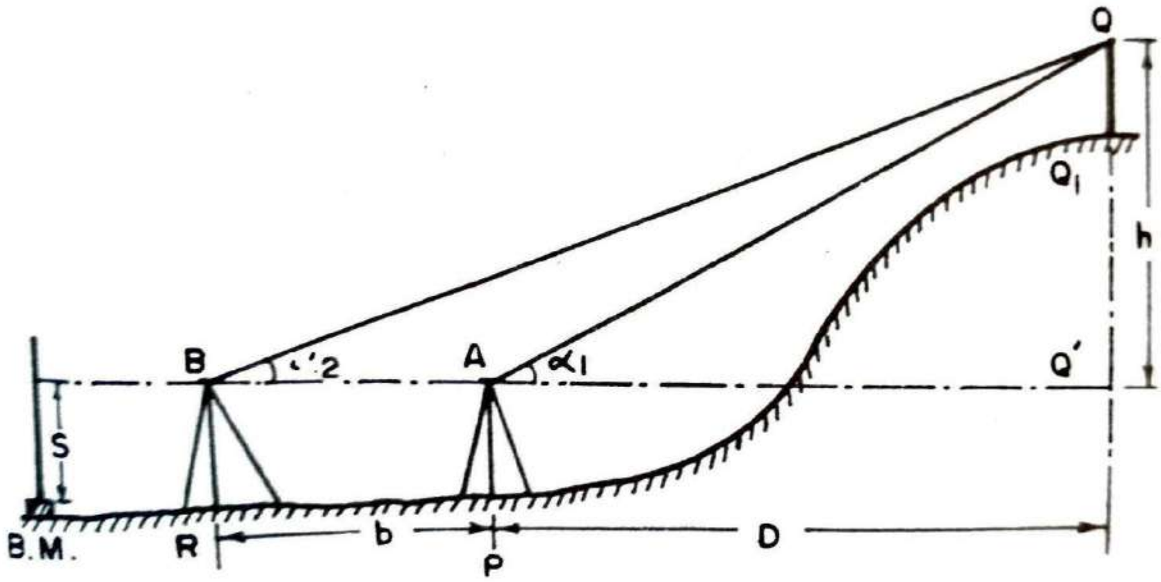
OBJECTIVE:

To perform the set of tasks in order to determine the horizontal and vertical distance of an object whose base is inaccessible when the two instrument stations and the object are in the same vertical plane.

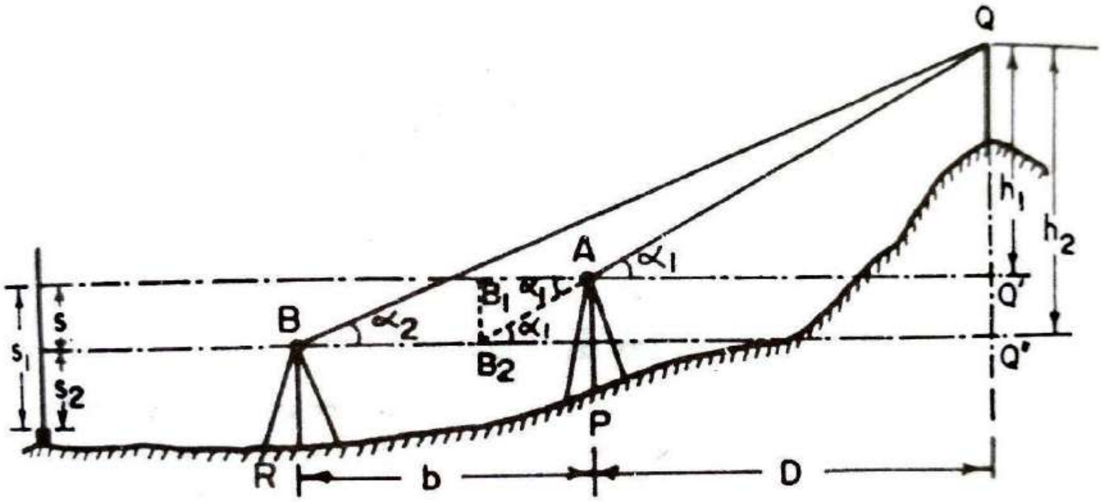
EQUIPMENT/APPARATUS/RESOURSES:

1. Theodolite
2. Tripod
3. Plumb bob
4. Ranging rod
5. Tape (or) chain
6. Wooden pegs (or) arrows
7. Levelling staff

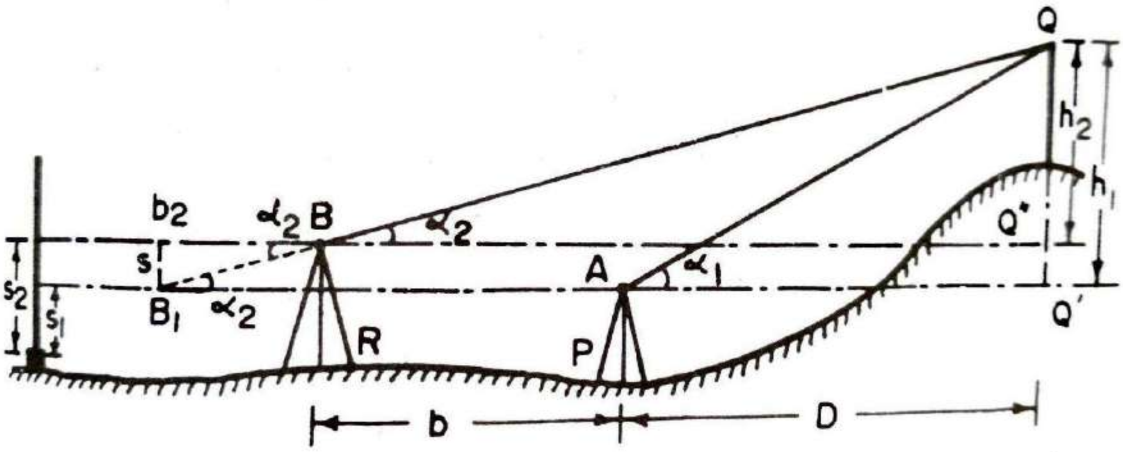
FIELD SKETCH:



a) Instrument axes at the same level



b) Instrument axes at the different level with instrument axis at A is higher



c) Instrument axes at the different level with instrument axis at B is higher

1. TASK ANALYSIS:

A. KNOWLEDGE:

- Component parts of the theodolite.
- Uses of theodolite.
- Temporary adjustments of theodolite.
- Terms such as transiting, swinging, Face left and Face right.
- Bench mark.
- Back sight reading

- Observation of readings on levelling staff.
- Basic principles of trigonometry.

B.SKILLS

CATEGORY OF SKILL	SUB TASK
Handling of apparatus	A. Identifying the convenient point and pressing the tripod legs into the ground firmly. B. Lifting the theodolite from the instrument box properly. C. Fixing the theodolite over the tripod head using screws. D. Removing the theodolite from the tripod head using screws. E. Keeping the theodolite in the instrument box in correct position. F. Carrying the ranging rods properly. G. Holding the levelling staff vertically. H. Holding the chain (or) tape in correct position while measuring the distances.
Manipulation of apparatus	**Temporary adjustments:** A. Centering the theodolite over the station mark using plumb bob and by moving tripod legs radially as well as circumferentially. B. Swinging the telescope such that plate level is parallel as well as perpendicular to the line joining the pair of levelling screws. C. Bringing the bubble to the centre of its run by turning the levelling screws uniformly. D. Setting the zero of the vertical vernier exactly to the zero of the vertical circle by means of the vertical clamp screw and tangent screw. E. Swinging the telescope such that altitude level is parallel to the line joining the pair of levelling screws. F. Bringing the bubble to the centre of its run by turning the levelling screws uniformly. G. Turning the telescope through 90^0 by unclamping the vernier plate. H. Bringing the bubble to the centre of its run by turning the third levelling screw. I. Making the cross hairs to look distinct and clear by focusing eye piece.

	J. Bringing the image of the object in the plane of cross hairs by focusing objective piece. **<u>Measurement of vertical angles:</u>** K. Directing the telescope towards the object by loosening vertical clamp screw. L. Sighting the object approximately and clamp the vertical circle using clamp screw. M. Bisecting the object accurately using tangent screw. N. Changing the face of the instrument by transiting and swinging the telescope.
Precise operation /activity	A. Taking the vernier readings in both face left and face right. B. Calculating the average vertical angle between two instrument stations and top of the object $\alpha 1$ and $\alpha 2$. C. Measuring the horizontal distance between two instrument stations. D. Observing and noting down the readings of levelling staff on bench mark. E. Calculating the horizontal distance between instrument station and object. F. Calculating the reduced level of the object.
Safety of the Equipment	A. Placing the theodolite in instrument box duly identifying the respective position of the component parts. B. Clamping the screws to avoid the movement of parts in instrument box.

2. TEACHING POINTS:

S. NO.	TEACHING POINTS	SUGGESTIVE DURATION (MIN.)
1.	Description about A. Trigonometric levelling. B. Component parts of the theodolite. C. Uses of theodolite	3
2.	About Face left , face right, swinging, transiting	2
3.	Observation & recording of vernier readings on vertical circle	3
4.	Observation of staff readings	1
5.	Calculation of horizontal distance between instrument station and object	2
6.	Calculation of reduced level of the object	2
7.	**Procedural precautions:** A. Care should be taken while observing the vernier readings. B. Care should be taken while operating clamp screws and tangent screws. C. Proper care should be taken while taking the staff readings and measuring the horizontal distances. D. Readings should be carefully recorded in appropriate columns of the field book.	2
	Total	15

3. NEED AND SCOPE OF THE EXPERIMENT:

To measure the horizontal distance and vertical distance of an object whose base is inaccessible due to the presence of obstacles when the two instrument stations and the object are in the same vertical plane.

4. PLANNING AND ORGANIZATION:

ACTION	ACTIVITY
Check for	A. Working condition of theodolite. B. Actual length of chain or tape. C. Readings on the levelling staff. D. Verticality of ranging rods.
For design of Instruction	Read the teaching points carefully.

5. SCHEME OF EVALUATION:

<table>
<tr><th>CATEGORY OF SKILL</th><th>SUB TASK</th><th>WEIGHT WITH COMPETENCY LEVEL INDIVIDUALLY</th><th>AWARDED
(50)</th></tr>
<tr><td>Handling of apparatus</td><td>A. Identifying the convenient point and pressing the tripod legs into the ground firmly.
B. Lifting the theodolite from the instrument box properly.
C. Fixing the theodolite over the tripod head using screws.
D. Removing the theodolite from the tripod head using screws.
E. Keeping the theodolite in the instrument box in correct position.
F. Carrying the ranging rods properly.
G. Holding the levelling staff vertically.
H. Holding the chain (or) tape in correct position while measuring the distances.</td><td><table><tr><td>A</td><td>1</td></tr><tr><td>B & E</td><td>1</td></tr><tr><td>C & D</td><td>1</td></tr><tr><td>F & H</td><td>1</td></tr><tr><td>G</td><td>1</td></tr><tr><td>Total</td><td>5</td></tr></table></td><td></td></tr>
<tr><td>Manipulation of apparatus</td><td><u>Temporary adjustments:</u>
A. Centering the theodolite over the station mark using plumb bob and by moving tripod legs radially as well as circumferentially.
B. Swinging the telescope such that plate level is parallel as well as perpendicular to the line joining the pair of levelling</td><td><table><tr><td>A</td><td>1</td></tr><tr><td>B</td><td>1</td></tr><tr><td>C</td><td>1</td></tr><tr><td>D</td><td>1</td></tr><tr><td>E</td><td>1</td></tr><tr><td>F</td><td>1</td></tr><tr><td>G</td><td>1</td></tr><tr><td>H</td><td>1</td></tr><tr><td>I</td><td>1</td></tr><tr><td>J</td><td>1</td></tr><tr><td>K</td><td>1</td></tr><tr><td>L</td><td>1</td></tr><tr><td>M</td><td>2</td></tr><tr><td>N</td><td>1</td></tr><tr><td>Total</td><td>15</td></tr></table></td><td></td></tr>
</table>

	screws. C. Bringing the bubble to the centre of its run by turning the levelling screws uniformly. D. Setting the zero of the vertical vernier exactly to the zero of the vertical circle by means of the vertical clamp screw and tangent screw. E. Swinging the telescope such that altitude level is parallel to the line joining the pair of levelling screws. F. Bringing the bubble to the centre of its run by turning the levelling screws uniformly. G. Turning the telescope through 90^0 by unclamping the vernier plate. H. Bringing the bubble to the centre of its run by turning the third levelling screw. I. Making the cross hairs to look distinct and clear by focusing eye piece. J. Bringing the image of the object in the plane of cross hairs by focusing objective piece. **<u>Measurement of vertical angles:</u>** K. Directing the telescope towards the object by loosening vertical clamp screw. L. Sighting the object approximately and clamp		

<table>
<tr>
<td></td>
<td>the vertical circle using clamp screw.
M. Bisecting the object accurately using tangent screw.
N. Changing the face of the instrument by transiting and swinging the telescope</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Precise operation/ Activity</td>
<td>A. Taking the vernier readings in both face left and face right.
B. Calculating the average vertical angle between two instrument stations and top of the object α1 and α2.
C. Measuring the horizontal distance between two instrument stations.
D. Observing and noting down the readings of levelling staff on bench mark.
E. Calculating the horizontal distance between instrument station and object.
F. Calculating the reduced level of the object.</td>
<td><table><tr><td>A</td><td>5</td></tr><tr><td>B</td><td>5</td></tr><tr><td>C</td><td>2</td></tr><tr><td>D</td><td>3</td></tr><tr><td>E</td><td>5</td></tr><tr><td>F</td><td>5</td></tr><tr><td>Total</td><td>25</td></tr></table></td>
<td></td>
</tr>
<tr>
<td>Values</td>
<td>A. Co-operation
B. Co-ordination
C. Communication
D. Sharing
E. Leadership</td>
<td><table><tr><td>A</td><td>1</td></tr><tr><td>B</td><td>1</td></tr><tr><td>C</td><td>1</td></tr><tr><td>D</td><td>1</td></tr><tr><td>E</td><td>1</td></tr><tr><td>Total</td><td>5</td></tr></table></td>
<td></td>
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<tr>
<td colspan="2">Total</td>
<td>50</td>
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</tr>
</table>

6. ASSESSMENT QUESTIONS (Only suggestive):

1. Calculate the horizontal distance between Theodolite and the object.
2. Tabulate observations and calculate the average vertical angle.
3. Determine height of the object.
4. Determine the reduced level of the object.

7. VIVA QUESTIONS:

(Only suggestive) The teacher may add questions depending upon the Context of examination

1. How do you calculate the vertical angle?
2. How do you calculate the height of the object?
3. What is the function of clip screw in theodolite?
4. What are verniers A, B, C, and D?
5. What are the functions of theodolite?
6. What is telescope normal position?
7. What is telescope inverted position?
8. What is face left and face right observations
9. What is the least count of theodolite?
10. When do you operate tangent screw?
11. When do you operate clamp screw?
12. What are the fundamental lines of transit theodolite?
13. What are the different sources of errors in theodolite survey?
14. What is the length of the levelling staff?
15. What are the different types of bench mark?
16. How do you get the reduced level of temporary bench mark?
17. What is called plus sight?
18. How do you calculate the height of the instrument station?

To Perform the different tasks for determining the horizontal and vertical distances of an object whose base is inaccessible when the instrument stations and objects are not in same vertical plane

OBJECTIVE

To Perform the different tasks for determining the horizontal and vertical distances of an object whose base is inaccessible when the instrument stations and objects are not in same vertical plane.

EQUIPMENT/APPARATUS/RESOURSES

1. Theodolite 1 no.,
2. Level Staff 01 no.,
3. Pegs 04nos.,
4. Plumb Bob 01 no.,
5. Tripod stand 01 no.,

1. TASK ANALYSIS

A. KNOWLEDGE

- *Lifting the Theodolite l from Box / case*,
- *Fixing the Theodolite to Tripod*,
- *Fixing the Tripod on ground*,
- *Holding the Level Staff*,
- *Leveling the instrument*
- *Focusing the Objective Lens*,
- *Focusing the Eye-piece*,
- *Observing the reading of level staff through* Theodolite
- *Noting the (observed) reading (from the level staff) in work sheet*,
- *Measuring the distance between given (two) points*,

B. SKILLS

Category of Skill	Sub task
1. Handling of apparatus	• Fixing the Tripod on ground. • Lifting the theodolite from Box / case. • Fixing the theodolite to Tripod. • Holding the Level Staff.
2.Manipulation of apparatus	• Observing the reading of level staff through theodolite. • Measuring the distance between given (two) points.
3. Precise operation /activity	• Focusing the Objective Lens. • Focusing the Eye-piece. • Leveling the instrument • Noting the (observed) reading (from the level staff) in work sheet

2. TEACHING POINTS

S. No.	Teaching points	Suggestive Duration (Min.)
1.	Description about Theodolite A. Importance of Theodolite	1
	B. Parts Theodolite	1
	C. Applications of Theodolite	1
2.	Meaning of instrument stations not in same vertical plane	1
3.	observation and recording of readings in horizontal plate Vernier A and Vernier B	1
4.	observation and recording of readings in vertical circle consisting of Vernier C and Vernier D	1
5.	formula derivation for horizontal distances from object	3
6.	formula derivation for Vertical distances from object	3
7.	Precautions	3
	A. Procedural precautions • Care should be taken in operating the objective and eye piece of Theodolite. • Exact bisecting of the level staff by using horizontal and vertical focusing screws • Proper care should be taken in noting the staff reading. • Properly measure the distance between the given two points without kinks, bends, etc. • Care should be taken while taking main scale readings in Vernier A and Vernier coincidence in Vernier B • Checking the lower and upper clamp screws while taking readings without any slippage	
	Total	15

2. NEED AND SCOPE OF THE EXPERIMENT

When the instrument stations are not possible to keep in same vertical plane as per the field conditions, then the procedure adopted and formula derivation is required so that two stations from the object form a well conditioned triangle

By applying sine rule to the two formed well conditioned triangles,the elevation of the object whose base is inaccessible can be found out.

4. PLANNING AND ORGANIZATION

Action	Activity
Check for	1. Working condition of Theodolite. 2. Tripod Legs 3. Level Staff in both unfolded and folded conditions.
For design of Instruction	Read the teaching points carefully.

5. SCHEME OF EVALUATION

Category of skill	Sub Task	Weight with competency level individually	Awarded (50)
1. Handling of apparatus	A. Fixing the Tripod on ground. B. Lifting the Theodolite Level from Box / case. C. Fixing the Theodolitel to Tripod D. Holding the Level Staff	A 1 B 2 C 4 D 3 Total 10	
2.Manipulation Of apparatus	A. Observing the reading from level staff through Theodolite B. Measuring the distance between given (two) points C. Exact bisection of object using horizontal and vertical focusing screws	A 1 B 1 C 3 Total 10	
3.Precise Operation / Activity	A. Focusing the Objective Lens B. Focusing the Eye-piece C. Leveling the instrument D. Calculating the horizontal and vertical distances. E. Observing the horizontal plate main scale readings and Vernier scale readings F. 0bserving the vertical circle readings Vernier C and Vernier D	A 3 B 3 C 5 D 4 E 5 F 5 Tot 25	
4. Values	A. Co-operation B. Co-ordination C. Communication D. Sharing E. Leadership	A 1 B 1 C 1 D 1 E 1 Tot 5	
Total		50	

6. ASSESSMENT QUESTIONS (suggestive only)

(this is for Formative Assessment only)

1. What is Trignometric levelling?
2. What is the necessity of Trignometric levelling?
3. What are the various methods to find the elevation of the object under different field conditions?
4. State the various components of theodolite?
5. State the fundamental lines of theodolite
6. What are the various uses of theodolite
7. What is Line of Collimation?
8. What is Reduced Level?
9. What is Bench Mark?
10. What are the various methods of finding the horizontal angle using theodolite
11. What the various methods of setting out a curve by using theodolite

7. VIVA QUESTIONS (suggestive only)

(this is for Summative Assessment)

The teacher may add questions depending upon the Context of examination

1. What is the Principle of Leveling?
2. Define Surveying.
3. What is the necessity of trigonometric levelling
4. State the temporary adjustments of theodolite
5. What is a Level Surface?
6. List any three minor instruments.
7. Why focusing of the objective and eyepiece is required
8. What the various methods of setting out a curve by using theodolite
9. What is the least count of main scale and Vernier scale in horizontal plate
10. What is the meant by face left and face right observation
11. What is meant by transiting and swinging
12. State the function of upper and lower plate clamping screws in theodolite
13. Why a theodolite surveying is required in the field

LAB SHEET

DETERMINATION OF CONSTANTS OF TACHEOMETER

OBJECTIVE

To perform a set of tasks in order to determine the constants ‘K’ and ‘C’ of the given tacheometer

EQUIPMENT/APPARATUS/RESOURCES

1. Theodolite
2. Tripod
3. Plumb bob
4. Tape or chain
5. Wooden pegs or arrows
6. Levelling staff

1. TASK ANALYSIS

A. KNOWLEDGE

- . Fixing theodolite to stand
- . Centering
- . Levelling
- . Reading staff
- . Measuring length

B. SKILLS

Category of skill	Sub task
HANDING OF APPARATUS	➢ Collecting Equipments required and carrying it to site
	➢ Removing the theodolite from the box.
	➢ Fixing the theodolite to the tripod.
	➢ Measuring the land with tape or chain
	➢ Unscrewing the theodolite from the tripod after completion of experiment.
	➢ Placing the theodolite in the box
MANIPULATION OF APPARATUS	➢ Centering the tripod over the station
	➢ Levelling the theodolite
	➢ Focussing the eye piece
	➢ Focussing the objective

	➢ Bringing vertical angle to 0 ‘ 0’ O”in the theodolite
	➢ Reading the staff
PRECISE OPERATION / ACTIVITY	➢ Calculating the staff intercept
	➢ Substituting the values of distance and staff intercept in the tacheometric equation.
	➢ Solving the equations in pairs
	➢ Calculating the value of tacheometric constants K&C
	➢ Calculating the average values of K&C.

2. TEACHING POINTS

Sl No	Teaching points	Suggestive Duration
1	**Description about tacheometer** A. What is Tacheometer B. Principle of tacheometer C. Uses of tacheometer	6
2	Define constants K & C	3
3	Standard values of K & C	
4	Different methods of determination of constants	4
5	Calculating the staff intercept	
6	Calculating the constants K & C	3
7	**PRECAUTIONS** Care should be taken in handling of the theodolite Care should be taken in setting vertical angle to 0 ‘ 0’ O” Care should be taken in taking staff readings Care should be taken while calculating K & C	4

3. NEED AND SCOPE OF THE EXPERIMENT

- To determine to tacheometric constants K & C of the Tacheometer
- Accuracy of constants gives the accurate results of distance.

4. PLANNING AND ORGANISATION

<table>
<tr><th>ACTION</th><th>ACTIVITY</th></tr>
<tr><td rowspan="4">Check for</td><td>1. Working condition of Theodolite</td></tr>
<tr><td>2. functioning of all the screws</td></tr>
<tr><td>3. chain and tape in good condition</td></tr>
<tr><td>4. Readings on leveling staff</td></tr>
<tr><td>For design of instruction</td><td>Read the teaching points carefully</td></tr>
</table>

5. SCHEME OF EVALUATION

<table>
<tr><th>SlNo</th><th>Category of skill</th><th>Sub task</th><th>Weight with competency level individually</th><th>Awarded
(50)</th></tr>
<tr><td rowspan="6">1</td><td rowspan="6">HANDING OF APPARATUS</td><td>A Collecting Equipments required and carrying it to site</td><td rowspan="6"><table><tr><td>A</td><td></td></tr><tr><td>B</td><td></td></tr><tr><td>C</td><td></td></tr><tr><td>D</td><td></td></tr><tr><td>E</td><td></td></tr><tr><td>F</td><td></td></tr><tr><td>Total</td><td></td></tr></table></td><td rowspan="6"></td></tr>
<tr><td>B Removing the theodolite from the box.</td></tr>
<tr><td>C Fixing the theodolite to the tripod.</td></tr>
<tr><td>D Measuring the land with tape or chain</td></tr>
<tr><td>E Unscrewing the theodolite from the tripod after completion of experiment.</td></tr>
<tr><td>F Placing the theodolite in the box</td></tr>
<tr><td rowspan="2">2</td><td rowspan="2">MANIPULATION OF APPARATUS</td><td>A Centering the tripod over the station</td><td rowspan="2"><table><tr><td>A</td><td></td></tr><tr><td>B</td><td></td></tr><tr><td>C</td><td></td></tr></table></td><td rowspan="2"></td></tr>
<tr><td>B Levelling the theodolite</td></tr>
</table>

		C Focussing the eYe piece	D E F Total	
		D Focussing the objective		
		E Bringing vertical angle to 0 ‘ 0’0” in the theodolite		
		F Reading the staff		
3	**PRECEEIES OPERATION/ ACTIVITY**	**A** Calculating the staff intercept	A B C D E Total	
		B Substituting the values of distance and staff intercept in the tacheometer equation.		
		C Solving the equations in pears		
		D Calculating the3 value of tacheometric constants		
		E Calculating the average values of K&C.		
4	**VALUES**	**A** Co-operation **B** Coordination **C** Communication **D** Sharing **E** Leadership	A B C D E Total	

6.ASSESSMENT QUESTIONS

1. Fix the distance of 20m,40m &60m with chain.

2.Tabulate the observations taken in the filed.

3. Calculate the values of K & C

7. VIVA QUESTIONS

1.what is the process of centering the instrument over the station.

2. How do you bring the bubble to centre.

3. How can you make the line of collination horizontal .

4. What are constants K & C

5. Why should we calculate K & C of the instruments.

6. Describe any other methods for finding K & C

7. What is the Distance Equation of Tacheometer.

8. What is a Tacheometer

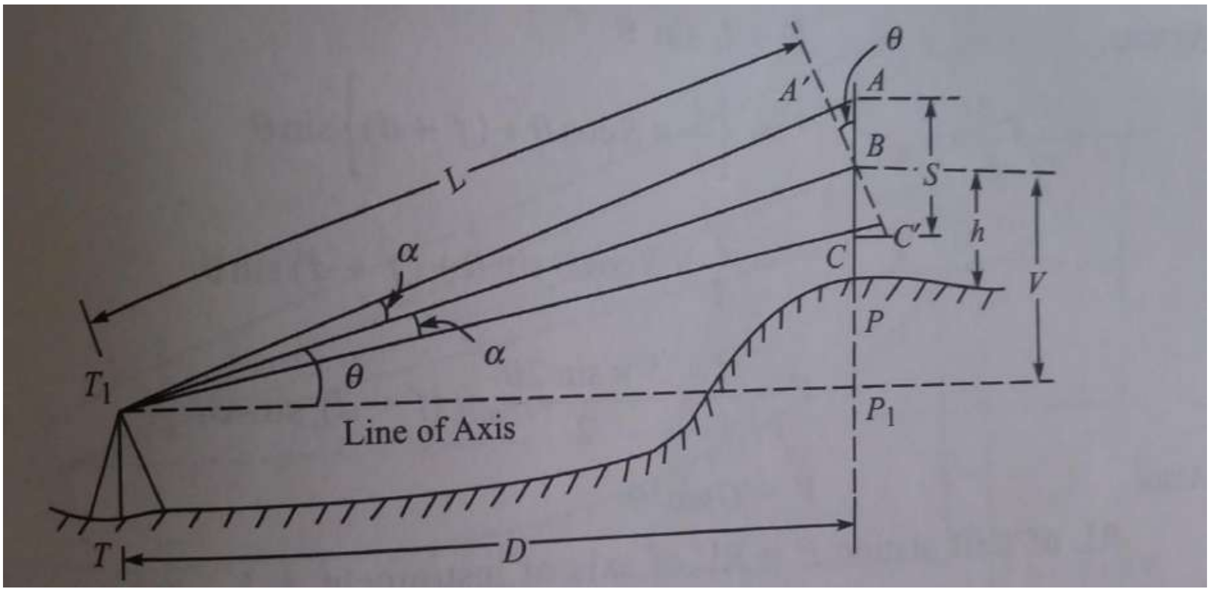
9. What is the principle of Tacheometry.

10. What is the use of Tacheometer.

4.14 DETERMINATION THE HORIZONTAL DISTANCE & ELEVATION BY THE PRINCIPLE OF STADIA TACHEOMETRY (CONSIDERING ANGLE OF ELEVATION)

OBJECTIVE

To Measure the horizontal distance & elevation by the principle of stadia tacheometry (considering angle of elevation)



EQUIPMENT/APPARATUS/RESOURCES

1. Transit theodolite with tripod
2. Ranging rods

TASK ANALYSIS

A.KNOWLEDGE

- Identifying the parts of Theodolite.
- Knowledge on operating the Theodolite.
- Measurement of horizontal angles.
- Reading the angles on both Vernier and main scales.
- Recording the angles on field book.

B.SKILLS

Category of Skill	Sub task
1. Handling of Apparatus	• Lifting the Theodolite from the box. • Fixing the instrument on tripod. • Removing the instrument from tripod. • Placing the Theodolite in to the box properly.
2. Manipulation of Apparatus	• Identifying the component parts of the Theodolite. • Making temporary adjustments. • Rotating eye piece to view cross hairs clearly. • Maintaining the verticality of the ranging rods over the stations. • Noting the readings on main scale & Vernier scale.
3. Precise operation /activity	• Centring the instrument over the given station. • .Levelling the bubble by adjusting the foot screws. • Bisecting the ranging rods accurately. • Calculating the angles from the observations.

2. TEACHING POINTS

S. No	Teaching points	Suggestive Duration (min.)
1.	Purposeof Repetition method.	2
2.	Explanation of set up the instrument and other tools on field	3
3.	Operation of theodolite for taking readings.	4
4.	Note down the readings in the field book.	2
5.	Calculation of readings.	4
6.	Precautions	
	A. Procedural precautions • Care should be taken while fixing the Theodolite on tripod. • Care shouldbe taken while taking readings on main scale and Vernier scale. • Get the connections checked by the concerned staff member. • Care should be taken while placing the Theodolite in box properly.	
	B. Safety precautions	

	• Ensure that should have to maintain the First aid kit and should have to wear Hat and Safety shoes.	
	Total	15

3. NEED AND SCOPE OF THE EXPERIMENT

This method is generally used for Measure the horizontal distance & elevation by the principle of stadia tacheometry (considering angle of elevation)

4. PLANNING AND ORGANIZATION

Action	Activity
Check for	1. Working condition of Theodolite. 2. Checking the telescope and cross hairs of Theodolite. 3. Checking the legs and screws of tripod. 4. Checking the bubble centring.
For design of Instruction	Read the teaching points carefully.

5. SCHEME OF EVALUATION

Category of skill	Sub Task	Weight with competency level individually	Awarded (50)
1. Handling of apparatus	A. Lifting the Theodolite from the box. B. Fixing the instrument on tripod. C. Removing the instrument from tripod. D. Placing the Theodolite in to the box properly	A: 2, B: 3, C: 2, D: 3, Tot: 10	
2.Manipulation of apparatus	A. Identifying the component parts of the Theodolite. B. Making temporary adjustments. C. Rotating eye piece to view cross hairs clearly. D. Maintaining the verticality of the ranging rods over the stations.	A: 3, B: 5, C: 2, D: 5, E: 5, Tot: 20	

<table>
<tr><td></td><td>E. Noting the readings on main scale & Vernier scale</td><td></td><td></td></tr>
<tr><td>3.Precise Operation/Activity</td><td>A. Centring the instrument over the given station.
B. Levelling the bubble by adjusting the foot screws.
C. Bisecting the ranging rods accurately.
D. Calculating the angles from the observations.</td><td><table><tr><td>A</td><td>B</td><td>C</td><td>D</td><td>Tot</td></tr><tr><td>2</td><td>5</td><td>3</td><td>5</td><td>15</td></tr></table></td><td></td></tr>
<tr><td>4. Values</td><td>A. Co-operation
B. Co-ordination
C. Communication
D. Sharing
E. Leadership</td><td><table><tr><td></td></tr><tr><td>5</td></tr></table></td><td></td></tr>
<tr><td colspan="2">Total</td><td>50</td><td></td></tr>
</table>

6. **ASSESSMENT QUESTIONS**(Only suggestive)

1. Tabulate observations made for the experiment.
2. Precision of measurement of horizontal angles by repetition.

7. **VIVA QUESTIONS**

(Only suggestive. The teacher may add questions depending upon the Context of examination)

1. What is the Stadia Tacheometry?
2. What is the least count of theodolite?
3. Define face left and face right of theodolite?
4. How to make bubble centre?

5. How to view cross hairs clearly?
6. How to bisect the ranging rods?

OBJECTIVE: Determination of Horizontal Distance and Elevation by Principle of Stadia Tacheometry (Considering Angle of Depression)

EQUIPMENT/APPARATUS/RESOURSES:

1. Transit Theodolite fitted with a stadia diaphragm
2. Tripod
3. Plumb bob
4. Cross staff

1. TASK ANALYSIS

A. KNOWLEDGE

- Level the tripod
- Lifting the Theodolite from the box
- Fixing of Theodolite on tripod
- Identifying parts of Theodolite
- Centering Theodolite
- Leveling the bubble tube
- Reading the vernier scale and main scale reading
- Focusing telescope
- Exactly bisecting the object

B.SKILLS

Category of Skill	Sub task
1. Handling of apparatus	A. Lifting the instrument from box B. Fixing the tripod over station C. Fixing theodolite on tripod D. Approximate leveling of tripod with legs
2.Manipulation of apparatus	• Centering by using plumb bob • Operating clamp screws and tangential screws • Swinging and Transiting the instrument
3. Precise operation /activity	• Centering the instrument • Leveling the instrument by operating foot screws • Focusing telescope by operating focusing screw • Transiting the theodolite by operating clamp screws • Placing the Leveling staff on the given station.

2. TEACHING POINTS

S. No.	Teaching points	Suggestive Duration (Min.)
1.	Fixing of the instrument	5
2.	Centering the instrument	
3.	Leveling the instrument	
4.	Focusing telescope	
5.	Operating clamp screws to tighten the lower and upper plates	4
6.	Swinging and transiting the instrument	6
7.	Placing Leveling staff	
8.	Precautions	
	A. Procedural precautions • Care should be taken while lifting the instrument • Care should be taken while fixing the instrument • Care should be taken while operating clamp screws • Care should be taken while focusing • Proper care should be taken in placing the leveling staff over the given station • Precautions for taking care of instrument while changing the instrument station.	
	Total	15

3. NEED AND SCOPE OF THE EXPERIMENT

This experimental procedure will be helpful when chaining is not applicable due to site conditions. With this method we can calculate the horizontal distance and elevations of the given stations by using Tacheometry.

4. PLANNING AND ORGANIZATION

Action	Activity
Check for	1. Working condition of theodolite and tripod. 2. Functioning of clamps. 3. Fixing of lower plate and upper plate by clamp screws 4. Temporary adjustments 5. Exact focusing of object 6. Fixing of leveling staff on the given point
For design of Instruction	Read the teaching points carefully.

5. SCHEME OF EVALUATION:

Category of skill	**Sub Task**	**Weight with competency level individually**	**Awarded (50)**
1. Handling of apparatus	A. Lifting the instrument from box B. Fixing the tripod over station C. Fixing theodolite on tripod D. Approximate leveling of tripod with legs	A 1 B 1 C 1 D 2 Total 5	
2.Manipulation Of apparatus	A. Centering by using plumb bob B. Operating clamp screws and tangential screws C. Swinging the instrument	A B C Tot 2 5 3 10	
3.Precise Operation/Activity	A. Centering the instrument B. Leveling the instrument by operating foot screws C. Focusing telescope by operating focusing screw D. Transiting the theodolite by operating clamp screws E. Placing of leveling staff on newly established stations.	A 5 B 5 C 5 D 10 E 5 Total 30	

4. Values	A. Co-operation B. Co-ordination C. Communication D. Sharing E. Leadership	5	
Total		50	

6. **ASSESSMENT QUESTIONS** (Only suggestive)

1. Describe the Operation of foot screws for leveling
2. Explain the precautions to be taken while shifting the instrument.
3. Explain Transiting from face left to face right

7. VIVA QUESTIONS

(Only suggestive) The teacher may add questions depending upon the Context of examination

1. Purpose of Tacheometry?
2. What is the principle of Tacheometry?
3. What is transiting?
4. What is swinging?
5. Which Plate is fixed to not to change the readings?
6. What is face left?
7. What is face right?
8. Which screw is operated to focus the telescope?

OFFSETS FROM LONG CHORD METHOD

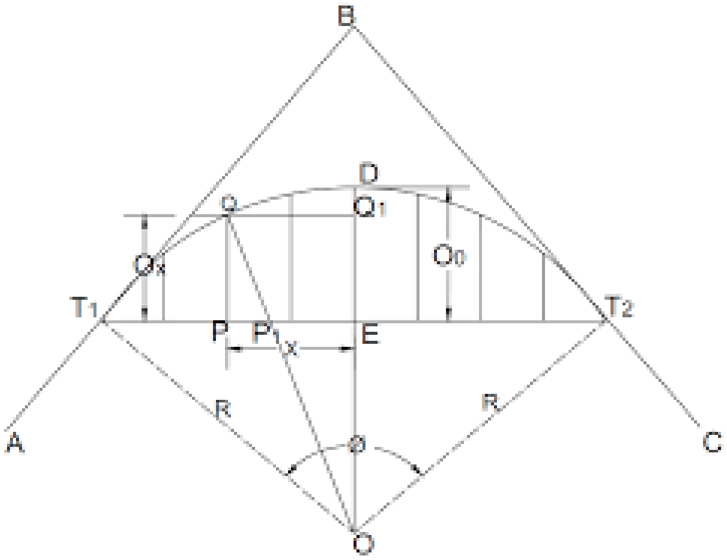
A) OBJECTIVE:

Performing the set of tasks in setting out simple circular curve by offsets from long chord method

B) PROCEDURE

1) Set the long chord on the ground with the help of chain.
2) To set out the curve, the long chord is divided into an even number of equal parts.
3) Offsets are then calculated from equation $O_x = \sqrt{R^2 - x^2} - (R - Ox)$
4) The calculated offsets are then set out at each interval and pegs are driven at there points.
5) Then the points are joined to obtain the required curve on the ground.
6) It should be clearly noted that the distance x in this method is measured from the mid point of the chord.

C) SKETCH:



Ø = 30°, R = 100m , Chainage at B= 150.50m

D) OBSERVATIONS:

Observing Elements of Curves

E) CALCULATIONS AND TABULATIONS:

1. Tangent length, T_1B = *R tan Ø/2 = 100 tan (30/2) = 26.79 m*

2. Chainage at T_1 = Chainage at B – Tangent Length =150.50 – 26.79 =123.71m.

3. Length of the curve, CL = $\frac{\Pi R \text{Ø}}{180} = \frac{\Pi \text{ x } 100 \text{x } 30°}{180}$ = 52.36 m

4. Chainage of T_2 = Chainage of T_1 + Curve Length = 123.71 + 52.36 = 176.07m.

5. Length of the long chord (L) = 2R sin Ø /2 = 2 x 100 x Sin (30/2) = 51.76m.

6. The Long Chord is divided into two equal parts

   Each half Part = 51.76/2 =25.88m.

7. Mid Ordinate = $O_o = R - \sqrt{R^2 - (\frac{L}{2})^2} = 100 - \sqrt{100^2 - (\frac{51.76}{2})^2}$ =3.41m

Distance from the mid-point of Long chord x in m	**Ordinate O_x**	**$O_x = \sqrt{R^2 - x^2} - (R - Ox)$**
0	O_0	3.41
5	O_5	3.28
10	O_{10}	2.90
15	O_{15}	2.278
20	O_{20}	1.389
25	O_{25}	0.23
25.88	$O_{25.88}$	0

F) RESULT:

The calculated offsets are set on the ground and the required curve is observed.

G) INFERENCE:

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SETTING OUT A CURVE BY SUCCESSIVE BISECTION OF ARCS

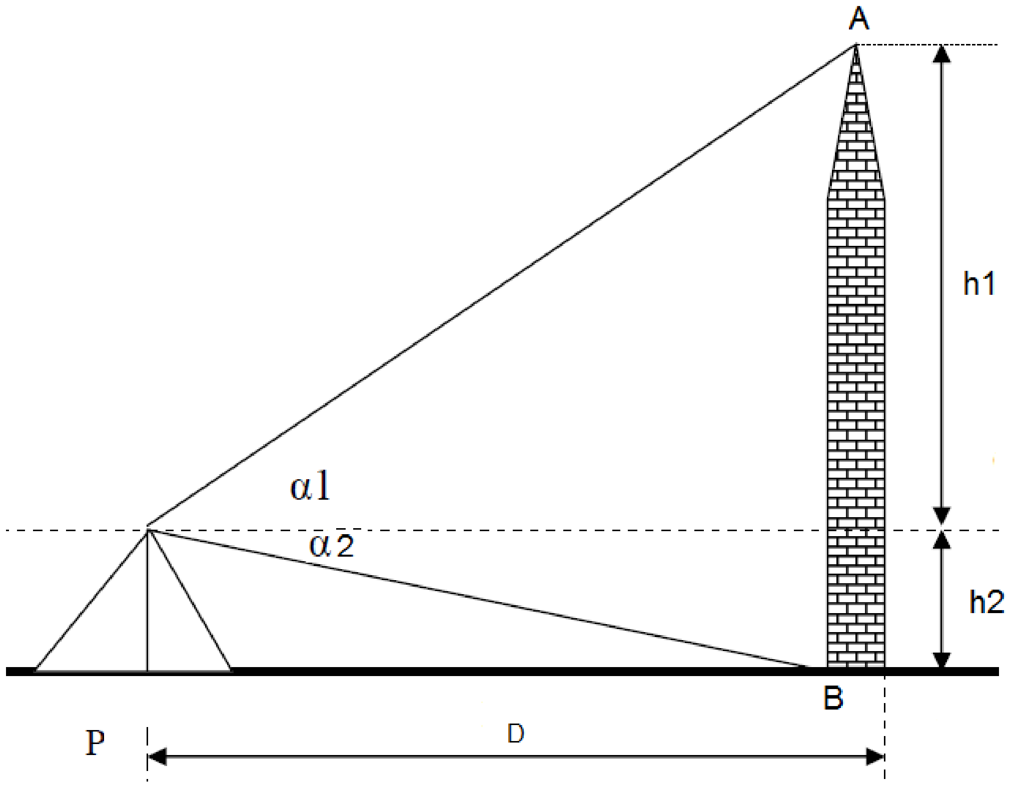
A) OBJECTIVE:

Performing the set of tasks in setting out simple circular curve by the method of successive bisection of arcs using chain and tape.

B) PROCEDURE

1) Join the tangent points T_1 & T_2
2) Bisect the long chord at D.
3) Erect the perpendicular DC
4) Set the zero reading in C and D verniers for face left observation
5) Measure the angle of elevation by pointing the telescope to the top of the object
6) Set the zero reading in C and D verniers for face left observation
7) Measure the angle of depression by pointing the telescope to the top of the object
8) Set the zero reading in C and D verniers for face right observation
9) Measure the angle of elevation by pointing the telescope to the top of the object
10) Set the zero reading in C and D verniers for face right observation
11) Measure the angle of depression by pointing the telescope to the top of the object

C) SKETCH:



D) OBSERVATIONS AND TABULATIONS:

Distance between Theodolite and Object D =20.20mts

S. No.	Inst. Station	Sight to	Face of observation	Vernier C ° ' "	Vernier D ° ' "	Mean of C & D Angle ° ' "	Average Vertical Angle ° ' "	Remarks
1	P	A	Left	28°10' 20"	0°10' 00"	28°10' 15"	28°10' 22.5"	Angle of Elevation (+α1)
2	P	A	Right	28°10' 20"	0°10' 40"	28°10' 30"		Angle of Elevation (+α1)
3	P	B	Left	18°10' 40"	0°10' 20"	18°10' 30"	18°10' 27.5"	Angle of Depression (-α2)
4	P	B	Right	18°10' 20"	0°10' 10"	18°10' 25"		Angle of Depression (-α2)

E) SPECIMEN CALCULATION:

Distance between Theodolite and Object D =<u>20.2</u> m

Calculate the height h1 = D X tan α1 = 20.2 X tan 28°10' 22.5" = 10.818 m

Calculate the height h2 = D X tan $\alpha 2$ = 20.2 X tan 18°10' 27.5" = 6.631 m

Calculate the height of the object 'AB' = (h1 + h2)m

= (10.818 + 6.631) m

= 17.449 m

F) RESULT:

Average Angle of elevation = 28°10' 22.5"

Average angle of depression = 18°10' 27.5"

Height of the object AB = 17.449 m

G) INFERENCE:

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Setting out a simple Circular curve by Radial offsets from tangents

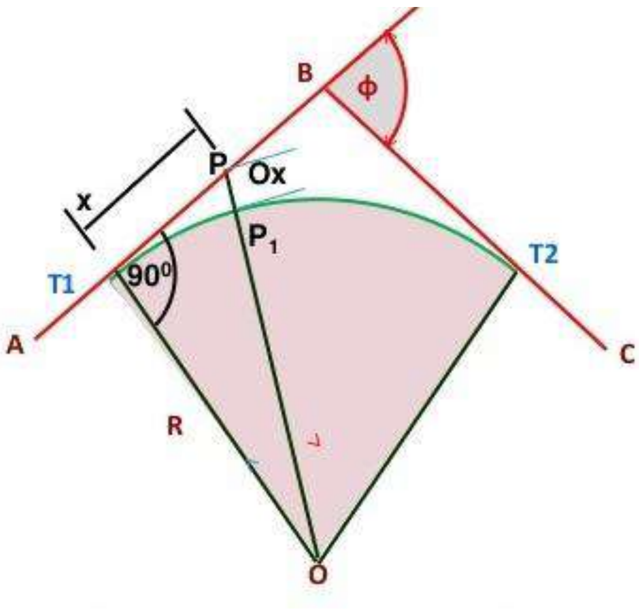
A) OBJECTIVE:

Performing the set of tasks in setting out of a simple circular curve in the field using chain and tape by the method of Radial offsets erected from tangents.

B) PROCEDURE

1) Tangent lengths T_1B, T_2B and offset values O_{x1}, O_{x2}, …., O_{xn} are calculated.
2) The tangents T_1B, T_2B are set up by prolonging the A T_1 line and by positioning the chain making an intersecting angle of (180 – Ø) with T_1B.
3) Now the offsets O_{x1}, O_{x2}, …., O_{xn} are erected radially to the tangent T_1B at X_1, X_2, X_3,…. Distances from T_1 and the toe points of offsets P_1, P_2, P_3,….. are marked by fixing arrows.
4) Similarly offsets are erected to the tangent T_2B calling the toe points P'_1, P'_2, P'_3,….. To get the required simple curve.
5) Then the points are joined to obtain the required curve on the ground.

C) SKETCH:



Ø = 45°, R = 200m , Chainage at B= 1839.2m, Given chain length = 30m

D) OBSERVATIONS:

Observing Elements of Curves

E) CALCULATIONS AND TABULATIONS:

1. Tangent length, $T_1B = R \tan Ø/2 = 200 \tan (45/2) = 82.84$ *m*

2. Chainage at T_1 = Chainage at B – Tangent Length =1839.2 – 82.84 =1756.36m.

3. Length of the curve, CL = $\frac{\Pi R Ø}{180} = \frac{\Pi \text{ x } 200\text{x } 45°}{180}$ = 157.08 m

4. Chainage of T_2 = Chainage of T_1 + Curve Length = 1756.36 + 157.08 = 1913.44m.

7. Calculation of Radial Offsets, $O_x = \sqrt{R^2 + x^2} - R$

Chainage of T1 = 1756.36 m

For 30 m chain, it is at = 58 chains + 16.36 m.

x1 = 30 – 16.36 = 13.64

x2 = 43.64 m

x3 = 73.64 m

and the last is at x4 = tangent length = 82.84 m

Distance from the tangent point x in m	**Ordinate O_x**	$O_x = \sqrt{R^2 + x^2} - R$
13.64	$O_{13.64}$	0.46
43.64	$O_{43.64}$	4.71
73.64	$O_{73.64}$	13.13
82.84	$O_{82.84}$	16.48

F) RESULT:

The calculated offsets are set on the ground and the required curve is observed.

G) INFERENCE:

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Setting out a simple circular curve by perpendicular offsets from tangents

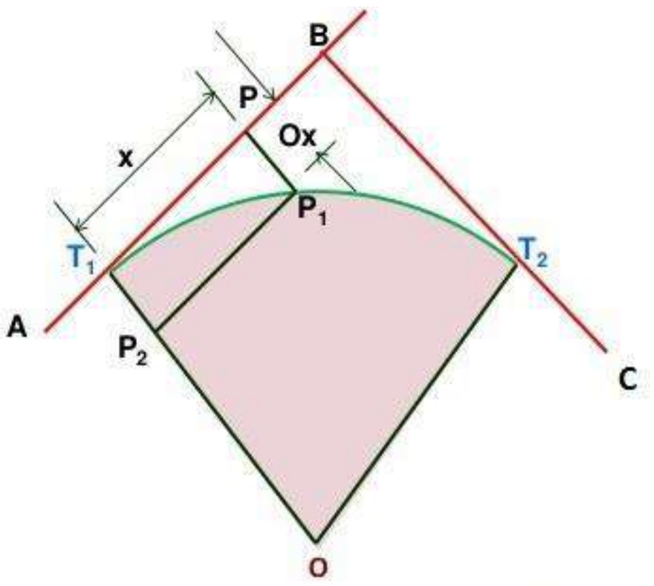
A) OBJECTIVE:

Performing the set of tasks in setting out simple circular curve by the method of perpendicular offsets from tangents.

B) PROCEDURE

1) Tangent lengths T_1B, T_2B and offset values O_{x1}, O_{x2}, …., O_{xn} are calculated.
2) The tangents T_1B, T_2B are set up by prolonging the A T_1 line and by positioning the chain making an intersecting angle of (180 – Ø) with T_1B.
3) Now the offsets O_{x1}, O_{x2}, …., O_{xn} are erected perpendicular to the tangent T_1B at X_1, X_2, X_3,…. Distances from T_1 and the toe points of offsets P_1, P_2, P_3,….. are marked by fixing arrows.
4) Similarly offsets are erected to the tangent T_2B calling the toe points P'_1, P'_2, P'_3,….. To get the required simple curve.
5) Then the points are joined to obtain the required curve on the ground.
6) When the distance 'x' increase the offset becomes too large to set out accurately.
7) In such case ,the central point position of the curve may be set out from a third tangent drawn through apex of the curve.

1. SKETCH:



Ø = 45°, R = 200m , Chainage at B= 1839.2m, Given chain length = 30m

C) OBSERVATIONS:

Observing Elements of Curves

D) CALCULATIONS AND TABULATIONS:

1. Tangent length, T_1B = *$R \tan Ø/2 = 200 \tan (45/2) = 82.84$ m*

2. Chainage at T_1 = Chainage at B – Tangent Length =1839.2 – 82.84 =1756.36m.

3. Length of the curve, CL = $\frac{\Pi R Ø}{180} = \frac{\Pi \text{ x } 200\text{x } 45°}{180}$ = 157.08 m

4. Chainage of T_2 = Chainage of T_1 + Curve Length = 1756.36 + 157.08 = 1913.44m.

7. Calculation of Radial Offsets, $O_x = R - \sqrt{R^2 - x^2}$

Chainage of T1 = 1756.36 m

For 30 m chain, it is at = 58 chains + 16.36 m.

x1 = 30 – 16.36 = 13.64

x2 = 43.64 m

x3 = 73.64 m

and the last is at x4 = tangent length = 82.84 m

Distance from the tangent point x in m	**Ordinate O_x**	$O_x = R - \sqrt{R^2 - x^2}$
13.64	$O_{13.64}$	0.46
43.64	$O_{43.64}$	4.82
73.64	$O_{73.64}$	14.05
82.84	$O_{82.84}$	17.96

2. RESULT:

The calculated offsets are set on the ground and the required curve is observed.

3. INFERENCE:

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OFFSETS FROM EXTENDED CHORDS

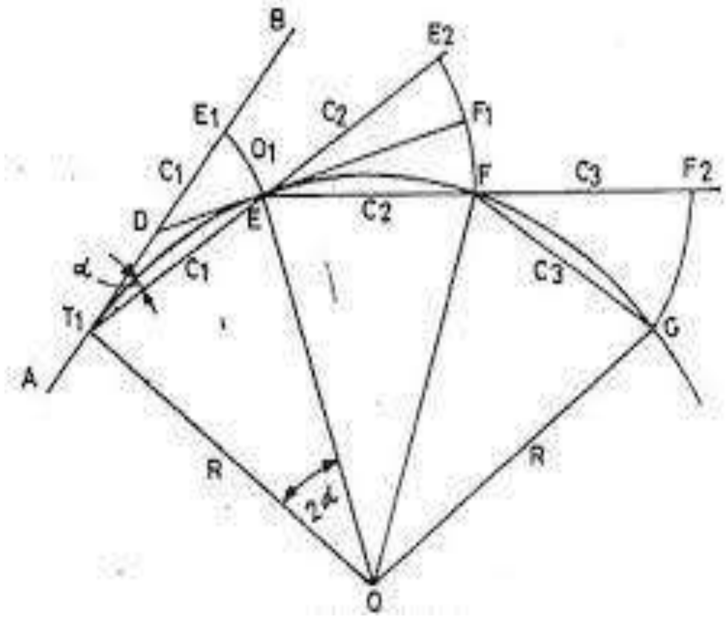
A) OBJECTIVE:

Performing the set of tasks in setting out of a simple circular curve in the field using chain and tape by the method of Extended chords.

B) PROCEDURE

1) On the line AT1, T_1 is located and AT_1 line is prolonged to a value of $C_1$and a perpendicular offset O_1 is erected and denote the toe point of offset as E.
2) Now change the chain position into T_1E direction and prolong it beyond E to a value of C_2 and erect the calculated perpendicular offset O_2 at E_2 by denoting it's toe point as F and make it by fixing an arrow. F is a point on the curve.
3) Now change the chain position into EF direction and prolong the line beyond F to a value of C_3 and at the point erect a perpendicular offset O_3 and denote the toe point as G. G is a point on the curve.
4) Like wise shift the chain to all other positions FG,GH, HI… and it's corresponding O_4, O_5, $O_{6....}$ Erections are done and hence H,I,J points are obtained.
5) By joining all points E,F,G,H,I,J,….. the required curve is obtained by extended chords method.

C) SKETCH:



Ø = 50°30', R = 300m , Chainage at B= 1192m, Given chain length = 20m

D) OBSERVATIONS:

Observing Elements of Curves

E) CALCULATIONS AND TABULATIONS:

1. Tangent length, T_1B = *R tan Ø/2 = 300 tan (*50°30'*/2) = 141.48 m*

2. Chainage at T_1 = Chainage at B – Tangent Length =1192 – 141.48 =1050.52.

3. Length of the curve, CL = $\frac{\Pi R Ø}{180} = \frac{\Pi \text{ x } 300\text{x}50°30'}{180}$ = 264.42 m

4. Chainage of T_2 = Chainage of T_1 + Curve Length = 1050.52 + 264.42 = 1314.94m.

5. Initial sub-chord = C_1 = 1060 – 1050.52 = 9.48 m

6. No. of full chords of length 20m = (1300-1060)/20 = 240/20 =12

7. Final sub-chord = 1314.94 – 1300 = 14.94 m

8. Total No of chords = 1+12+1 =14

9. First offset for initial sub-chord = $O_1 = C_1^2/2R = (9.48)^2$ / (2 x 300) = 0.15m

10. Second offset for full chord = $O_2 = C_2 (C_1+ C_2)/2R$ = [20(9.48+20)] / (2 x 300) = 0.98m

11. Similarly O_3 to $O_{n-1} = C^2 /R = (20^2)/300$ =1.33m

12. Last offset for final sub-chord = $C_n(C_{n-1}+ C_n)/2R$ = [14.94(20+14.94)]/ (2 x 300) = 0.87m

F) RESULT:

The calculated offsets are set on the ground and the required curve is observed.

G) INFERENCE:

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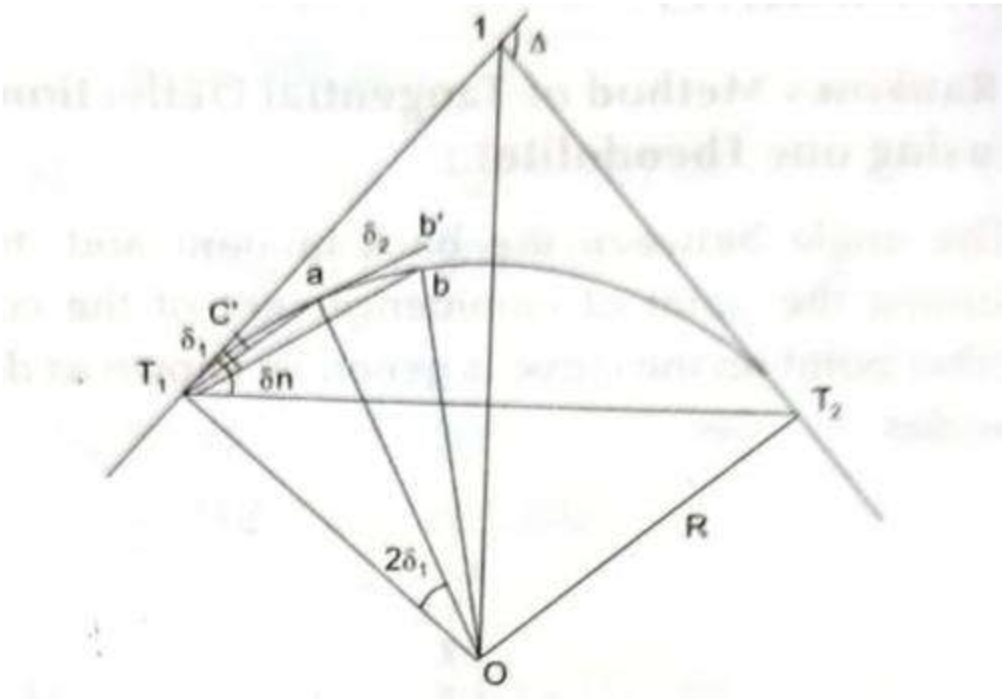
SETTING OUT OF THE CURVE BY USING ONE THEODOLITE

A) OBJECTIVE: To perform the set of tasks in Setting out of the curve by using one Theodolite (Rankine's Deflection angle method).

B) PROCEDURE

1) Set up the tripod, and theodolite at the point of commencement of the curve. This point can be arrived by knowing the length of tangent and point of intersection.
2) Let the chainage of the point of commencement finally occurs at M chains and N links.
3) Calculate the length of first sub chord to have a continuous chainage.
4) Calculate the deflection angles for the first sub chord, normal chord and last sub chord.
5) Center the theodolite over the point of commencement and level it.
6) Make the vernier to zero degree, zero minutes and zero seconds using the upper clamp and tangent screw and then clamp the upper clamp.
7) With the help of the lower clamp and lower tangent screw sight the point of intersection of the curve I.
8) Unclamp the upper plate of theodolite and set the vernier to read the deflection angle Δ_1 for the first sub chord – C_1 . Now the line of sight is along the first sub chord.
9) With T_1 as center and C_1 as radius swing chain or tape and fix arrow in the line of sight.
10) Set the vernier to read the deflection angle Δ_2 for the first normal chord, to point the telescope in the direction of the other and the first normal chord.
11) Keeping the one end of the chain at the point a previously fixed on the curve swing the chain until other end of the chain falls in the line of sight of the telescope. Pull the chain straight to fix the point b on the curve.
12) This procedure will be continued till the point of tangency is located.

C) SKETCH:



D) OBSERVATIONS AND TABULATIONS:

Calculate the elements of the curve

Tangent length= R tan Φ/2

Length of long chord= 2 R sin Φ/2

Arc length = πR Φ/360

Length of first sub chord =

Length of normal chord =

Length of last sub chord=

Deflection angle for first sub chord δ_1 = 1718.9 C_1/R

Deflection angle for normal chord δ_2 = 1718.9 C/R

Deflection angle for last sub chord δ_n = 1718.9 C_2/R

$\Delta_1 = \delta_1$

$\Delta_2 = \delta_1 + \delta_2$

$\Delta_3 = \delta_1 + \delta_2 + \delta_3$

$\Delta_n = \delta_1 + \delta_2 + \delta_3 + \ldots\ldots\ldots + \delta_n$

Table of Deflection angles:

S.No	**Chainage in m**	**Length of chord**	**Deflection angle**	**Total deflection angle**	**Theodolite readings**	**Remarks**
1						
2						
3						
4						
5						
6						

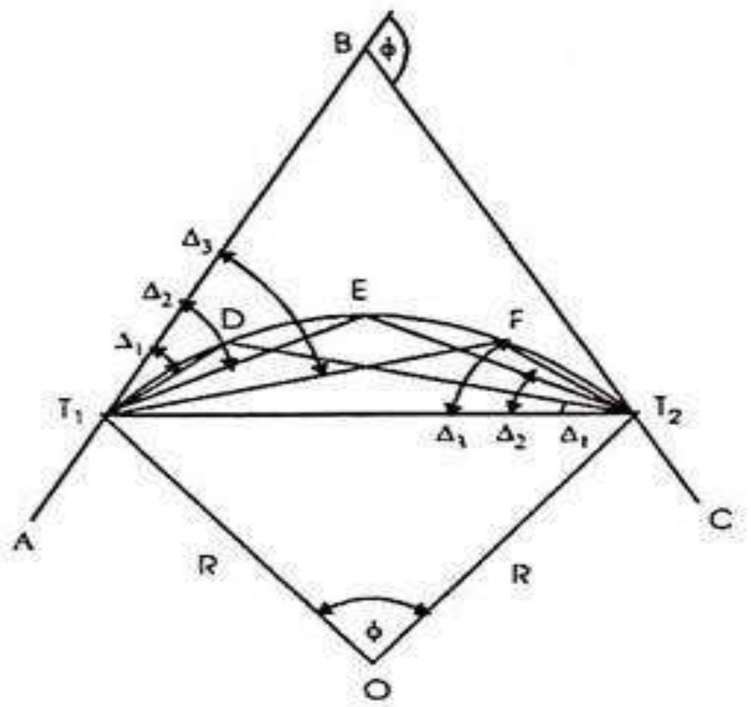
E. Comments:

SETTING OUT OF THE CURVE BY USING TWO THEODOLITES

A) OBJECTIVE: To perform the set of tasks in Setting out of the curve by using Two Theodolites.

B) INFORMATION REQUIRED & SKETCH:

This method is very useful in the absence of chain or tape and also when ground is not favourable for accurate chaining. This is simple and accurate method but requires essentially two instruments and two surveyors to operate upon them, so it is not as commonly used as the method of deflection angles. In this method, the property of circle 'that the angle between the tangent and the chord equals the angle which that chord subtends in the opposite segment' is used.



Let D, E, F, etc. be the points on the curve. The angle (Δ1) between the tangent T1B and the chord T1D i.e. ∠BT1 D = ∠T1T2D. Similarly, ∠BT1E = Δ2 = ∠T1T2 E, and ∠BT1F = Δ3 = ∠T1T2F etc. The total deflection angles Δ1, Δ2, Δ3, etc. are calculated from the given data as in the previous method (i.e. as in Rankine's method of deflection angles).

C) PROCEDURE:

1. Set up two theodolites, one at T1 and the other at T2.
2. Set Vernier of the horizontal circle of each of the theodolites to zero.
3. Turn the instrument at T1 to sight the intersection point B and that at T2 to sight T1.
4. Set the Vernier of each of the instruments to read the first deflection angle Δ1. Now the line of sight of the instrument at T1 is along T1D and that of the instrument at T2 is along T2D. Their point of intersection is the required point on the curve Direct

the assistant to move the ranging rod until it is sighted exactly by both the theodolites, thus fixing the point D on the curve.

5. Then set the Vernier of each of the instrument to the second deflection angle Δ2, proceed as before to obtained the second point (E) on the curve.
6. Repeat the process until the whole curve is set out.

D) OBSERVATIONS AND TABULATIONS:

Calculate the elements of the curve

Tangent length= R tan Φ/2

Length of long chord= 2 R sin Φ/2

Arc length = πR Φ/360

Length of first sub chord =

Length of normal chord =

Length of last sub chord=

Deflection angle for first sub chord δ_1 = 1718.9 C_1/R

Deflection angle for normal chord δ_2 = 1718.9 C/R

Deflection angle for last sub chord δ_n = 1718.9 C_2/R

$\Delta_1 = \delta_1$, $\Delta_2 = \delta_1 + \delta_2$, $\Delta_3 = \delta_1 + \delta_2 + \delta_3$, $\Delta_n = \delta_1 + \delta_2 + \delta_3 + \ldots\ldots\ldots + \delta_n$

Table of Deflection angles:

Point	Chainage (m)	Chord Length (m)	Deflection angle for chord (d)	Total Deflection angle (D)	Theodolite Vernier Reading	Remarks
1						
2						
3						
4						
5						
6						

E) COMMENTS:

LABORATORY SHEET 4.23	Plot the data observed in measuring the horizontal distance between two inaccessible points using Theodolite and obtained the inaccessible distance from the plot

OBJECTIVE: ***Plot the Data Observed in Measuring the Horizontal Disance between Two Inaccessible Points Using Theodolie and Obtained he Inaccessible distance from the Plot***

APPARATUS/RESOURSES FOR PLOTTING:

1. Drawing Sheet
2. Drawing Board
3. Mini Drafter
4. Protractor
5. T. Square
6. Set Squares
7. Compass
8. Divider
9. Clips
10. Pencil
11. Eraser
12. Scale

1. TASK ANALYSIS

A. KNOWLEDGE

- Drawing sheet Sizes like A_0, A_1, A_2, A_3, A_4 etc.,
- Fixing the Mini Drafter
- North Direction Marking with compass
- Usages of Set squares
- Selection of Scale According to measurements

B.SKILLS

Category of Skill	Sub task
1. Handling of apparatus	A. Fixing the Drawing Sheet B. Fixing the Drafter C. Drawing the Title Box
2.Manipulation Of apparatus	A. Assume Scale as Required B. Draw angles According to given Measurements C. Check the measurements , scales & Angles

LABORATORY SHEET 4.23

Plot the data observed in measuring the horizontal distance between two inaccessible points using Theodolite and obtained the inaccessible distance from the plot

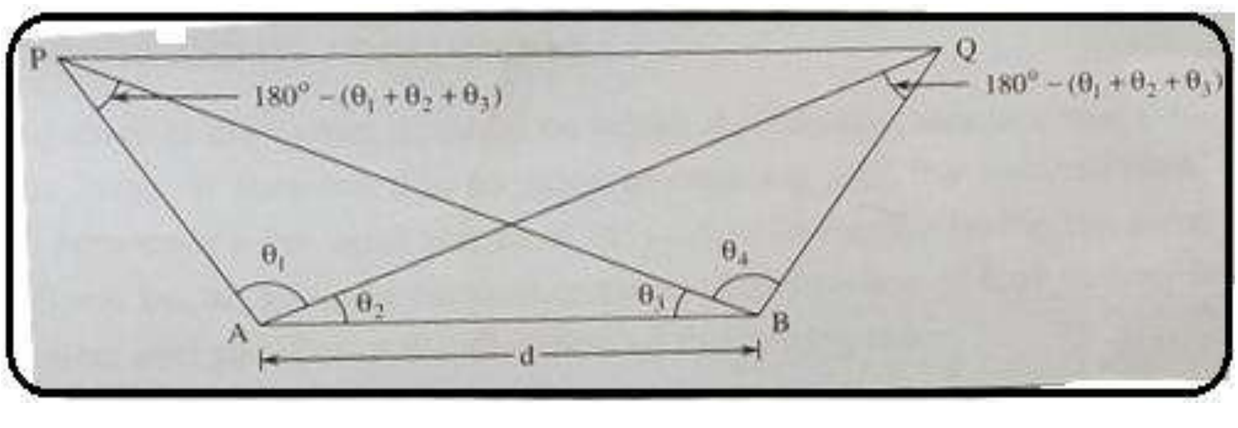
3.Precise Operation/Activity	A. Marking the North direction B. Measurements are drawn with suitable scales C. Check the Accuracy of angles D. Completion of the work using measurements with assumed Scales E. Plot with Neatness

2. TEACHING POINTS:

S. No.	Teaching points	Suggestive Duration (Min.)
1.	Fix the Drawing Sheet to Drawing table	5
2.	Mark the North Direction on the Drawing sheet by using compass	
3.	Draw the Dimensions accurately with given scales, Measurements & angles	10

3. EXPLANATORY NOTES:

The procedure of measurement of horizontal distance between two inaccessible points by using Theodolite is described in the experiment no 4.7. The faculty is requested to ascertain two inaccessible points in the field, practice the procedure to the students and note all the actual required length, angles etc in the field and calculate them the horizontal distance as per procedure.



Let P and Q be the in accessible points the distance from P to Q is to be determined.

Let at'd' = Distance between two instrument station.

From at (A) = The angles Θ_1 and Θ_2 can be measured.

From at (B) = The angle Θ_3 and Θ_4 can be measured.

With above information using the formulas in experiment no 4.7. The distance can be obtained. All the measurements can be plotted to a suitable scale and confirm.

4. NEED AND SCOPE OF THE EXPERIMENT: The Experiment Procedure will be Helpful to find the distance between two inaccessible points and plotting will help to draw the drawing according to a suitable scale for any other Reference.

5. PLANNING AND ORGANIZATION

Action	Activity
Check for	1. Drawing Sheet is fixed to Drawing Table tightly. 2. According to scale the Measurements are plotted on the Drawing Sheet. 3. The angles will be Plotted Accurately in the Drawing sheet.
For design of Instruction	Read the teaching points carefully.

5. SCHEME OF EVALUATION: For Plotting operation

Category of skill	**Sub Task**	**Weight with competency level individually**	**Awarded (50)**
1. Handling of apparatus	D. Fixing the Drawing Sheet E. Fixing the Drafter F. Drawing the Title Box	A 1.5 B 1.5 C 2 Total 5	

LABORATORY SHEET 4.23

Plot the data observed in measuring the horizontal distance between two inaccessible points using Theodolite and obtained the inaccessible distance from the plot

2.Manipulation Of apparatus	D. Assume Scale as Required E. Draw angles According to given Measurements F. Check the measurements , scales & Angles	A: 3, B: 4, C: 3, Tot: 10	
3.Precise Operation/Activity	F. Marking the North direction G. Measurements are drawn with suitable scales H. Check the Accuracy of angles I. Completion of the work using measurements with assumed Scales J. Plot with Neatness	A: 5 B: 5 C: 5 D: 10 E: 5 Total: 30	
4. Values	A. Co-operation B. Co-ordination C. Communication D. Sharing E. Leadership	5	
Total		50	

6. ASSESSEMENT QUESTIONS :(Only Suggestive)

1. What is the Necessity of Scale in Plotting?
2. Explain the types of Scale?
3. Explain the types of Drawing sheet Sizes?

Plot the closed traverse of theodolite, distribute the closing error by Bowditch/transit rule calculate the area of traverse.

OBJECTIVE

To Perform the different tasks for Plot the closed traverse of theodolite, distribute the closing error by Bowditch/transit rule calculate the area of traverse.

EQUIPMENT/APPARATUS/RESOURSES

1. A Drawing board,
2. A Tee Square,
3. Set squares,
4. A drawing instrument box,
5. Drawing-paper of good-quality of required size.
6. Pencils of grade 2H, 3H or 4H.
7. Sundries such as rubber, brushes, drawing-pins, weights, sandpaper, knife etc.

1. TASK ANALYSIS

A. KNOWLEDGE

- *Knowledge of field work,*
- *Assuming suitable scale,*
- *Using of plotting instruments,*
- *Fixing drawing board and drawing sheet,*
- *Bowditch's rule & Transit rule.*
- *Error correction in traversing,*
- *Area calculation of traverse*

B. SKILLS

Category of Skill	Sub task
1. Handling of apparatus	• Fixing the drawing board without tilt. • Proper Use of plotting instruments, • Fixing of Drawing sheet to drawing board. • Units of measurements on scale.
2.Manipulation of apparatus	• Assuming suitable scale to plot on drawing sheet. • Plotting the closed traverse as per scale assumed. • Measuring with scales as plotted measurements are correct
3. Precise operation /activity	• Plotting procedure. • Identifying mistakes while plotting • Checking the errors using formulae. • Calculating area of traverse.

Plot the closed traverse of theodolite, distribute the closing error by Bowditch/transit rule calculate the area of traverse.

2. TEACHING POINTS

S. No.	Teaching points	Suggestive Duration (Min.)
1.	Description about Theodolite A. Importance of Plotting of closed traverse	1
	B. Method of plotting closed traverse	1
	C. Size of drawing sheet to be used for plotting.	1
2.	Fixing of drawing sheet to drawing board.	1
3.	Using of instruments for plotting	1
4.	Errors involved in closed traverse.	1
5.	Balancing a closed traverse by Bowditch's rule and Transit rule	3
6.	Calculation of area of closed traverse.	3
7.	Precautions	3
	A. Procedural precautions • Care should be taken while fixing the drawing board and drawing sheet. • Any errors in scales and instruments should be observe. • Proper scale should be selected. • Proper care should be taken for selection of suitable position of the base line, because the entire accuracy of the frame-work depends upon it. • Check the accuracy of the plotted frame work.	
	Total	15

Plot the closed traverse of theodolite, distribute the closing error by Bowditch/transit rule calculate the area of traverse.

2. NEED AND SCOPE OF THE EXPERIMENT

Plotting means to represent on paper, to a suitable scale, the previously surveyed objects in accordance with their shape and size. Plotting is commenced after the field-work is over.

By Plotting the closed traverse on paper, we can eliminate errors occurred during field work. Area of closed traverse can be calculated easily.

4. PLANNING AND ORGANIZATION

Action	Activity
Check for	1. Drawing board and drawing sheet. 2. Field measurements before plotting commencing. 3. The accuracy of the plotted frame work according to field measurements.
For design of Instruction	Observe the field work and measurements before plotting

Plot the closed traverse of theodolite, distribute the closing error by Bowditch/transit rule calculate the area of traverse.

5. SCHEME OF EVALUATION

Category of skill	Sub Task	Weight with competency level individually	Awarded (50)
1. Handling of apparatus	A. Fixing the drawing board without tilt. B. Proper use of plotting instruments. C. Fixing the base line at suitable position with scales. D. Errors in instruments.	A 1 B 2 C 4 D 3 Total 10	
2. Manipulation Of apparatus	A. Assuming of suitable scale. B. Units of measurements on scales. C. Method of plotting closed traverse.	A 1 B 1 C 3 Total 10	
3. Precise Operation / Activity	A. Plotting procedure B. Identifying mistakes while plotting. C. Observation of field work. D. Bowditch's rule and transit rule. E. Calculation of area of closed traverse. F. The accuracy of the plotted frame work according to field measurements	A 3 B 3 C 5 D 4 E 5 F 5 Tot 25	
4. Values	A. Co-operation B. Co-ordination C. Communication D. Sharing E. Leadership	A 1 B 1 C 1 D 1 E 1 Tot 5	
Total		50	

Plot the closed traverse of theodolite, distribute the closing error by Bowditch/transit rule calculate the area of traverse.

6. ASSESSMENT QUESTIONS (suggestive only)

(this is for Formative Assessment only)

1. What is plotting?
2. What is the necessity of plotting?
3. What sizes of drawing sheets available in market?
4. What instrument should be used for plotting of closed traverse.
5. What are the errors involved in closed traverse?
6. How to eliminate the errors?
7. What method used for plotting of closed traverse by theodolite.
8. What is Bowditch's rule and its use in closed traverse?
9. What is Transit rule and its use in closed traverse?
10. How the area will be calculated in closed traverse.

7. VIVA QUESTIONS (suggestive only)

(this is for Summative Assessment)

The teacher may add questions depending upon the Context of examination

1. What is traversing?
2. Define Surveying.
3. What is the necessity of plotting the traversing?
4. State the instruments used for plotting closed traverse.
5. What are the uses of theodolite?
6. What are the errors involved in traversing.
7. What is Latitude and departure in traversing.
8. What is the least count of main scale and Vernier scale in horizontal plate
9. What is the meant by face left and face right observation
10. What is principle of surveying?

Plot the Simple Curve after setting out the Curve in the Field by Ordinates from long chord method

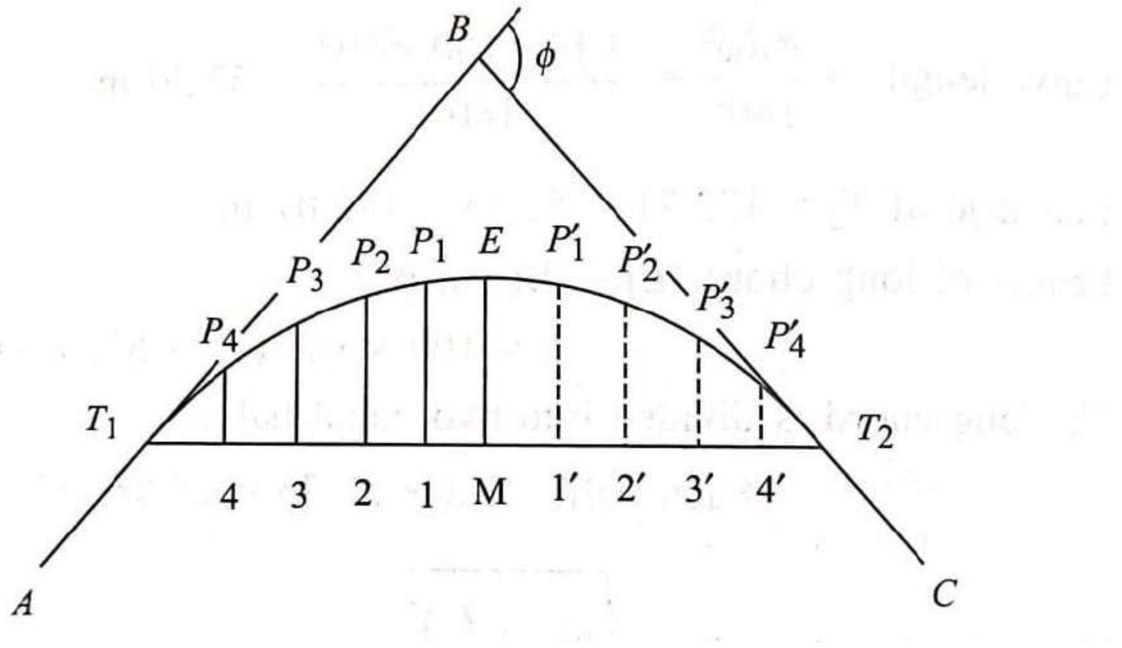
OBJECTIVE

Performing the set of tasks to Plot the Simple curve after setting out the curve in the field by Ordinates from long chord method

EQUIPMENT/APPARATUS/RESOURSES

1. Chain – 1 No.
2. Tape – 1 No.
3. Ranging rods – 4 No
4. Arrows – 10 No.
5. Cross staff - 01 No
6. Lime
7. Rope or Thread

FIELD SKETCH:



1. TASK ANALYSIS

A. KNOWLEDGE

- Unfolding chain and joining Tangent points (Long Chord)
- Fixing ranging rods at Tangent points
- Erecting mid ordinate on long chord using cross staff.
- Joining Tangent points with mid ordinate using tape.

- Erecting mid ordinate at mid-point of long chord using cross staff.
- Erecting Ordinates on both sides of the mid ordinate on long chord.

B.SKILLS

Category of Skill	Sub task
1. Handling of apparatus	• Unfolding the chain and making it into straight. • Fixing the Ranging rods at station. • Driving arrows / Pegs at required points. • Using Cross staff to mark Perpendicular Offsets. • Using tape to measure the horizontal distance.
2.Manipulation of apparatus	• Stretching the chain in between Points T1 and T2 mark the long chord. • Bisect the long chord to obtain the point M. • Using cross staff mark the perpendicular offset ME. • Using cross staff mark the ordinates at regular intervals on both sides of mid ordinate on long chord. • Joining the all the points in between T_1 E T_2 to get the smooth Curve.
3. Precise operation /activity	• Calculating the Length of long chord, using the formula, L = 2R sin Ø /2 • Calculating the mid ordinate of the long chord, using the formula, $O_o = R - \sqrt{R^2 - (\frac{L}{2})^2}$ • Calculating the ordinates at regular intervals on both sides of mid ordinate, using the formula, $O_x = \sqrt{R^2 - x^2} - (R - Ox)$
4. Safety of the Equipment	• Unfolding the chain on level and smooth ground toavoid detaching of links and tallies. • Holding the ranging rod at certain height above the ground so as to avoid touching its tip to ground while carrying. • Driving ranging rods firmly into the ground so as to avoid falling on to the ground frequently and loosing its verticality • Avoiding driving of cross staff, ranging rods, arrows on stones/rocks.

2. TEACHING POINTS

<table>
<tr><th>S. No.</th><th>Teaching points</th><th>Suggestive Duration (Min.)</th></tr>
<tr><td>1.</td><td>Description about
A. Deflection Angle
B. Tangent Points
C. Long Chord
D. Mid ordinates</td><td rowspan="3">5</td></tr>
<tr><td>2.</td><td>Using of Chain &Tape in the field</td></tr>
<tr><td>3.</td><td>Using of Ranging rods and Arrows in the field</td></tr>
<tr><td>4.</td><td>Calculating the length of long chord</td><td rowspan="5">10</td></tr>
<tr><td>5.</td><td>Calculating the mid ordinate of long chord</td></tr>
<tr><td>6.</td><td>Calculating the ordinates on long chord on both sides of mid ordinate.</td></tr>
<tr><td>7.</td><td>Fixing the Pegs / Arrows at ordinates on both sides of mid ordinate.</td></tr>
<tr><td>8.</td><td>Joining the all marked ordinates to get required curve</td></tr>
</table>

8.	**Procedural precautions** • Care should be taken while measuring horizontal distance • Care should be taken while folding and unfolding the chain. • Care should be taken while erecting ranging rods vertically • Care should be taken while bisecting the chords • Care should be taken while placing the Arrows. • Care should be taken while erecting perpendiculars with cross staff • Care should be taken while joining the all ordinates obtained to get smooth curve	
	Total	15

3. NEED AND SCOPE OF THE EXPERIMENT

The curves required in the horizontal plane are known as Horizontal Curves. Whenever the direction of a road or railway line is to be changed, curves are provided between the intersecting straights. This is necessary for smooth and safe movement of the vehicles and for the comfort of passengers.

4. PLANNING AND ORGANIZATION

Action	Activity
Check for	1. All Links and Tallies in the chain. 2. Actual length of Chain and Tape 3. Opened links in chain and Tape. 4. Marked readings on Tape. 5. Straightness of ranging rods. 6. Fixing the pegs at ordinates

5. SCHEME OF EVALUATION

Category of skill	Sub Task	Weight with competency level individually	Awarded (50)

<table>
<tr>
<td>1. Handling of apparatus</td>
<td>A. Unfolding the chain
B. Fixing the Ranging rods at stations
C. Driving arrows / pegs at required points.
D. Using Cross staff to mark perpendicular offsets
E. Folding the Chain</td>
<td><table><tr><td>A</td><td>2</td></tr><tr><td>B</td><td>2</td></tr><tr><td>C</td><td>2</td></tr><tr><td>D</td><td>2</td></tr><tr><td>E</td><td>2</td></tr><tr><td>Total</td><td>10</td></tr></table></td>
<td></td>
</tr>
<tr>
<td>2.Manipulation Ofapparatus</td>
<td>A. Stretching the chain in between Points T1 and T2 mark the long chord Bisect the long chord to obtain the point M
B. Bisect the long chord to obtain the point E.
C. Using cross staff mark the perpendicular offset ME
D. Using cross staff,mark the ordinates at regular intervals on both sides of mid ordinate on long chord.
E. Joining the all ordinates to get the smooth Curve.</td>
<td><table><tr><td>A</td><td>4</td></tr><tr><td>B</td><td>4</td></tr><tr><td>C</td><td>4</td></tr><tr><td>D</td><td>4</td></tr><tr><td>E</td><td>4</td></tr><tr><td>Total</td><td>20</td></tr></table></td>
<td></td>
</tr>
<tr>
<td>3.Precise Operation/Activity</td>
<td>A. Calculating the Length of long chord using the formula, L = 2R sin Ø /2
B. Calculating the mid ordinate of the long chord, using the formula DE = R(1-cos (Ø/2)) or O_o = R – $\sqrt{R^2} - (\frac{L}{2})^2$
C. Calculating the ordinates at regular intervals on both sides of mid ordinate, using the formula,
$O_x = \sqrt{R^2 - x^2} - (R - Ox)$</td>
<td><table><tr><td>A</td><td>5</td></tr><tr><td>B</td><td>5</td></tr><tr><td>C</td><td>5</td></tr><tr><td>Tot</td><td>15</td></tr></table></td>
<td></td>
</tr>
<tr>
<td>4. Values</td>
<td>A. Co-operation
B. Co-ordination
C. Communication
D. Sharing
E. Leadership</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td colspan="2">Total</td>
<td>50</td>
<td></td>
</tr>
</table>

6. **ASSESSMENT QUESTIONS** (Only suggestive)

1. Give the formula for calculatingthe length of Long Chord.

2. Give the formula for calculating the mid ordinate.

3. Determine the Ordinates from long chord at various Intervals.
4. List the linear methods of setting out a simple curve.
5. Give the formula for calculating the ordinates by offsets from long chord method.

7. VIVA QUESTIONS

(Only suggestive) The teacher may add questions depending upon the Context of examination

1. What are the significance of curves?
2. What are the Various Methods of Setting out the curves?
3. What are the various elements of the Curves?
4. How to calculate the Chainage of T_1 and T_2?
5. What is the procedure for Setting of Curve by Offsets from long Chord method?
6. What is simple curve?
7. Is the simple curve radius uniform throughout?

WORKSHEET 4.1

TEMPORARY ADJUSTMENTS OF THEODOLITE

Name of the student:		Date of experiment:
PIN:	Branch:	
Institution:		Experiment No:

- Title of the experiment: Temporary adjustments of a Theodolite
- Objective of the experiment: ______________________________
- Apparatus/Tools required: ______________________________
- PROCEDURE:

1)
2)
3)
4)
5)
6)
7)
8)

- INFERENCE:____

- DEFICIENCIES/MALFUNCTIONING OF ANY APPARATUS: _______________________

Check for	• functioning of foot screws. • bubble tube sluggishness. • check for permanent adjustments • check whether the clamp screws are tightened or loosened • legs and adjusting screws of tripod
For Instructions	Read the teaching points carefully.

Scheme of Evaluation

Category of skill	Sub Task	Weight with competency level individually	Awarded (50)
1. Handling of apparatus	• fixing the theodolite to the tripod • operating foot screws appropriately	10	
2.Manipulation of apparatus	• centering the instrument exactly over station using plumbob • rotating the telescope parallel /perpendicular to the bubble tube • bringing bubble to the center of bubble tube using approproiate foot screws	15	
3.Precise Operation/Activity	• focusing the eyepiece until crosshairs are distinctly visible • focusing the object glass to bring image clearly in the plane of crosshairs • elimination of parallax and sighting the staff	20	
4. Values	• Co-operation • Co-ordination • Communication • Sharing • Leadership	5	
Total		50	

WORK SHEET

Name of the student:		Date of experiment:
PIN:	Branch:	
Institution:		Experiment No:

1. Title of the experiment: **MEASUREMENT OF HORIZONTAL ANGLE USING THEODOLITE**
2. Objective of the experiment: ____
3. Apparatus/Tools required: ____
4. PROCEDURE:

1)
2)
3)
4)
5)
6)
7)
8)

5. OBSERVATIONS:

Instrument station	object	face	Readings on verniers	Mean	angle	Remarks

7.INFERENCE:____

____
_

____
_

____
_

____
_

8. DEFICIENCIES/MALFUNCTIONING OF ANY APPARATUS:

____

_

_

WORK SHEET 3.1a

9. SCHEME OF EVALUATION

Category of skill	Sub Task	Weight with competency level individually	Awarded (50)
1. Handling of apparatus	A. Fixing of theodolite to the tripod stand. B. Checking for centering of instrument using plumb bob. Making temporary adjustments of the instrument. A.	10	
2.Manipulation of apparatus	A. Focusing the telescope to the points 'A' and 'B'. B. Bisecting the points 'A' and 'B'. C. Reading vernier scale and		

	main scale of the theodolite.	15	
3.Precise Operation/Activity	A. Convert all measurements into single unit B. Finding the distanace between two points 'A' and 'B'. C. Observing the readings on vernier scale and main scale of the thedolite. D. Noting the readings in field book. A. Calculating the horizontal angle.	20	
4. Values	A. Co-operation B. Co-ordination C. Communication D. Sharing E. Leadership	5	
Total		50	

WORK SHEET

Name of the student :		Date of experiment:
PIN :	Branch:	
Institution:		Experiment No.

1. Title of the Experiment: Measure the horizontal angles by repetition method.

2. Objective of the Experiment: ____________________

3. Equipment Required: ____________________

____

5. Procedure:

Face left swing right						Face right swing left				
Instrument at	Sighted to	A	B	Mean	Horizontal angle	A	B	Mean	Horizontal angle	Average Horizontal angle

6. RESULT:

7. INFERENCE:

8. DEFICIENCIES/MALFUNCTIONING OF ANY APPARATUS:

9. SCHEME OF EVALUATION

CATEGORY OF SKILL	SUB TASK	WEIGHTAGE WITH COMPETENCY LEVEL INDIVIDUALLY	Marks Awarded
1. Handling of apparatus	A. Lifting the Theodolite from the box B. Fixing the instrument on tripod. C. Removing the instrument from tripod. D. Placing the Theodolite in to the box properly	10	
2. Manipulation of apparatus	A. Identifying the component parts of the Theodolite. B. Making temporary adjustments. C. Rotating eye piece to view cross hairs clearly. D. Maintaining the verticality of the ranging rods over the stations. E. Noting the readings on main scale & Vernier scale	20	
3.Precise operations/Activities	. A. Centering the instrument over the given station. B. Levelling the bubble by adjusting the foot screws. C. Bisecting the ranging rods accurately. D. Calculating the angles from the observations.	15	
4.Values	A. Co Operation B. Co-Ordination C. Communication D. Sharing E. Leadership	5	
		Total	50

Signature of the Staff | Signature of the Student

WORK SHEET

Name of the student :		Date of experiment:
PIN :	Branch:	
Institution:		Experiment No.

1. Title of the Experiment: Measurement of horizontal angle by Reiteration method.

2. Objective of the Experiment: ____

3. Equipment Required: ____

____

5. Procedure:

Face left swing right						Face right swing left				
Instrument at	Sighted to	A	B	Mean	Horizontal angle	A	B	Mean	Horizontal angle	Average Horizontal angle
O	P									
	Q									
	R									
	S									
	T									

6. RESULT:

7. INFERENCE:

8. DEFICIENCIES/MALFUNCTIONING OF ANY APPARATUS:

9. SCHEME OF EVALUATION

CATEGORY OF SKILL	SUB TASK	WEIGHTAGE WITH COMPETENCY LEVEL INDIVIDUALLY	Marks Awarded
1. Handling of apparatus	A. Lifting the Theodolite from the box B. Fixing the instrument on tripod. C. Removing the instrument from tripod. D. Placing the Theodolite in to the box properly	10	
2. Manipulation of apparatus	A. Identifying the component parts of the Theodolite. B. Making temporary adjustments. C. Rotating eye piece to view cross hairs clearly. D. Maintaining the verticality of the ranging rods over the stations. E. Noting the readings on main scale & Vernier scale	20	
3.Precise operations/Activities	. A. Centering the instrument over the given station. B. Levelling the bubble by adjusting the foot screws. C. Bisecting the ranging rods accurately. D. Calculating the angles from the observations.	15	
4.Values	A. Co Operation B. Co-Ordination C. Communication D. Sharing E. Leadership	5	
		Total	50

Signature of the Lab Incharge

Signature of the Student

WORK SHEET

Name of the student:		Date of experiment:
PIN:	Branch:	
Institution:		Experiment No:

1. Title of the experiment: MEASUREMENT OF VERTICAL ANGLES

2. Objective of the experiment: ______________________________

____

3. Apparatus/Tools required: ______________________________

____

4. Rough Sketch:

5. Survey Group Details:

6. Distribution of work among survey group if any

S.No.	Name of the student	Work allotted	Time	
			from	to

7. PROCEDURE:

1)
2)
3)
4)
5)
6)
7)
9)
10)
11)
12)
13)
14)
15)
16)
17)
18)
19)
20)

8. OBSERVATIONS:

Distance between Theodolite and Object D =__________ mts

S. No.	Inst. Station	Sight to	Face of observation	Vernier C ° ' "	Vernier D ° ' "	Mean of C & D Angle ° ' "	Average Vertical Angle ° ' "	Remarks
1	P	A	Left					Angle of Elevation (+α1)
2	P	A	Right					Angle of Elevation (+α1)
3	P	B	Left					Angle of Depression (-α2)
4	P	B	Right					Angle of Depression (-α2)

SPECIMENS CALCULATIONS

Calculate the height h1 (instrument horizontal position to top of object) = D X tan α1 =_________ m

Calculate the height h1 (instrument horizontal position to top of object) = D X tan α2 =_________ m

Height of the object AB = h1+h2 =__________ + ___________ = _____________ m

6.RESULT:____

____

7. COMMENTS / REMARKS: (Not mandatory)

____

____

____

8. DEFICIENCIES/MALFUNCTIONING OF ANY APPARATUS:

____

____

____

9. SCHEME OF EVALUATION

<table>
<tr><th>Category of skill</th><th>Sub Task</th><th>Weight with competency level individually</th><th>Awarded (50)</th></tr>
<tr><td>1. Handling of apparatus</td><td>A. Fixing the Theodolite to the tripod
B. Unclamp the upper clamps of the Theodolite and observe the movement of theodolite in horizontal direction and telescope in vertical plane.
C. Carry out the temporary adjustments of Theodolite using foot screws and altitude bubble tube
D. Using the tape or chain measure the horizontal distance, ‘D’ between the Theodolite and the object whose height is to be measured
E. Identifying the situations of using ranging rod and pegs</td><td><table><tr><td>A</td><td>1</td><td></td></tr><tr><td>B</td><td>3</td><td></td></tr><tr><td>C</td><td>3</td><td></td></tr><tr><td>D</td><td>2</td><td></td></tr><tr><td>E</td><td>1</td><td></td></tr><tr><td>Total</td><td>10</td><td></td></tr></table></td><td></td></tr>
<tr><td>2.Manipulation Of apparatus</td><td>A. Bisecting the top accurately and measuring the angle of elevation in face left and right observations
B. Bisecting the bottom accurately and measuring the angle of depression in face left and right observations
C. Reading values carefully</td><td><table><tr><td>A</td><td>B</td><td>C</td><td>Tot</td></tr><tr><td>5</td><td>5</td><td>5</td><td>15</td></tr><tr><td></td><td></td><td></td><td></td></tr></table></td><td></td></tr>
</table>

<table>
<tr>
<td>3.Precise Operation/Activity</td>
<td>A. Convert all measurements into single unit viz, distance and angles
B. Measuring the distance between theodolite and object
C. Calculating the average angle of elevation.
D. Calculating the average angle of depression.
E. Calculating the Height of the object</td>
<td><table>
<tr><td>A</td><td>2</td><td></td></tr>
<tr><td>B</td><td>5</td><td></td></tr>
<tr><td>C</td><td>5</td><td></td></tr>
<tr><td>D</td><td>3</td><td></td></tr>
<tr><td>E</td><td>5</td><td></td></tr>
<tr><td>Tot</td><td>20</td><td></td></tr>
</table></td>
<td></td>
</tr>
<tr>
<td>4. Values</td>
<td>A. Co-operation
B. Co-ordination
C. Communication
D. Sharing
E. Leadership</td>
<td><table><tr><td>5</td><td></td></tr></table></td>
<td></td>
</tr>
<tr>
<td colspan="2">Total</td>
<td>50</td>
<td></td>
</tr>
</table>

SIGNATURE OF THE STUDENT

SIGNATURE OF THE FACULTY WITH DATE

WORK SHEET 3.

Prolong a given survey line by double transiting method

WORK SHEET

Name of the student:		Date of experiment:
PIN:	Branch:	
Institution:		Experiment No:

1. Title of the experiment: To perform prolonging of a given survey line by double transiting method

2. Objective of the experiment: __ To perform prolonging of a given survey line

____

3. Apparatus/Tools required: _ Theodolite, Tripod, Plumb bob, Ranging rods, Arrows,

4. PROCEDURE:

.

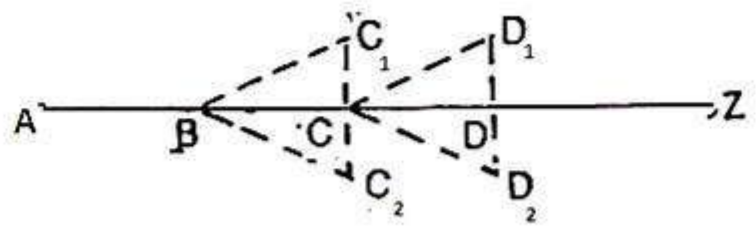


Fig. 9.12

1) Fix the ranging rod at station A on survey line AB
2) Fix the tripod at station B and approximately level by adjusting the legs, then legs fixed firmly into the ground.
3) Lift theodolite carefully from the box and fix it on tripod stand
4) Temporary adjustments were carried out.
5. With the face of instrument left, focus ranging road at station A and tight both the upper and lower clamp screws.
6. Transit the telescope and set a point C_1 ahead in line AB.
7) Now change the face of the instrument right by loosening the lower clamp, then revolve the telescope in the horizontal plane and focus (back sight) on A, Bisect A exactly by using the lower clamp & its tangent screw.

8) Transit the telescope and establish a point C_2 in line beside the point C_1.
9)The exact position of the true point C must be midway between C_1 and C_2.
10) Measure C_1, C_2 and establish a point C exactly mid-way, which lies on the true prolongation of AB.
11) Shift the instrument to C, double-sight on B, establish the points D_1 and D_2 and establish the true point D as before.
12) Continue the process until the last point Z is established

5. OBSERVATIONS:

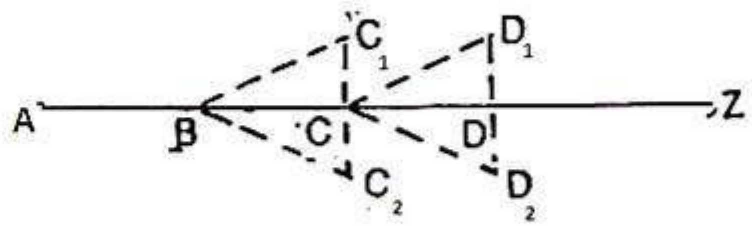


Fig. 9.12

8. DEFICIENCIES/MALFUNCTIONING OF ANY APPARATUS:

9. SCHEME OF EVALUATION

Category of skill	Sub Task	Weight with competency level individually	Awarded (50)
1. Handling of apparatus	A. Lifting the instrument from box B. Fixing the tripod over station C. Fixing theodolite on tripod D. Approximate leveling of tripod with legs	5	
2.Manipulation of apparatus	A. Centering by using plumb bob B. Operating clamp screws and tangential screws C. Swinging the instrument	10	
3.Precise Operation/Activity	A. Centering the instrument B. Levelling the instrument by operating foot screws C. Focusing telescope by operating focusing screw D. Transiting the theodolite by operating clamp screws E. Fixing of ranging rods on newly established stations.	30	
4. Values	A. Co-operation B. Co-ordination C. Communication D. Sharing E. Leadership	5	
Total		50	

Determination of horizontal distance between two inaccessible points by using theodolite

WORK SHEET

Name of the student:		Date of experiment:
PIN:	Branch:	
Institution:		Experiment No:

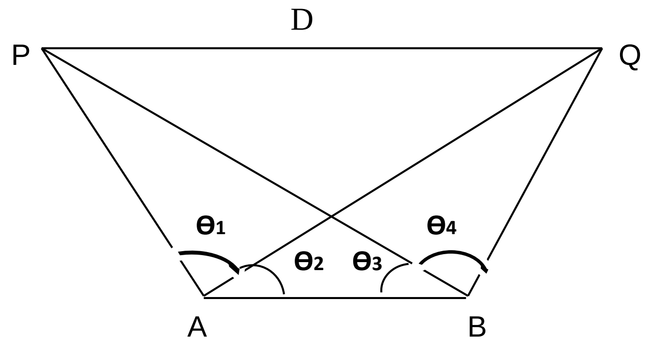
1. Title of the experiment: To Perform Theodolite surveying to determine the horizontal distance between two inaccessible points.

2. Objective of the experiment: To perform Theodolite surveying to determine the horizontal distance between two inaccessible points.

3. Apparatus/Tools required: _ Theodolite, Tripod, Plumb bob, Ranging rods, Arrows,

4. PROCEDURE:

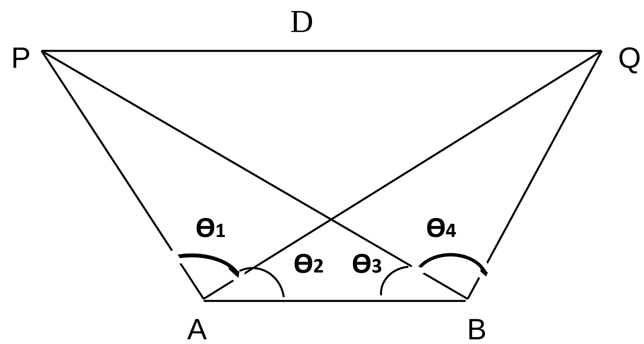
.



1. **Set up** the theodolite at **A** by making the **temporary adjustments** level it **accurately** with respect to the **altitude bubble**.
2. Sight the point **P** by keeping the horizontal circle **reading at zero.**
3. Loosen the **upper clamp** and rotate the telescope to **sight Q** and get the horizontal angle **PAQ (Θ_1).**

4. Sight the point **Q** by keeping the horizontal circle **reading at zero.**
5.Loosen the **upper clamp** and rotate the telescope to **sight B** and get the horizontal angle **QAB (Ɵ2).**
6.**Shift** the instrument to **station B** and do the **temporary adjustments**.
7.**Sight** the point **A** by keeping the horizontal circle **reading at zero.**
8. Loosen the **upper clamp** and rotate the telescope to **sight P** and get the horizontal angle **ABP (Ɵ3).**
9.Sight the point **P** by keeping the horizontal circle **reading at zero**.
10. **Loosen** the **upper clamp** and rotate the telescope to **sight Q** and get the horizontal angle **PBQ (Ɵ4).**
11.**Measure** the horizontal distance between and **A and B** using tape accurately.

5. OBSERVATIONS:



8. DEFICIENCIES/MALFUNCTIONING OF ANY APPARATUS:

9. SCHEME OF EVALUATION

Category of skill	Sub Task	Weight with competency level individually	Awarded (50)
1. Handling of apparatus	A. Using tape to measure the horizontal distance. B. Using plumb bob to centering the theodolite. C. Adjusting tripod legs to required line of sight. D. Rotating foot screws to levelling the theodolite. E. Eliminating parallax error by focusing.	5	
2.Manipulation of apparatus	A. Maintaining Centre of the bubble tube of the theodolite. B. Releasing of clamps to rotate the telescope. C. Setting horizontal plate angle to zero.	10	
3.Precise Operation/Activity	A. Convert all measurements into single unit B. Noting down the horizontal angle accurately C. Drawing plot in proto type. D. Applying sine and cosine rules. E. Calculating the horizontal distance.	30	
4. Values	A. Co-operation B. Co-ordination C. Communication D. Sharing E. Leadership	5	
Total		50	

WORK SHEET 4.8

Measure the bearing of survey line

WORK SHEET

Name of the student:		Date of experiment:
PIN:	Branch:	
Institution:		Experiment No:

1. Title of the experiment: **Measurement Of Magnetic Bearing Of Survey Line**

2. Objective of the experiment: ______________________________

____

3. Apparatus/Tools required: ______________________________

____

4. PROCEDURE:

1)
2)
3)
4)
5)
6)
7)
8)

WORK SHEET 4.9

Measure the bearing of survey line

5. OBSERVATIONS:

Length of survey line = m

Inst .at	Sighted to	Face Left					Swing Right		Face Right					Swing Right		Average Bearing of AB	Remarks
		A			B		Mean	Bearing of AB	A			B		Mean	Bearing of AB		

6.RESULT:____

7.INFERENCE:____

8. DEFICIENCIES/MALFUNCTIONING OF ANY APPARATUS:

WORK SHEET 4.9

Measure the bearing of survey line

9. SCHEME OF EVALUATION

Category of skill	Sub Task	Weight with competency level individually	Awarded (50)
1. Handling of apparatus	A. Pick the theodolite from box B. Fixing the theodolite on tripod C. Releasing lockingnob of trough compass D. Erecting the pegs on survey line	5	
2.Manipulation of apparatus	A. Setting up of theodolite over the tripod B. Approximate levelling by the tripod C. Centering of instrument over a station D. Levelling the theodolite E. Focussing the eye piece F. Focussing the the objective G. Fixing the trough compass to the theodolite H. Loosen the lower clamp and trough compass needle and swing the telescope until magnetic needle on N-S graduation on trough compass	30	
3.Precise Operation/Activity	A. Average Reading on vernier A and Veriner B B. Magnetic bearing should be read on both the face (face left and face right) C. Compare and average both face left and face right observations	10	
4. Values	A. Co-operation B. Co-ordination C. Communication D. Sharing E. Leadership	5	
Total		50	

WORK SHEET 4.9

Perform the task of theodolite traversing (closed), to Compute latitudes and departures, and the area of closed traverse.

Name of the student:		**Date of experiment:**
PIN:	**Branch:**	
Institution:		**Experiment No:**

1. Title of the experiment: **To Perform the task of theodolite traversing (closed), to Compute latitudes and departures, and the area of closed traverse.**

2. Objective of the experiment:

____

____

3. Apparatus/Tools required:

____

____

4. PROCEDURE:

1)
2)
3)
4)
5)
6)
7)
8)
9)
10)
11)
12)
13)
14)

WORK SHEET 4,10

To Perform the task of theodolite traversing (closed), to Compute latitudes and departures, and the area of closed traverse.

5. OBSERVATIONS:

S.no	Inst at	Sighted to	Length of line (m)	Fore bearing (whole circle bearing)
1.	A	B		
2.	B	C		
3.	C	D		
4.	D	E		
5.	E	A		

6.CALCULATIONS:

Latitude and Departure Calculations:

S.no	line	Whole circle bearing	Reduced bearing	Latitude	Departure
1	AB				
2	BC				
3	CD				
4	DE				

5	**EA**				
Total latitude and departure				**ΣL**	**ΣD**

Check for error closure:

The algebraic sum of all latitudes should be equal to zero

The algebraic sum of all departures should be equal to zero

WORK SHEET 4.10

To Perform the task of theodolite traversing (closed), to Compute latitudes and departures, and the area of closed traverse

Traverse Balance By Bowditch method:

Correction to latitude or departure of any side

$$= \text{total error in latitude or departure} \times \left(\frac{\text{length of that side}}{\text{perimeter of traverse}}\right)$$

$$\text{Correction to latitude (CL)} = \sum L` \ X \frac{1}{\sum 1}$$

$$\text{Correction to departure (CD)} = \sum D` \ X \frac{1}{\sum 1}$$

AREA CALCULATION BY CO-ORDINATE METHOD:

				Independent coordinates

Line	Corected Latitude	Corrected Departure	Station	North (y)	East (x)
AB					
BC					
CD					
DE					
EA					

WORK SHEET 4.10

To Perform the task of theodolite traversing (closed), to Compute latitudes and departures, and the area of closed traverse

Formula :

In terms of X and Y coordinates

$$2(\text{Area}) = X_A(Y_E - Y_B) + X_B(Y_A - Y_C) + X_C(Y_B - Y_D) + X_D(Y_C - Y_E) + X_E(Y_D - Y_A)$$

- In general, if we have 'n' stations, we get

$$\text{Area} = \frac{1}{2}\{y_1(x_2 - x_4) + y_2(x_3 - x_1) + y_3(x_4 - x_2) + \ldots + y_n(x_1 - x_{n-1})\}$$

6.RESULT:____

____

7. INFERENCE:

8. DEFICIENCIES / MALFUNCTIONING OF ANY APPARATUS:

WORK SHEET 4.9

9. SCHEME OF EVALUATION

To Perform the task of theodolite traversing (closed), to Compute latitudes and departures, and the area of closed traverse

Category of skill	Sub Task	Weight with competency level individually	Awarded (50)
1. Handling of apparatus	A. Fixing the Tripod on ground. B. Lifting the Theodolite Level from Box / case. C. Fixing the Theodolite to Tripod and magnetic compass to theodolite D. Hold/fix the ranging rod	A – 1 B – 2 C – 4 D – 3 Total – 10	
2.Manipulation Of apparatus	A. Observing the reading from vernier through Theodolite B. Measuring the distance between given (two) points C. Exact bisection of object (ranging rod) using horizontal focusing screws	A – 3 B – 3 C – 4 Total – 10	
3.Precise Operation / Activity	A. Focusing the Objective Lens B. Focusing the Eye-piece C. Leveling the instrument D. Measuring the linear distances. E. Observing the horizontal plate main scale readings and Vernier scale readings F. Fitting magnetic compass , fixing ranging rods , pegs . To form closed traverse	A – 3 B – 3 C – 5 D – 4 E – 5 F – 5 Total – 25	
4. Values	A. Co-operation B. Co-ordination C. Communication D. Sharing E. Leadership	A – 1 B – 1 C – 1 D – 1 E – 1 Total – 5	
Total		50	

WORK SHEET

<table>
<tr><td colspan="2">Name of the student:</td><td rowspan="2">Date of experiment:</td></tr>
<tr><td>PIN:</td><td>Branch:</td></tr>
<tr><td colspan="2">Institution:</td><td>Experiment No:</td></tr>
</table>

1. Title of the experiment: Determination of horizontal and vertical distance of an object whose base is accessible
2. Objective of the experiment: Measuring Horizontal and Vertical Distances of an object whose base is accessible
3. APPARATUS/TOOLS REQUIRED:
    1. Transit Theodolite
    2. Tripod
    3. Plumb bob
    4. Tape
    5. Leveling Staff
    6. Pegs.

4. FIELD/ROUGH SHETCH

Let,

FROM FIG 1.0

P	= instrument station
Q	= Point to be observed
A	= Center of the instrument
α	= Angle of elevation from A to Q
h'	= height of the instrument at P
Q1	=Projection of Q on horizontal plane
D	= horizontal distance between P and Q1(Measured with Tape/Chain)
S	= Reading on staff kept on B.M, with line of sight on horizontal

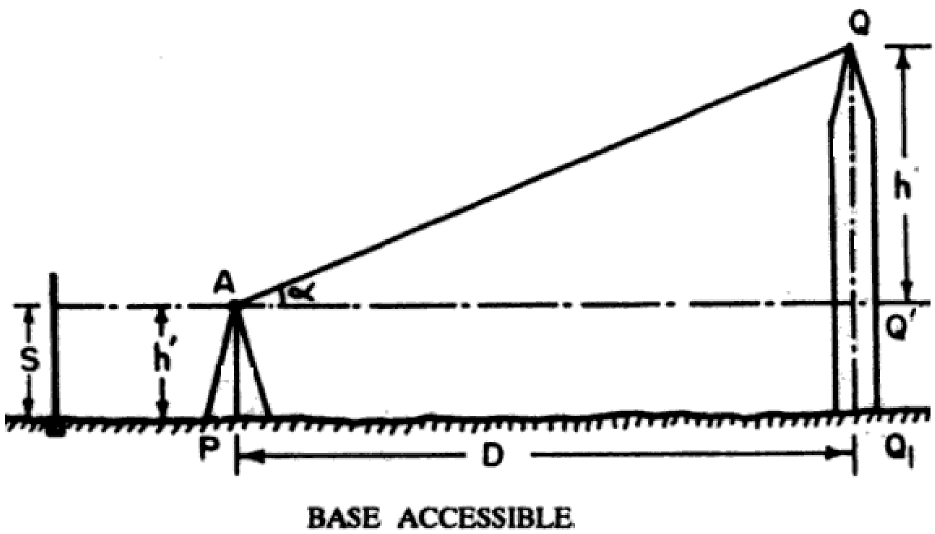


FIG 1.0

Horizontal Distance PQ_1 = D= Measured with tape / chain

Vertical Distance QQ' = h = D. tanα

RL of Q (m) = RL of P + h' + h

5. TEAM MEMBERS:

6. WORK DISTRIBUTION, IF ANY:

S.NO	NAME OF THE STUDENT	WORK ALLOTED / PERFORMED	TIME TAKEN TO PERFORM

7. PROCEDURE:

1) Setting up the instrument over station 'O' in such a way that all the points should be visible from the instrument station.
2) Carrying out the temporary adjustments, setting vernier zero reading and making line of sight horizontal.
3) Taking the first staff reading on Benchmark and determining height of instrument.
4) Swinging the telescope towards the object.
5) Release the vertical clamp screw, sight the top of the object Q, and clamp the vertical clamp screw.
6) Read vernier readings and enter in the tabular form.
7) The above procedure will be repeated with the face right observation.
8) The average of the two observations by transiting the telescope taken with different faces will be vertical angle.
9) Measure the Horizontal distance between the instrument station and the object (PQ1 – FIG 1.0)
10) Determining the vertical height of an object and R.L top and bottom of an object using appropriate equations

8. FIELD BOOK:

9. CALCULATIONS:

10. RESULT:

11. INFERENCE:

12. DEFICIENCIES/MALFUNCTIONING OF ANY APPARATUS:

SIGNATURE OF THE STUDENT

DATE:

SIGNATURE OF THE FACULTY

DATE:

13. SCHEME OF EVALUATION

Category of skill	Sub Task	Weight with competency level individually	Awarded (50)
1. Handling of apparatus	A. Fixing the Theodolite over a tripod B. Centering a theodolite over a station C. Levelling the instrument accurately with the help of foot screws D. D.Focussing the eye-piece E. Focussing the object	10	
2.Manipulation of apparatus	A. Reading the Main scale and vernier scale B. Operating Lower clamp screw and tangent screw and upper clamp and tangent screw C. Transiting and Swinging the Telescope	15	
3.Precise Operation/Activity	A. Entering the face left and face right readings in tabular form B. Calculating the average horizontal angle C. Calculating average vertical angle D. Calculating horizontal and vertical distance E. Calculating RL	20	
4. Values	A. Co-operation B. Co-ordination C. Communication D. Sharing E. Leadership	5	
Total		50	

Determine the horizontal and vertical distance of an object whose base is inaccessible when the two instrument stations and the object are in the same vertical plane.

WORK SHEET

Name of the student:		Date of experiment:
PIN:	Branch:	
Institution:		Experiment No:

1. **TITLE OF THE EXPERIMENT:**

Measurement of horizontal and vertical distance of an object whose base is inaccessible when the two instrument stations and the object are in the same vertical plane.

2. OBJECTIVE OF THE EXPERIMENT:

3. APPARATUS/TOOLS REQUIRED:

4. ROUGH SKETCH:

5. SURVEY GROUP DETAILS:

6. DISTRIBUTION OF WORK AMONG SURVEY GROUPIF ANY

S.No.	Name of the student	Work allotted/ Performed	Time	
			from	to

7. PROCEDURE:

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8. OBSERVATIONS:

Horizontal Distance between two instrument stations b =________m.

Staff reading on bench mark taken from A and B, S = ________ m.

Reduced level of the bench mark R.L = + ___________ m.

S. No.	Inst. Station	Sight to	Face of observation	Vernier C ° ' "	Vernier D ° ' "	Mean of C & D Angle ° ' "	Average Vertical Angle ° ' "	Remarks
1	A	Q	Left					Angle of Elevation ($+\alpha 1$)

2	A	Q	Right					Angle of Elevation (+α1)
3	B	Q	Left					Angle of Elevation (+α2)
4	B	Q	Right					Angle of Elevation (+α2)

9.SPECIMENS CALCULATIONS:

a) Instrument axes at the same level:

Calculate the horizontal distance between P and Q, $D = b \tan \alpha 2 / (\tan\alpha 1 - \tan\alpha 2)$

D = __________m.

Calculate the height of the object, $h = b \sin\alpha 1 \sin\alpha 2 / \sin(\alpha 1 - \alpha 2)$

h = ___________ m.

Calculate reduced level of Q = Reduced level of BM + S + h

= _____________m.

b) Instrument axes at the different level:

If S_1 and S_2 are the corresponding staff readings on staff kept at Bench mark, the difference in levels of the instrument axes will be $S_2 - S_1$.

Staff reading S_1 =

Staff reading S_2 =

$s = S_2 - S_1$

Calculate the horizontal distance between P and Q, $D = (b \pm s \cot \alpha 2) \tan \alpha 2 / (\tan\alpha 1 - \tan\alpha 2)$

D = __________m.

Calculate the height of the object, $h_1 = (b \pm s \cot \alpha 2) \sin\alpha 1 \sin\alpha 2 / \sin(\alpha 1 - \alpha 2)$

h_1 = ___________ m.

(use + sign with s cot α2 when the instrument axis at A is lower and – sign when it is higher than at B)

Calculate reduced level of Q = Reduced level of BM + S_1 + h_1

$= \underline{\hspace{5cm}} m.$

10. RESULT:

11. COMMENTS / REMARKS :(Not mandatory)

12. DEFICIENCIES/MALFUNCTIONING OF ANY APPARATUS:

C

<table>
<tr><th>CATEGORY OF SKILL</th><th>SUB TASK</th><th>WEIGHT WITH COMPETENCY LEVEL INDIVIDUALLY</th><th>AWARDED

(50)</th></tr>
<tr><td>Handling of apparatus</td><td>A. Identifying the convenient point and pressing the tripod legs into the ground firmly.
B. Lifting the theodolite from the instrument box properly.
C. Fixing the theodolite over the tripod head using screws.
D. Removing the theodolite from the tripod head using screws.
E. Keeping the theodolite in the instrument box in correct position.
F. Carrying the ranging rods properly.
G. Holding the levelling staff vertically.
H. Holding the chain (or) tape in correct position while measuring the distances.</td><td><table>
<tr><td>A</td><td>1</td><td></td></tr>
<tr><td>B & E</td><td>1</td><td></td></tr>
<tr><td>C & D</td><td>1</td><td></td></tr>
<tr><td>F & H</td><td>1</td><td></td></tr>
<tr><td>G</td><td>1</td><td></td></tr>
<tr><td>Total</td><td>5</td><td></td></tr>
</table></td><td></td></tr>
</table>

<table>
<tr>
<td>Manipulation of apparatus</td>
<td><u>Temporary adjustments:</u>
A. Centering the theodolite over the station mark using plumb bob and by moving tripod legs radially as well as circumferentially.
B. Swinging the telescope such that plate level is parallel as well as perpendicular to the line joining the pair of levelling screws.
C. Bringing the bubble to the centre of its run by turning the levelling screws uniformly.
D. Setting the zero of the vertical vernier exactly to the zero of the vertical circle by means of the vertical clamp screw and tangent screw.
E. Swinging the telescope such that altitude level is parallel to the line joining the pair of levelling screws.
F. Bringing the bubble to the centre of its run by turning the levelling screws uniformly.
G. Turning the telescope through 90^0 by unclamping the vernier plate.
H. Bringing the bubble to the centre of its run by turning the third levelling screw.
I. Making the cross hairs to look distinct and clear by</td>
<td>
<table>
<tr><td>A</td><td>1</td><td></td></tr>
<tr><td>B</td><td>1</td><td></td></tr>
<tr><td>C</td><td>1</td><td></td></tr>
<tr><td>D</td><td>1</td><td></td></tr>
<tr><td>E</td><td>1</td><td></td></tr>
<tr><td>F</td><td>1</td><td></td></tr>
<tr><td>G</td><td>1</td><td></td></tr>
<tr><td>H</td><td>1</td><td></td></tr>
<tr><td>I</td><td>1</td><td></td></tr>
<tr><td>J</td><td>1</td><td></td></tr>
<tr><td>K</td><td>1</td><td></td></tr>
<tr><td>L</td><td>1</td><td></td></tr>
<tr><td>M</td><td>2</td><td></td></tr>
<tr><td>N</td><td>1</td><td></td></tr>
<tr><td>Total</td><td>15</td><td></td></tr>
</table>
</td>
<td></td>
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</table>

<table>
<tr>
<td></td>
<td>focusing eye piece.
J. Bringing the image of the object in the plane of cross hairs by focusing objective piece.

<u>Measurement of vertical angles:</u>

K. Directing the telescope towards the object by loosening vertical clamp screw.
L. Sighting the object approximately and clamp the vertical circle using clamp screw.
M. Bisecting the object accurately using tangent screw.
N. Changing the face of the instrument by transiting and swinging the telescope</td>
<td></td>
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</tr>
<tr>
<td>Precise operation/ Activity</td>
<td>A. Taking the vernier readings in both face left and face right.
B. Calculating the average vertical angle between two instrument stations and top of the object α1 and α2.
C. Measuring the horizontal distance between two instrument stations.
D. Observing and noting down the readings of levelling staff on bench mark.
E. Calculating the horizontal distance between instrument station and object.</td>
<td><table>
<tr><td>A</td><td>5</td><td></td></tr>
<tr><td>B</td><td>5</td><td></td></tr>
<tr><td>C</td><td>2</td><td></td></tr>
<tr><td>D</td><td>3</td><td></td></tr>
<tr><td>E</td><td>5</td><td></td></tr>
<tr><td>F</td><td>5</td><td></td></tr>
<tr><td>Total</td><td>25</td><td></td></tr>
</table></td>
<td></td>
</tr>
</table>

<table>
<tr><td></td><td>F. Calculating the reduced level of the object.</td><td></td><td></td></tr>
<tr><td>Values</td><td>A. Co-operation
B. Co-ordination
C. Communication
D. Sharing
E. Leadership</td><td><table><tr><td>A</td><td>1</td><td></td></tr><tr><td>B</td><td>1</td><td></td></tr><tr><td>C</td><td>1</td><td></td></tr><tr><td>D</td><td>1</td><td></td></tr><tr><td>E</td><td>1</td><td></td></tr><tr><td>Total</td><td>5</td><td></td></tr></table></td><td></td></tr>
<tr><td colspan="2">Total</td><td>50</td><td></td></tr>
</table>

<u>14. CERTIFICATION:</u>

SIGNATURE OF THE STUDENT
WITH DATE

SIGNATURE OF THE FACULTY
WITH DATE

WORK SHEET 4.12

To Perform the different tasks for determining the horizontal and vertical distances of an object whose base is inaccessible when the instrument stations and obiects are not in same vertical

Name of the student:		Date of experiment:
PIN:	Branch:	
Institution:		Experiment No:

1. Title of the experiment: To Perform the different tasks for determining the horizontal and vertical distances of an object whose base is inaccessible when the instrument stations and objects are not in same vertical

2. Objective of the experiment: ____
____

3. Apparatus/Tools required: ____
____

4. PROCEDURE:

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WORK SHEET 4,12

To Perform the different tasks for determining the horizontal and vertical distances of an object whose base is inaccessible when the instrument stations and objects are not in same vertical plane

5. OBSERVATIONS:

d = __________ m (distance between P and R)

S. No	Instrument at	Sight to	Horizontal angle	Vertical angle	Staff Readings	Remarks
1	P	Q		α_1	S1	Reading on Bench mark from instrument at P
2	P	R,Q	θ_1			Horizontal angle RPQ
3	R	Q		α2	S2	Reading on Bench mark from instrument at R
4	R		θ_2			Horizontal angle PRQ

CALCULATIONS

$$PQ_3 = \frac{b \sin\theta_2}{\sin(\theta_1+\theta_2)} \text{ --------- } 2$$

$$RQ_3 = \frac{b \sin\theta_1}{\sin(\theta_1+\theta_2)} \text{ --------- } 3$$

WORK SHEET 4.12

To Perform the different tasks for determining the horizontal and vertical distances of an object whose base is inaccessible when the instrument stations and objects are not in same vertical plane

$$h_2 = RQ_3 \tan \alpha_2 = \frac{b \sin \theta 1 \tan \alpha 2}{\sin (\theta 1 + \theta 2)}$$

$$\text{Then R.L of Q} = \text{R.L of B.M} + s_2 + h_2 .$$

6.RESULT:____

7. INFERENCE:____

8. DEFICIENCIES / MALFUNCTIONING OF ANY APPARATUS:

WORK SHEET 4.12

9. SCHEME OF EVALUATION

To Perform the different tasks for determining the horizontal and vertical distances of an object whose base is inaccessible when the instrument stations and objects are not in same vertical plan

Category of skill	**Sub Task**	**Weight with competency level individually**	**Awarded (50)**
1. Handling of apparatus	A. Fixing the Tripod on ground. B. Lifting the Theodolite Level from Box / case. C. Fixing the Theodolitel to Tripod D. Holding the Level Staff	A – 1 B – 2 C – 4 D – 3 Total – 10	
2.Manipulation Of apparatus	A. Observing the reading from level staff through Theodolite B. Measuring the distance between given (two) points C. Exact bisection of object using horizontal and vertical focusing screws	A – 1 B – 1 C – 3 Total – 10	
3.Precise Operation / Activity	A. Focusing the Objective Lens B. Focusing the Eye-piece C. Leveling the instrument D. Calculating the horizontal and vertical distances. E. Observing the horizontal plate main scale readings and Vernier scale readings F. 0bserving the vertical circle readings Vernier C and Vernier D	A – 3 B – 3 C – 5 D – 4 E – 5 F – 5 Tot – 25	
4. Values	A. Co-operation B. Co-ordination C. Communication D. Sharing E. Leadership	A – 1 B – 1 C – 1 D – 1 E – 1 Tot – 5	
Total		50	

WORK SHEET

Name of the student		Date of Experiment
Pin	Branch	
Institution		Experiment Number

1. Title of experiment : Determine the Tacheometric constants K & C

2. Objective of the experiment **:**

   ____

   ____

3. Apparatus/Equipment required**:**

   ____

   ____

4. Field Rough sketch

5. Team Members

6. Distribution of work

SlNo	Name of student	Work allotted

7. Procedure .

1	
2	
3	
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8. Observation / Tabulation of Readings

SlNo	Distance D (M)	Stadia Hair Reading (M)			Staff intercept S (m)
		Top	Middle	Bottom	
1	20				
2	40				
3	60				

9. SPECIMAN CALCUATIONS

S1= Top hair Reading 1 – Bottom hair reading 1 = -------- m

S2= Top hair Reading 2 – Bottom hair reading 2 = -------- m.

S3= Top hair Reading 3 – Bottom hair reading 3 = -------- m

D1= KS1+C------------- (1)

D2= KS2+C------------- (2)

D3= KS3+C------------- (3)

Solving equations above

Multiplying constant K=____________

Additive Constant C=____________

10. Result ____

____

11. Inference ____

____

12. Deficiencies / malfunctioning of any Apparatus

____

____

13. Scheme of Evaluation

SlNo	Category of skill	Sub task	Weight with competency level individually	AWARDED (50)
1	HANDING OF APPARATUS	**A** Collecting Equipments required and carrying it to site	10	
		B Removing the theodolite from the box.		
		C Fixing the theodolite to the tripod.		
		D Measuring the land with tape or chain		
		E Unscrewing the theodolite from the tripod after completion of experiment.		
		F Placing the theodolite in the box		
2	MANIPULATION OF APPARATUS	**A** Centering the tripod over the station	15	
		B Levelling the theodolite		
		C Focussing the eYe piece		
		D Focussing the objective		
		E Bringing vertical angle to 0 ‘ 0’0” in the theodolite		
		F Reading the staff		

3	**PRECEIES OPERATION/ ACTIVITY**	**A** Calculating the staff intercept **B** Substituting the values of distance and staff intercept in the tacheometer equation. **C** Solving the equations in pears **D** Calculating the3 value of tacheometric constants **E** Calculating the average values of K&C.	20	
4	**VALUES**	**A** Co-operation **B** Coordination **C** Communication **D** Sharing **E** Leadership	5	
TOTAL			**50**	

WORK SHEET

Name of the student :		Date of experiment:
PIN :	Branch:	
Institution:		Experiment No.

1. Title of the Experiment: Determination of horizontal distance and elevation by principle of stadia tacheometry (considering angle of elevation)

2. Objective of the Experiment: ____

3. Equipment Required: ____

____

5. Procedure:

Face left Observation (Angle of elevation)						Face right Observation (Angle of elevation)				
Instrument at	Sighted to	C	D	Mean	Vertical angle	C	D	Mean	Vertical angle	Average Vertical angle

6. RESULT:

7. INFERENCE:

8. DEFICIENCIES/MALFUNCTIONING OF ANY APPARATUS:

9. SCHEME OF EVALUATION

CATEGORY OF SKILL	SUB TASK	WEIGHTAGE WITH COMPETENCY LEVEL INDIVIDUALLY	Marks Awarded
1. Handling of apparatus	A. Lifting the Theodolite from the box B. Fixing the instrument on tripod. C. Removing the instrument from tripod. D. Placing the Theodolite in to the box properly	10	
2. Manipulation of apparatus	A. Identifying the component parts of the Theodolite. B. Making temporary adjustments. C. Rotating eye piece to view cross hairs clearly. D. Maintaining the verticality of the ranging rods over the stations. E. Noting the readings on main scale & Vernier scale	20	
3.Precise operations/Activities	. A. Centering the instrument over the given station. B. Levelling the bubble by adjusting the foot screws. C. Bisecting the object accurately. D. Calculating the angles from the observations.	15	
4.Values	A. Co Operation B. Co-Ordination C. Communication D. Sharing E. Leadership	5	
		Total	50
Signature of the Staff		Signature of the Student	

WORK SHEET 4.15

Determination of Horizontal Distance and Elevation by principle of stadia Tacheometry (considering angle of depression)

WORK SHEET

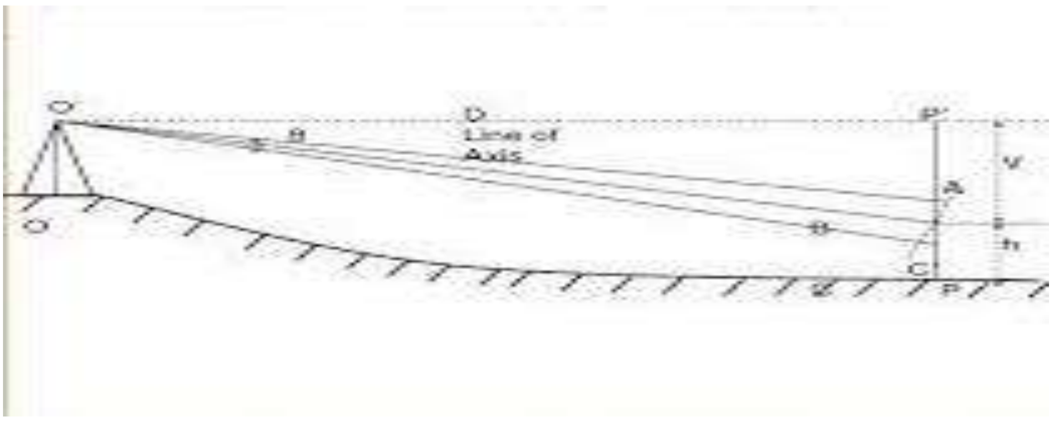
Name of the student:		Date of experiment:
PIN:	Branch:	
Institution:		Experiment No:

1. Title of the experiment: Determination of Horizontal Distance and Elevation by principle Of stadia Tacheometry (considering angle of depression

2. Objective of the experiment: Determination of Horizontal Distance and Elevation by Principle of stadia Tacheometry (considering angle of depression)

3. Apparatus/Tools required: Theodolite, Tripod, Plumb bob and cross staff

B. PROCEDURE:



- Fix the Theodolite on station O
- Fix the tripod at station O and approximately level by adjusting the legs, then legs fixed firmly into the ground.
- Lift theodolite carefully from the box and fix it on tripod stand
- Temporary adjustments were carried out.
- With the face of instrument left, focus leveling staff at station P and tight both the upper and lower clamp screws.

- Transit the telescope and focus towards the leveling staff.
- Adjust the focusing screw and use transit screws if necessary for clear vision.
- By observing C and D verniers note the vertical angle of depression.
- Also note down the corresponding staff readings.
- The horizontal distance
- $D = L \cos\Theta$
- $= (k\ s \cos\Theta + C) \cos\Theta$
- $D = k\ s \cos^2\Theta + C \cos\Theta$ . . . . . . (1)
- $V = L \sin \Theta$
- $= (k\ s \cos\Theta + C) \sin\Theta$
- $= k\ s \cos\Theta \cdot \sin\Theta + C \sin\Theta$
- $V = k\ s \sin^2\Theta/2 + C \sin\Theta$…….. (2)
- Thus equations (1) and (2) are the distance and Vertical component formulae for inclined line of sight.
- R.L of Station P= RL of Line of axis – V- h

C.RESULT

The horizontal distance and elevation of the given station are determined by using Stadia tachometry.

WORK SHEET 4.15

4. SCHEME OF EVALUATION

Category of skill	Sub Task	Weight with competency level individually	Awarded (50)
1. Handling of apparatus	A. Lifting the instrument from box B. Fixing the tripod over station C. Fixing Theodolite on tripod D. Approximate leveling of tripod with legs	5	
2.Manipulation of apparatus	A. Centering by using plumb bob B. Operating clamp screws and tangential screws C. Swinging the instrument	10	
3.Precise Operation/Activity	A. Centering the instrument B. Leveling the instrument by operating foot screws C. Focusing telescope by operating focusing screw D. Transiting the Theodolite by operating clamp screws E. Fixing of ranging rods on newly established stations.	30	
4. Values	A. Co-operation B. Co-ordination C. Communication D. Sharing E. Leadership	5	
Total		50	

WORK SHEET

<table>
<tr><td colspan="2">Name of the student:</td><td rowspan="2">Date of experiment:</td></tr>
<tr><td>PIN:</td><td>Branch:</td></tr>
<tr><td colspan="2">Institution:</td><td>Experiment No:</td></tr>
</table>

1. Title of the experiment: CURVE SETTING (Offsets from Long chord method*)*

2. Objective of the experiment: ____

3. Apparatus/Tools required:____

4. Rough Sketch:

5. Survey Group Details:

6. Distribution of work among survey group if any

<table>
<tr><th rowspan="2">S.No.</th><th rowspan="2">Name of the student</th><th rowspan="2">Work allotted</th><th colspan="2">Time</th></tr>
<tr><th>FROM</th><th>TO</th></tr>
<tr><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td></td><td></td><td></td><td></td><td></td></tr>
</table>

7. PROCEDURE:

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8. CALCULATIONS

1. Tangent length, TL = R tan Ø/2 = ________ m

2. Length of the curve, CL = $\frac{\Pi R Ø}{180}$ = ________ m

3. Length of the long chord (L) = 2R sin Ø /2 = ________ m

4. Mid-Ordinate O_o = R(1- cos Ø/2) = ________ m

5. Chainage of T_1 = Chainage of POI – TL

6. Chainage of T_2 = Chainage of T_1 + CL

7. Calculation of Ordinates, $O_x = \sqrt{R^2 - x^2} - (R - Ox)$

x = Length of Interval

9.RESULT:____

____

10. COMMENTS / REMARKS:(Not mandatory)

____

____

____

11. DEFICIENCIES/MALFUNCTIONING OF ANY APPARATUS:

____

____

____

12. SCHEME OF EVALUATION:

Category of skill	**Sub Task**	**Weight with competency level individually**	**Awarded (50)**
1. Handling of apparatus	A. Unfolding the chain B. Fixing the Ranging rods at stations C. Driving arrows / pegs at required points. D. Using Cross staff to mark perpendicular offsets E. . Folding the Chain	A 2 B 2 C 2 D 2 E 2 Total 10	
2.Manipulation Ofapparatus	A. Stretching the chain in between Points T1 and T2 mark the long chord Bisect the long chord to obtain the point D B. Bisect the long chord to obtain the point E. C. Using cross staff mark the perpendicular offset DE D. Using cross staff, mark the ordinates at regular intervals on both sides of mid ordinate on long chord. E. Joining the points T_1DT_2 to get the smooth Curve.	A 3 B 3 C 3 D 3 E 3 Total 15	
3.Precise Operation/Activity	A. Calculating the Length of long chord using the formula, L = 2R sin Ø /2 B. Calculating the mid ordinate of the long chord, using the formula DE = R(1-cos (Ø/2)) or $O_o = R - \sqrt{R^2 - (\frac{L}{2})^2}$ C. Calculating the ordinates at regular intervals on both sides of mid ordinate, using the formula, $O_x = \sqrt{R^2 - x^2} - (R - Ox)$	A 5 B 5 C 10 Tot 20	
4. Values	A. Co-operation B. Co-ordination C. Communication D. Sharing E. Leadership	5	
	Total	50	

SIGNATURE OF THE STUDENT **SIGNATURE OF THE FACULTY WITH DATE**

WORK SHEET

Name of the student:		Date of experiment:
PIN:	Branch:	
Institution:		Experiment No:

1. **Title of the experiment:** CURVE SETTING BY SUCCESSIVE BISECTION OF ARCS

2. Objective of the experiment: ____

____

3. Apparatus/Tools required:____

____

4. Rough Sketch:

5. Survey Group Details:

6. Distribution of work among survey group if any

S.No.	Name of the student	Work allotted	Time	
			from	to

7. PROCEDURE:

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8. CALCULATIONS

The Perpendicular CD length = $R(1-\cos(\theta/2))$

The Perpendicular lengths $C_1D_1 = C_2D_2 = R(1-\cos(\theta/4))$

The Perpendicular lengths $C_3D_3 = C_4D_4 = R(1-\cos(\theta/8))$

9.RESULT:____

10. COMMENTS / REMARKS: (Not mandatory)

11. DEFICIENCIES/MALFUNCTIONING OF ANY APPARATUS:

12. SCHEME OF EVALUATION

<table>
<tr><th>Category of skill</th><th>Sub Task</th><th>Weight with competency level individually</th><th>Awarded(50)</th></tr>
<tr><td>1. Handling of apparatus</td><td>A. Unfolding the chain .
B. Fixing th Ranging rods at stations
C. Driving arrows / pegs at required points
D. Using Cross staff to mark perpendicular offset
E. Folding the Chain</td><td><table><tr><td>A</td><td>2</td></tr><tr><td>B</td><td>2</td></tr><tr><td>C</td><td>2</td></tr><tr><td>D</td><td>2</td></tr><tr><td>E</td><td>2</td></tr><tr><td>Total</td><td>10</td></tr></table></td><td></td></tr>
<tr><td>2.Manipulation Of apparatus</td><td>A. Stretching the chain in between Points T_1 and T_2 mark the long chord.Bisect the long chord to obtain the point D.
B. Using cross staff, mark the perpendicular offset DC.
C. Using tape join T_1 and T_2 with C.
D. Bisecting the sub chords T_1C and T_2C
E. Joining C, C_1, C_2,…….to obtain smooth curve</td><td><table><tr><td>A</td><td>3</td></tr><tr><td>B</td><td>3</td></tr><tr><td>C</td><td>3</td></tr><tr><td>D</td><td>3</td></tr><tr><td>E</td><td>3</td></tr><tr><td>Tot</td><td>15</td></tr></table></td><td></td></tr>
</table>

<table>
<tr>
<td>3.Precise Operation/Activity</td>
<td>A. Calculating the Length of long chord
B. Calculating the mid ordinate of the long chord, using the formula DC = R(1-cos (θ/2)) (or) R-$\sqrt{R^2 - (\frac{L}{2})^2}$.
C. Calculating the mid ordinate of sub chord, using the formula
$D_1C_1 = D_2C_2 = R(1-\cos(\theta/4))$
D. Calculating the mid ordinate of sub chords, using the formula
$D_3C_3 = D_4C_4 = R(1-\cos(\theta/8))$</td>
<td><table><tr><td>A</td><td>5</td><td></td></tr><tr><td>B</td><td>5</td><td></td></tr><tr><td>C</td><td>5</td><td></td></tr><tr><td>D</td><td>5</td><td></td></tr><tr><td>Tot</td><td>20</td><td></td></tr></table></td>
<td></td>
</tr>
<tr>
<td>4. Values</td>
<td>A. Co-operation
B. Co-ordination
C. Communication
D. Sharing
E. Leadership</td>
<td><table><tr><td>5</td><td></td></tr></table></td>
<td></td>
</tr>
<tr>
<td colspan="2">Total</td>
<td>50</td>
<td></td>
</tr>
</table>

SIGNATURE OF THE STUDENT **SIGNATURE OF THE FACULTY WITH DATE**

WORK SHEET

Name of the student:		Date of experiment:
PIN:	Branch:	
Institution:		Experiment No:

1. Title of the experiment: CURVE SETTING (*Radial offsets from tangents)*

2. Objective of the experiment: ____

3. Apparatus/Tools required:____

4. Rough Sketch:

5. Survey Group Details:

6. Distribution of work among survey group if any

S.No.	Name of the student	Work allotted	Time	
			FROM	TO

7. PROCEDURE:

1)
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20)

8. CALCULATIONS

1. Tangent length, TL = R tan Ø/2 = ________ m

2. Length of the curve, CL = $\frac{\Pi R Ø}{180}$ = ________ m

3. Chainage of T_1 = Chainage of POI – TL

4. Chainage of T_2 = Chainage of T_1 + CL

5. Calculation of Radial Offsets, $O_x = \sqrt{R^2 + x^2} - R$

x = Length of Interval

9.RESULT:____

____

10. COMMENTS / REMARKS:(Not mandatory)

____

____

____

11. DEFICIENCIES/MALFUNCTIONING OF ANY APPARATUS:

____

____

____

12. SCHEME OF EVALUATION:

Category of skill	Sub Task	Weight with competency level individually	Awarded (50)
1. Handling of apparatus	A. Unfolding the chain B. Fixing the Ranging rods at stations C. Driving arrows / pegs at required points. D. Using tape to mark the radial offsets E. . Folding the Chain	A 2 B 2 C 2 D 2 E 2 Total 10	
2.Manipulation Ofapparatus	**A.** Stretching the chain in between Points T1 and B mark the Tangent Length. **B.** Offsets O_{x1}, O_{x2}, O_{x3}........are erected radially to the tangent T_1B with tape to get P_1, P_2, P_3...... points on the curve. **C.** Check the apex distance using tape to checkthe accuracy of work. D. Joining the points P_1, P_2, P_3,... to get the smooth curve.	A 2 B 9 C 2 D 2 Total 15	
3.Precise Operation/Activity	A. Calculating the Length of tangent, T_1B = R tan Ø/2 B. Calculating the radial Offsets O_{x1}, O_{x2}, O_{x3}........ , are calculated using the formula, $O_x = \sqrt{R^2 + x^2} - R$ C. Check should be made by measuring the apex distance, which should be equal to R[sec Ø/2 - 1]	A 5 B 10 C 5 Tot 20	
4. Values	A. Co-operation B. Co-ordination C. Communication D. Sharing E. Leadership	5	
Total		50	

SIGNATURE OF THE STUDENT **SIGNATURE OF THE FACULTY WITH DATE**

WORK SHEET

<table>
<tr><td colspan="2">Name of the student:</td><td rowspan="2">Date of experiment:</td></tr>
<tr><td>PIN:</td><td>Branch:</td></tr>
<tr><td colspan="2">Institution:</td><td>Experiment No:</td></tr>
</table>

1. **Title of the experiment:** **CURVE SETTING**(*perpendicular offsets from tangents)*

2. Objective of the experiment: ____

____

3. Apparatus/Tools required:____

____

4. Rough Sketch:

5. Survey Group Details:

6. Distribution of work among survey group if any

S.No.	Name of the student	Work allotted	Time	
			from	to

7. PROCEDURE:

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12)
13)
14)
15)
16)
17)
18)

19)
20)

8. CALCULATIONS

1. Tangent length, TL = R tan Ø/2 = ________ m

2. Length of the curve, CL = $\frac{\Pi R \emptyset}{180}$ = ________ m

3. Chainage of T_1 = Chainage of POI – TL

4. Chainage of T_2 = Chainage of T_1 + CL

5. Calculation of Ordinates, O_x = $R - \sqrt{R^2 - x^2}$

x = Length of Interval

9.RESULT:____

____

10. COMMENTS / REMARKS: (Not mandatory)

____

____

____

11. DEFICIENCIES/MALFUNCTIONING OF ANY APPARATUS:

____

____

____

12. SCHEME OF EVALUATION

<table>
<tr><th>Category of skill</th><th>Sub Task</th><th>Weight with competency level individually</th><th>Awarded(50)</th></tr>
<tr><td>1. Handling of apparatus</td><td>A. Unfolding the chain .
B. Fixing th Ranging rods at stations
C. Driving arrows / pegs at required points
D. Using Cross staff to mark perpendicular offset
E. Folding the Chain</td><td>A 2
B 2
C 2
D 2
E 2
Total 10</td><td></td></tr>
<tr><td>2.Manipulation Of apparatus</td><td>• Stretching the chain in between Points T1 and B mark the tangent length.
• Using compass or theodolite mark the deflection angle to obtain other tangent T_2B.
• Using cross staff mark the perpendicular offsets from tangents at regular intervals.
• Using tape mark the calculated ordinates on perpendicular offsets.
• Joining the toe points of the offsets , smooth Curve may be observed</td><td>A 3
B 3
C 3
D 3
E 3
Tot 15</td><td></td></tr>
<tr><td>3.Precise Operation/Activity</td><td>• Calculating the Length of tangent , L = $R \tan Ø/2$
• Length of the curve, CL = $\frac{\Pi R Ø}{180}$
• Chainage of T_2 = Chainage of T_1 + Curve Length
• Calculating the perpendicular offsets at regular intervals, from tangents $O_o = R - \sqrt{(R^2 - x^2)}$</td><td>A 5
B 5
C 3
D 07
Tot 20</td><td></td></tr>
</table>

4. Values	A. Co-operation B. Co-ordination C. Communication D. Sharing E. Leadership	5	
Total		50	

SIGNATURE OF THE STUDENT **SIGNATURE OF THE FACULTY WITH DATE**

WORK SHEET

Name of the student:		Date of experiment:
PIN:	Branch:	
Institution:		Experiment No:

1. Title of the experiment: CURVE SETTING (Offsets from chord Produced method*)*

2. Objective of the experiment: ____

3. Apparatus/Tools required:____

4. Rough Sketch:

5. Survey Group Details:

6. Distribution of work among survey group if any

<table>
<tr><th rowspan="2">S.No.</th><th rowspan="2">Name of the student</th><th rowspan="2">Work allotted</th><th colspan="2">Time</th></tr>
<tr><th>FROM</th><th>TO</th></tr>
<tr><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td></td><td></td><td></td><td></td><td></td></tr>
</table>

7. PROCEDURE:

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20)	

8. CALCULATIONS

1. Tangent length, TL = R tan Ø/2 = ________ m

2. Length of the curve, CL = $\frac{\Pi R Ø}{180}$ = ________ m

3. Chainage of T_1 = Chainage of POI – TL

4. Chainage of T_2 = Chainage of T_1 + CL

5. Initial sub-chord = C_1 = -------------- m

6. No. of full chords of length 30m =

7. Chainage covered = ----------------- m

8. Final sub-chord = ------------- m

9. First offset for initial sub-chord = $O_1 = C_1^2/2R$ = ------------ m

10. Second offset for full chord = $O_2 = C_2 (C_1 + C_2)/2R$ = ---------- m

11. Similarly O_3 to $O_{n-1} = C^2/R$ = ------------ m

12. Last offset for final sub-chord = $C_n(C_{n-1} + C_n)/2R$ = ------------ m

9.RESULT:____

____

10. COMMENTS / REMARKS:(Not mandatory)

____

____

11. DEFICIENCIES/MALFUNCTIONING OF ANY APPARATUS:

____

12. SCHEME OF EVALUATION:

<table>
<tr><th>Category of skill</th><th>Sub Task</th><th>Weight with competency level individually</th><th>Awarded
(50)</th></tr>
<tr><td>1. Handling of apparatus</td><td>A. Unfolding the chain
B. Fixing the Ranging rods at stations
C. Driving arrows / pegs at required points.
D. Using tape to mark the radial offsets
E. . Folding the Chain</td><td><table><tr><td>A</td><td>2</td></tr><tr><td>B</td><td>2</td></tr><tr><td>C</td><td>2</td></tr><tr><td>D</td><td>2</td></tr><tr><td>E</td><td>2</td></tr><tr><td>Total</td><td>10</td></tr></table></td><td></td></tr>
<tr><td>2.Manipulation Ofapparatus</td><td>A. Stretching the chain in between Points T_1 and A mark the tangent length.
B. Marking the calculated chord length C_1 on tangent using tape.
C. Using cross staff mark the perpendicular offset at C_1 to denote the toe point E.
D. Positioning of chain be changed into direction T_1E and prolonged it to beyond E to a value of C_2.
E. Joining the toe points of the offsets, smooth Curve may be observed.</td><td><table><tr><td>A</td><td>3</td><td></td></tr><tr><td>B</td><td>3</td><td></td></tr><tr><td>C</td><td>2</td><td></td></tr><tr><td>D</td><td>3</td><td></td></tr><tr><td>E</td><td>3</td><td></td></tr><tr><td>F</td><td>3</td><td></td></tr><tr><td>G</td><td>3</td><td></td></tr><tr><td>Tot</td><td>20</td><td></td></tr></table></td><td></td></tr>
<tr><td>3.Precise Operation/Activity</td><td>A. Calculating the Length of tangent, $T_1B = R \tan Ø/2$
B. Calculating the radial Offsets O_{x1}, O_{x2}, O_{x3}…….. , are calculated using the formula, $O_x = \sqrt{R^2 + x^2} - R$
C. Check should be made by measuring the apex distance, which should be equal to R[sec Ø/2 - 1]</td><td><table><tr><td>A</td><td>3</td><td></td></tr><tr><td>B</td><td>3</td><td></td></tr><tr><td>C</td><td>2</td><td></td></tr><tr><td>D</td><td>3</td><td></td></tr><tr><td>E</td><td>3</td><td></td></tr><tr><td>F</td><td>3</td><td></td></tr><tr><td>G</td><td>3</td><td></td></tr><tr><td>Tot</td><td>20</td><td></td></tr></table></td><td></td></tr>
<tr><td>4. Values</td><td>A. Co-operation
B. Co-ordination
C. Communication
D. Sharing
E. Leadership</td><td>5</td><td></td></tr>
</table>

Total	50	

SIGNATURE OF THE STUDENT **SIGNATURE OF THE FACULTY WITH DATE**

WORK SHEET

<table>
<tr><td colspan="2">Name of the student:</td><td rowspan="2">Date of experiment:</td></tr>
<tr><td>PIN:</td><td>Branch:</td></tr>
<tr><td colspan="2">Institution:</td><td>Experiment No:</td></tr>
</table>

1. Title of the experiment: Setting out of curve by using one theodolite

2. Objective of the experiment: ____

____

3. Apparatus/Tools required:____

____

4. Rough Sketch:

5. Survey Group Details:

6. Distribution of work among survey groupif any

<table>
<tr><th rowspan="2">S.No.</th><th rowspan="2">Name of the student</th><th rowspan="2">Work allotted</th><th colspan="2">Time</th></tr>
<tr><th>from</th><th>to</th></tr>
<tr><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td></td><td></td><td></td><td></td><td></td></tr>
</table>

7. PROCEDURE:

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20)

8. OBSERVATIONS AND TABULATIONS:

Calculate the elements of the curve

Tangent length= R tan $\Phi/2$

Length of long chord= 2 R sin $\Phi/2$

Arc length = $\pi R\ \Phi/360$

Length of first sub chord =

Length of normal chord =

Length of last sub chord=

Deflection angle for first sub chord δ_1 = 1718.9 C_1/R

Deflection angle for normal chord δ_2 = 1718.9 C/R

Deflection angle for last sub chord δ_n = 1718.9 C_2/R

$\Delta_1 = \delta_1$

$\Delta_2 = \delta_1 + \delta_2$

$\Delta_3 = \delta_1 + \delta_2 + \delta_3$

$\Delta_n = \delta_1 + \delta_2 + \delta_3 + \dots\dots\dots + \delta_n$

<u>Table of Deflection angles</u>:

S.No	Chainage in m	Length of chord	Deflection angle	Total deflection angle	Theodolite readings	Remarks
1						
2						
3						
4						
5						
6						

9. COMMENTS / REMARKS:(Not mandatory)

10. SCHEME OF EVALUATION

<table>
<tr><th>Category of skill</th><th>Sub Task</th><th>Weight with competency level individually</th><th>Awarded

(50)</th></tr>
<tr><td>1. Handling of apparatus</td><td>A. Fixing the Theodolite to the tripod
B. Unclamp the upper clamps of the Theodolite and observe the movement of theodolite in horizontal direction and telescope in vertical plane.
C. Carry out the temporary adjustments of Theodolite using foot screws and altitude bubble tube
D. Using the tape or chain measure the chord length along the deflection angle line
E. Identifying the situations of using ranging rod and pegs</td><td><table><tr><td>A</td><td>1</td></tr><tr><td>B</td><td>3</td></tr><tr><td>C</td><td>3</td></tr><tr><td>D</td><td>2</td></tr><tr><td>E</td><td>1</td></tr><tr><td>Total</td><td>10</td></tr></table></td><td></td></tr>
<tr><td>2.Manipulation Of apparatus</td><td>A. Setting the horizontal circle should be zero by using the upper clamp and upper tangent screw
B. Setting the point of intersection by sighting the object and place the arrow
C. Setting the center point of the curve by using tape with arrow
D. Measuring the chord length by using chain or tape
E. bisecting the ranging rod along the deflection angles</td><td><table><tr><td>A</td><td>2</td></tr><tr><td>B</td><td>3</td></tr><tr><td>C</td><td>2</td></tr><tr><td>D</td><td>3</td></tr><tr><td>E</td><td>5</td></tr><tr><td>Tot</td><td>15</td></tr></table></td><td></td></tr>
<tr><td>3.Precise Operation/Activity</td><td>A. setting the deflection angles in the theodolite by using upper clamp and upper tangent screw
B. bisecting the deflection angles through chain and tape and fix the arrow on point of curve</td><td><table><tr><td>A</td><td>5</td></tr><tr><td>B</td><td>5</td></tr><tr><td>C</td><td>5</td></tr><tr><td>D</td><td>5</td></tr><tr><td>Tot</td><td>20</td></tr></table></td><td></td></tr>
</table>

	C. placing the points on curve reaching up to point of tangency D. checking the deflection angle at the point of tangency		
4. Values	A. Co-operation B. Co-ordination C. Communication D. Sharing E. Leadership	5	
Total		50	

SIGNATURE OF THE STUDENT **SIGNATURE OF THE FACULTY WITH DATE**

WORK SHEET

Name of the student:		Date of experiment:
PIN:	Branch:	
Institution:		Experiment No:

1. **Title of the experiment:** Setting out of the Curve using two Theodolites.
2. **Objective of the experiment:**

___

___

3. **Apparatus/Tools required:**

___

___

4. **Rough Sketch:**

5. **Survey Group Details:**

6. **Distribution of work among survey group if any**

S.No.	Name of the student	Work allotted	Time	
			from	to

7. PROCEDURE:

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12)
13)
14)
15)
16)
17)
18)
19)

8. OBSERVATIONS AND TABULATIONS:

Calculate the elements of the curve

Tangent length= R tan Φ/2

Length of long chord= 2 R sin Φ/2

Arc length = πR Φ/360

Length of first sub chord =

Length of normal chord =

Length of last sub chord=

Deflection angle for first sub chord δ_1 = 1718.9 C_1/R

Deflection angle for normal chord δ_2 = 1718.9 C/R

Deflection angle for last sub chord δ_n = 1718.9 C_2/R

$\Delta_1 = \delta_1$, $\Delta_2 = \delta_1 + \delta_2$, $\Delta_3 = \delta_1 + \delta_2 + \delta_3$, $\Delta_n = \delta_1 + \delta_2 + \delta_3 + \ldots\ldots\ldots + \delta_n$

<u>Table of Deflection angles</u>:

Point	Chainage (m)	Chord Length (m)	Deflection angle for chord (d)	Total Deflection angle (D)	Theodolite Vernier Reading	Remarks
1						
2						
3						
4						
5						
6						

9. COMMENTS / REMARKS :(Not mandatory)

10. SCHEME OF EVALUATION:

Category of skill	Sub task	Weight with competency level individually	Awarded (50)
1. Handling of Instrument	A. Setting up of the tripod stand on the ground. B. Taking the instrument from the box and fixing it on the tripod stand. C. Adjusting the tripod stand legs and fix firmly in to the ground by pressing the legs. D. Adjusting the legs of tripod to place the instrument over the station point approximately.	A: 2, B: 2, C: 3, D: 3, Tot: 10	
2. Manipulation of Instrument	A. Setting up of the theodolites over tangent points. B. Performing all the temporary adjustments accurately. C. Sighting and bisecting the ranging rods by turning the telescope and by focussing.	A: 5, B: 5, C: 5, Tot: 15	
3. Precision	A. Calculating the values of deflection angles from the given data. B. Setting the horizontal angle to read Zero degrees using horizontal circle clamp. C. Fixing the exact required deflection angle in the instrument by the two people.	A: 10, B: 5, C: 5, Tot: 20	
4. Values	A. Co-operation B. Co-ordination C. Communication D. Sharing E. Leadership	5	
	TOTAL	50	

Signature of the Student **Signature of the Staff Member**

WORK SHEET 4.23

Plot the data observed in measuring the horizontal distance between two inaccessible points using Theodolite and obtain the inaccessible distance from the plot

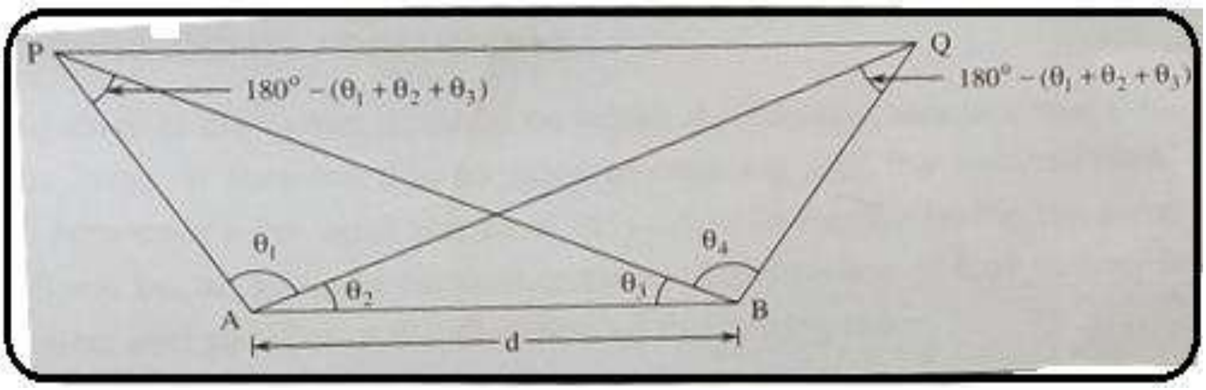
Name of the student:		Date of experiment:
PIN:	Branch:	
Institution:		Experiment No:

1. Title of the experiment: Plot the data observed in measuring the horizontal distance between two inaccessible points using Theodolite and Obtain the inaccessible distance from the plot

2. Objective of the experiment: Plot the data observed in measuring the horizontal distance between two inaccessible points using Theodolite and obtain the inaccessible distance from the plot

3. Apparatus/Tools required: Theodolite, Tripod, Plumb bob and cross staff

B. PROCEDURE:



1. Set up the Theodolite at A by making the temporary adjustments level it accurately with respect to the altitude bubble.
2. Sight the point P by keeping the horizontal circle reading at zero.
3. Loosen the upper clamp and rotate the telescope to sight Q and get the horizontal angle PAQ (Θ_1).
4. Sight the point Q by keeping the horizontal circle reading at zero.

5. Loosen the upper clamp and rotate the telescope to sight B and get the horizontal angle QAB (Θ_2).
6. Shift the instrument to station B and do the temporary adjustments
7. Sight the point A by keeping the horizontal circle reading at zero.
8. Loosen the upper clamp and rotate the telescope to sight P and get the horizontal angle ABP (Θ_3).
9. Sight the point P by keeping the horizontal circle reading at zero.
10. Loosen the upper clamp and rotate the telescope to sight Q and get the horizontal angle PBQ (Θ_4).
11. Measure the horizontal distance between and A and B using tape accurately.
12. After Measuring the distance between Two Inaccessible points A and B. Plot the data on a drawing sheet according to the given Scale.

Instrument At A :

Ref from Figure, $h_1 = D_1 \tan \alpha_1$

Where D_1 is the horizontal distance between A and P

$$H_2 = D_2 \tan \alpha_2$$

Where D_2 is the horizontal distance between A and Q

4. SCHEME OF EVALUATION:

Category of skill	Sub Task	Weight with competency level individually		Awarded (50)
1. Handling of apparatus	A. Fixing the Drawing Sheet B. Fixing the Drafter C. Drawing the Title Box	A	1.5	
		B	1.5	
		C	2	
		Total	5	

2.Manipulation Of apparatus	A. Assume Scale as Required B. Draw angles According to given Measurements C. Check the measurements , scales & Angles	A: 3 B: 4 C: 3 Tot: 10	
3.Precise Operation/Activity	A. Marking the North direction B. Measurements are drawn with suitable scales C. Check the Accuracy of angles D. Completion of the work using measurements with assumed Scales E. Plot with Neatness	A: 5 B: 5 C: 5 D: 10 E: 5 Total: 30	
4. Values	A. Co-operation B. Co-ordination C. Communication D. Sharing E. Leadership	5	
Total		50	

C.RESULT: Plot the data observed in measuring the horizontal distance between two inaccessible points using Theodolite and Obtain the inaccessible distance from the plot

WORK SHEET 4.24

Plot the closed traverse of theodolite, distribute the closing error by Bowditch/transit rule calculate the area of traverse.

WORK SHEET

Name of the student:		Date of experiment:
PIN:	Branch:	
Institution:		Experiment No:

1. **Title of the experiment**: To Perform the different tasks for Plot the closed traverse of theodolite, distribute the closing error by Bowditch/transit rule calculate the area of traverse.

2. Objective of the experiment: ____

____

3. Apparatus/Tools required: ____

____

4. PROCEDURE:

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WORK SHEET 4,24

Plot the closed traverse of theodolite, distribute the closing error by Bowditch/transit rule calculate the area of traverse.

5. OBSERVATIONS:

Bowditch's rule

Correction to latitude/departure of any side = Total error in latitude/departure $\times \frac{\text{length of that side}}{\text{perimeter of traverse}}$

Thus if C_L = correction of latitude of any side

C_D = correction of departure of any side

ΣL = Total error in latitude

ΣD = Total error in departure

Σl = length of the perimeter

l = length of any side.

We have $C_L = \Sigma L \times \frac{l}{\Sigma l}$

$C_D = \Sigma D \times \frac{l}{\Sigma l}$

Transit's rule

Correction to latitude/departure of any side =

Total error in latitude/departure $\times \frac{\text{latitude/departure of the line}}{\text{Arithemetic sum of latitudes/departures}}$

If

L= Latitude of any line.

D= departure of any line

L_T= Arithmetic sum of latitudes

D_T= Arithmetic sum of departures

We have $C_L = \Sigma L \times \frac{L}{LT}$

$C_D = \Sigma D \times \frac{D}{DT}$

Plot the closed traverse of theodolite, distribute the closing error by Bowditch/transit rule calculate the area of traverse.

WORK SHEET 4.25

Area of closed traverse by co-ordinate method

The sum of the products of coordinates joined by solid lines,

$$\Sigma P = (y_1x_2 + y_2x_3 + y_3x_4 + y_4x_5 + y_5x_1)$$

The sum of products of coordinates joined by dotted lines,

$$\Sigma Q = (x_1 y_2 + x_2 y_3 + x_3 y_4 + x_4y_5 + x_5y_1)$$

Double area = ΣP – ΣQ

Required area = $= \frac{1}{2}(\Sigma P - \Sigma Q)$

6.RESULT:____

7. INFERENCE:____

8. DEFICIENCIES / MALFUNCTIONING OF ANY APPARATUS:

WORK SHEET 4.24

Plot the closed traverse of theodolite, distribute the closing error by Bowditch/transit rule calculate the area of traverse.

9. SCHEME OF EVALUATION

<table>
<tr><th>Category of skill</th><th>Sub Task</th><th>Weight with competency level individually</th><th>Awarded

(50)</th></tr>
<tr><td>1. Handling of apparatus</td><td>A. Fixing the drawing board without tilt.
B. Proper use of plotting instruments.
C. Fixing the base line at suitable position with scales.
Errors in instruments.</td><td><table><tr><td>A</td><td>1</td></tr><tr><td>B</td><td>2</td></tr><tr><td>C</td><td>4</td></tr><tr><td>D</td><td>3</td></tr><tr><td>Total</td><td>10</td></tr></table></td><td></td></tr>
<tr><td>2.Manipulation Of apparatus</td><td>A. Assuming of suitable scale.
B. Units of measurements on scales.
C. Method of plotting closed traverse.</td><td><table><tr><td>A</td><td>1</td></tr><tr><td>B</td><td>1</td></tr><tr><td>C</td><td>3</td></tr><tr><td>Total</td><td>10</td></tr></table></td><td></td></tr>
<tr><td>3.Precise Operation / Activity</td><td>A. Plotting procedure
B. Identifying mistakes while plotting.
C. Observation of field work.
D. Bowditch's rule and transit rule.
E. Calculation of area of closed traverse.
F. The accuracy of the plotted frame work according to field measurements</td><td><table><tr><td>A</td><td>3</td></tr><tr><td>B</td><td>3</td></tr><tr><td>C</td><td>5</td></tr><tr><td>D</td><td>4</td></tr><tr><td>E</td><td>5</td></tr><tr><td>F</td><td>5</td></tr><tr><td>Tot</td><td>25</td></tr></table></td><td></td></tr>
<tr><td>4. Values</td><td>A. Co-operation
B. Co-ordination
C. Communication
D. Sharing
E. Leadership</td><td><table><tr><td>A</td><td>1</td></tr><tr><td>B</td><td>1</td></tr><tr><td>C</td><td>1</td></tr><tr><td>D</td><td>1</td></tr><tr><td>E</td><td>1</td></tr><tr><td>Tot</td><td>5</td></tr></table></td><td></td></tr>
<tr><td colspan="2">Total</td><td>50</td><td></td></tr>
</table>

Plot the Simple curve after setting out the curve in the field

WORK SHEET

Name of the student:		Date of experiment:
PIN:	Branch:	
Institution:		Experiment No:

1. Title of the experiment: Simple Curve Plotting in the Field

2. Objective of the experiment:____

3. Apparatus/Tools required: ____

4. Rough Sketch:

5. Survey Group Details:

6. Distribution of work among survey groupif any

S.No.	Name of the student	Work allotted	Time	
			FROM	TO

7. PROCEDURE:

1)
2)
3)
4)
5)
6)
7)
9)
10)
11)
12)
13)
14)
15)
16)
17)
18)
19)
20)

8. CALCULATIONS

1. Tangent length, TL = R tan Ø/2 = ________ m

2. Length of the curve,CL $= \frac{\Pi R Ø}{180} =$ ________ m

3. Length of the long chord (L) = 2R sin Ø /2 = ________ m

4. Mid-Ordinate O_o = R(1- cos Ø/2) = ________ m

5. Chainage of T_1 = Chainage of POI – TL

6. Chainage of T_2 = Chainage of T_1 + CL

7. Calculation of Ordinates, $O_x = \sqrt{R^2 - x^2} - (R - Ox)$

x = Length of Interval

9.RESULT:____

____

10.COMMENTS / REMARKS:(Not mandatory)____

_

____

____

11. DEFICIENCIES/MALFUNCTIONING OF ANY APPARATUS:

____

____

____

12. SCHEME OF EVALUATION:

Category of skill	Sub Task	Weight with competency level individually	Awarded (50)
1. Handling of apparatus	A. Unfolding the chain B. Fixing the Ranging rods at stations C. Driving arrows / pegs at required points. D. Using Cross staff to mark perpendicular offsets E. .Folding the Chain	A 2 B 2 C 2 D 2 E 2 Total 10	
2.Manipulation Of apparatus	A. Stretching the chain in between Points T1 and T2 mark the long chord Bisect the long chord to obtain the point M B. Bisect the long chord to obtain the point E. C. Using cross staff mark the perpendicular offset ME D. Using cross staff, mark the ordinates at regular intervals on both sides of mid ordinate on long chord. E. Joining the all ordinates to get the smooth Curve.	A 4 B 4 C 4 D 4 E 4 Total 20	
3.Precise Operation/Activity	A. Calculating the Length of long chord using the formula,$L = 2R \sin Ø /2$ B. Calculating the mid ordinate of the long chord, using the formula $DE = R(1-\cos (Ø/2))$ or$O_o = R - \sqrt{R^2 - (\frac{L}{2})^2}$ C. Calculating the ordinates at regular intervals on both sides of mid ordinate, using the formula,$O_x=\sqrt{R^2 - x^2} - (R - Ox)$	A 5 B 5 C 5 Tot 15	
4. Values	A. Co-operation B. Co-ordination C. Communication D. Sharing E. Leadership	5	
	Total	50	

SIGNATURE OF THE STUDENT **SIGNATURE OF THE FACULTY WITH DATE**

PERFORMING TEMPORARY ADJUSTMENTS FOR A THEODOLITE

A. THEORY

The theodolite is one of the most precise survey instruments and is suitable for measurement of angles (horizontal and vertical), prolonging a straight line, measurements of bearings, traversing etc. Experiments involving theodolite requires performing temporary adjustments at each and every setup of the instrument

B. Objective:

To perform series of tasks involved in Temporary adjustments of theodolite

C. PROCEDURE

There are three temporary adjustments of a theodolite. These are

1. Setting up the theodolite over a station.
2. Leveling up.
3. Elimination of parallax.

1.SETTING UP:

It includes two operations

1. Centering a theodolite over a station: Done by means of plumb bob.

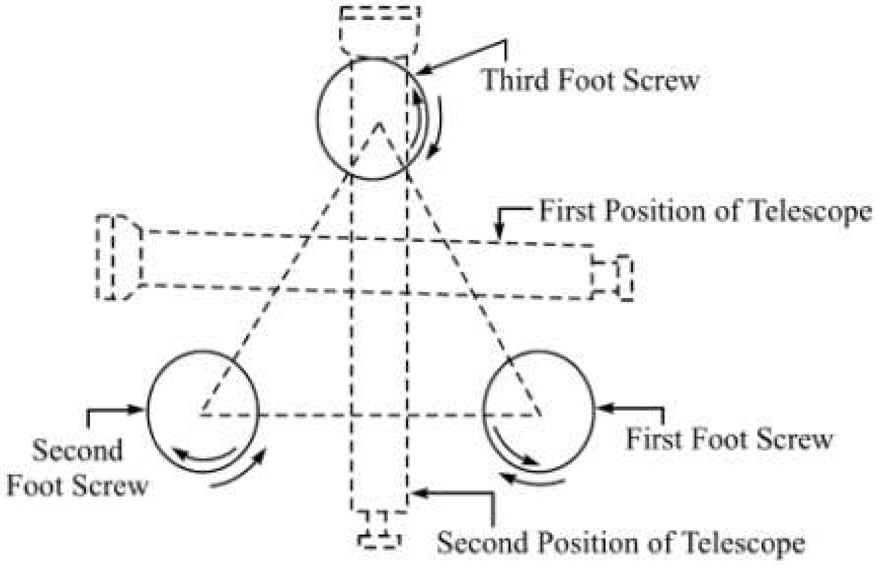
2. Approximately leveling it by tripod legs only: Done by moving tripod legs radially

2.LEVELING UP:

Having centered and approximately leveled the instrument, accurate leveling is done with the help of foot screws with reference to the plate levels, so that the vertical axis shall be truly vertical.

To level the instrument the following operations have to be done.

1. Turn the upper plate until the longitudinal axis of the plate level is **roughly parallel to a line joining any two of the leveling screws** (A & B).



Levelling of Foot Screws

2. Hold these two leveling screws between the thumb and first finger of each hand uniformly so that the thumb moves **either towards each other or away from each other** until the **bubble comes to the center.**

3. Turn the upper plate through 90º i.e until the axes of the level passes over the position of the third leveling screw ‘C’.

4. Turn this leveling screw until the bubble comes to the center.

5. Rotate the upper plate through 90º to its original position **in the same quadrant of circle** and as shown in fig and repeat step(2) till the bubble comes to the center.

6. Turn back again through 90º and repeat step 4.

7. Repeat the steps 2 and 4 till the bubble is central in both the positions.

8. Now rotate the instrument through 180º. The bubble should be remaining in the center of its run, provided it is in correct adjustment. **The vertical axis will then be truly vertical.**

3. ELIMINATION OF PARALLAX:

Parallax is a condition arising when the image formed by the objective is not in the plane of the cross hairs. Unless parallax is eliminated, accurate sighting is not possible. Parallax can be eliminated in two steps.

a. FOCUSSING THE EYE-PIECE:

Point the telescope to the sky or hold a piece of white paper in front of the telescope. Move the eyepiece in and out until a distant and sharp black image of the cross-hairs is seen.

b. FOCUSSING THE OBJECT:

Telescope is now turned towards object to be sighted and the focusing screw is turned until image appears clear and sharp.

D. PRECAUTIONS

- Care should be taken in direction of rotation of footscrews
- care should be taken not to rotate telescope with both clamp screws fixed
- Proper care should be taken centering will not get disturbed while levelling

MEASUREMENT OF HORIZONTAL ANGLE USING THEODOLITE

A. THEORY

In topography, the angle made by two ground lines is measured horizontally, and is called a horizontal angle. These angles are used to determine the bearings and directions in surveys and for setting out all types of structure

The theodolite is a precise instrument used for measuring both horizontal an dverticla angles up to 20” or 10”.

.

B. PROCEDURE

1. i) Set up the theodolite at station point O and level it accurately.

ii) Set the vernier A to the zero or 360^0 of the horizontal circle. Tighten the upper clamp.

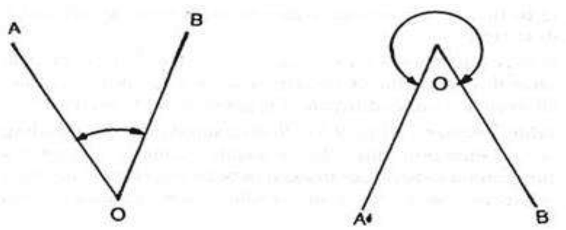
iii) Loosen the lower clamp. Turn the instrument and direct the telescope towards A to bisect it accurately with the use of tangent screw. After bisecting accurately check the reading which must still read zero. Read the vernier B and record both the readings.

iv) Loosen the upper clamp and turn the telescope clockwise until line of sight bisects point B on the right hand side. Then tighten the upper clamp and bisect it accurately by turning its tangent screw.

v) Read both verniers. The reading of the vernier a which was initially set at zero gives the value of the angle AOB directly and that of the other vernier B by deducting 180 .The mean of the two vernier readings gives the value of the required angle AOB.

vi) Change the face of the instrument and repeat the whole process. The mean of the two vernier readings gives the second value of the angle AOB which should be approximately or exactly equal to the previous value.

vii) The mean of the two values of the angle AOB ,one with face left and the other with face right ,gives the required angle free from all instrumental errors.



(a) (b)

B. OBSERVATIONS AND TABULATIONS:

Instrument station	object	face	Readings on verniers	Mean	angle	Remarks

MEASUREMENT OF HORIZENTAL ANGLES BY REPETITION METHOD

A. THEORY

When the precision of measurement of a horizontal angle is desired to be more than the least count of the instrument, repetition method is used. In this method the desired angle is measured several times, and average of the observed values is considered as the values of the angle. The precision thus attained is to much a finer degree than the least count of the Vernier.

B. PROCEDURE

1. Set up the theodolite exactly over selected station point "Q". And do the **temporary adjustments**.

2.With the help of **upper clamp screw and tangent screw,** set 0^0, reading on Vernier "A" and note the reading of Vernier "B".

3. Release the **lower clamp** and sight the telescope towards point "P" exactly using **lower clamp and tangent screw.**

4. Release the **upper clamp** and turn the **telescope clockwise** and bisect the object "R". Clamp the upper clamp screw and bisect "R" exactly using tangent screw.

5. Note the **readings of Vernier A&B** to get the approximate value of angle PQR.

6. Release the **lower clamp** and turn the **telescope anti-clock wise** to sight "P" again. Clamp the lower clamp and tangent screw and bisect "P" exactly. In this condition Vernier readings will not be changed.

7. Release the **upper clamp** and turn the **telescope clock** wise to sight "R". Bisect "R" exactly by using the upper clamp and tangent screw. In this condition Vernier readings will be twice the angle PQR.

8. Repeat the process until the angle is repeated the required number of times. The **average angle** is obtained by dividing the **final reading by the number of repetitions**.

9. Similarly repeat the procedure by changing **left**.

10. The **average horizontal angle** is determined by taking **average of the two angles obtained with face left and face right.**

C. OBERVATIONS AND TABULATIONS

Face left swing right						Face right swing left				
Instrument at	Sighted to	A	B	Mean	Horizental angle	A	B	Mean	Horizental angle	Average Horizental angle

D. SPECIMEN CALCULATIONS

E. RESULT

G.INFERENCES

H. PRECAUTIONS

1. Note down the readings carefully.

MEASUREMENT OF HORIZONTAL ANGLE BY REITERATION METHOD

A. THEORY

Reiteration is a method of measuring horizontal angles with high precision. It is less tedious and is generally preferred when there are several angles to be measured at a station. Several angles are measured successively and finally the horizon is closed. Closing the horizon is the process of measuring the angles around a point to obtain a check on their sum which should be equal to 360^0.

B. PROCEDURE

1. Select a station point O.

2. Set the theodolite at O and do the temporary adjustments. The telescope is adjusted for right face right swing.

3. Set the Vernier A to zero using upper clamp. Loosen the lower clamp, direct the telescope to the station point P and bisect A exactly by using the lower clamp and lower tangent screw.

4. Note the Vernier readings (A and B).

5. Loosen the upper clamp and turn the telescope clockwise until the point Q is exactly bisected.

6. Note the Vernier readings (A and B).

7. The mean of the two Vernier readings gives the value of angle POQ.

8. Bisect all the points successively(R,S & T) and note the readings of both Vernier's at each bisection.

9. Finally close the horizon by sighting the station point P. The A Vernier should be 3600. If not, note the closing error.

10. Adjust the telescope for left face left swing.

11. Repeat the whole process by turning the telescope in anticlockwise direction.

12. Distribute the closing error proportionately the several observed angles.

13. Take the average of face left and face right observations to give the corresponding horizontal angles.

C. OBERVATIONS AND TABULATIONS

Face left swing right						Face right swing left				
Instrument at	Sighted to	A	B	Mean	Horizontal angle	A	B	Mean	Horizontal angle	Average Horizontal angle
O	P Q R S T									

D. SPECIMEN CALCULATIONS

E. RESULT

G.INFERENCES

H. PRECAUTIONS

1. Note down the readings carefully.

MEASUREMENT OF VERTICAL ANGLES – RECORDING THE OBSERVATIONS IN FIELD BOOK

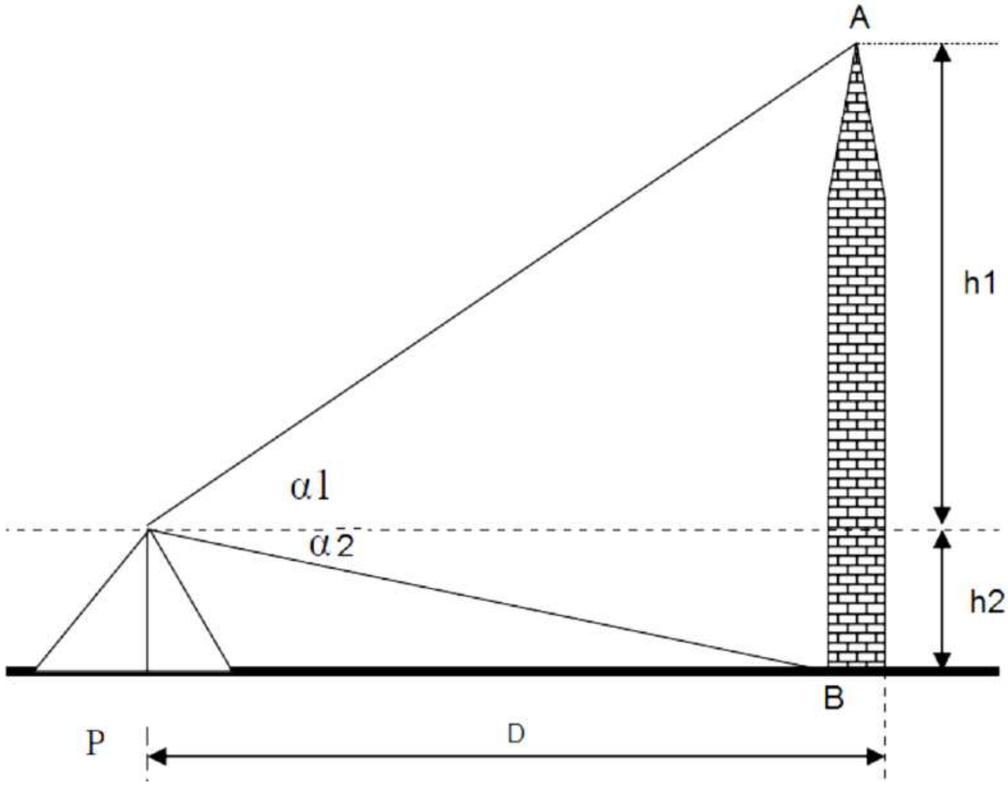
OBJECTIVE

To perform the set of tasks in determining the height of an object by measuring vertical angles.

EQUIPMENT / RESOURSES

1. Theodolite – 1 No.,
2. Tripod – 1 No.,
3. Tape (or chain) – 01 No.,
4. Plumb bob – 01 No.,
5. Ranging rods – 03 No., (if the object height is more)
6. Pegs – 04 No. (if the object height is more)

FIELD SKETCH:



1. TASK ANALYSIS

A. KNOWLEDGE

- Approximate centering and levelling of tripod
- Identification and functioning of parts of theodolite
- Temporary adjustments of theodolite
- Focusing and Elimination of parallax
- To read the vernier readings

B.SKILLS

Category of Skill	Sub task
1. Handling of apparatus	• Identifying the convenient point and set up the tripod and approximately center over the point and level it (use tripod bubble if available) • Fixing the Theodolite to the tripod • Unclamping the upper clamps of the Theodolite and observe the movement of theodolite in horizontal direction and telescope in vertical plane. • Carrying out the temporary adjustments of Theodolite using foot screws and altitude bubble tube • Using the tape or chain measure the horizontal distance, 'D' between the Theodolite and the object whose height is to be measured in meters. (Use ranging rods and pegs if the distance is more)
2.Manipulation of apparatus	**<u>Angle of Elevation (α1):</u>** a) Setting the vertical verniers C and D exactly to zero by using the vertical circle clamp and tangent screw, while the altitude level remain in the center of its run and keeping the face of the theodolite to left. b) Releasing the vertical circle clamp screw and rotate the telescope in vertical plane so as to bisect the top point A of the object. Tighten the vertical circle clamp and exactly bisect the object by slow motion screw. c) Reading both verniers C and D in degrees, minutes and seconds. The mean of the two readings gives the value of the required angle α1. These observations are called face left observations d) Plunging the telescope so that the vertical scale is to the right of the telescope while viewing the object. e) Similar observation may be taken which is called face right observation **<u>Angle of Depression (α2):</u>** 1) Repeating the steps from (a) to (e) as above and pointing the telescope to point B, the bottom of the object. 2) Reading and recording the face left observations of both C and D verniers 3) Reading and recording the face right observation of both C and D verniers 4) Calculating average of 2 and 4 gives α2.

3. Precise operation /activity	• Recording the Vernier reading of C and D for face left and face right observations in one row for each position of telescope viz., at top,and bottom at each instrument station. • Calculating the average angle of elevation ($\alpha 1$) for face left and face right observations • Calculating the average angle of depression ($\alpha 2$) for face left and face right observations • Calculating the height $h1 = D \times \tan \alpha 1$ • Calculating the height $h2 = D \times \tan \alpha 2$ • Calculating the height of the object 'AB' using the following equation = (h1 + h2) meters
4. Safety of the Equipment	• Unclamping of clamp screws for properly placing the theodolite into safety box • Unfixing of theodolite to tripod • Placing the theodolite in safety box properly identifying the position • Clamping the clamp screws to avoid the movement of parts in safety box.

2. TEACHING POINTS

S. No.	Teaching points	Suggestive Duration (Min.)
1.	Description about A. Face left and face right observations B. Verniers readings of verniers C. Angle of elevation and depression	5
2.	Relationship between three sides of triangle and definition of $\tan\alpha$	
3.	Least count of Theodolite and tape	
4.	Calculating angle of elevation with face left and face right observations	10
5.	Calculating angle of depression with face left and face right observations	
6.	Calculating the height of the object	

7.	**Procedural precautions** • Care should be taken while measuring horizontal distance • Care should be taken in operating clamps and screws. • Bisection of the top and bottom points should be precise • Proper care should be taken in recording the reading the verniers	
	Total	15

3. NEED AND SCOPE OF THE EXPERIMENT

To measure the height of objects so as to identify their correct elevation and for further continuation of work, location of position of electric cables, to assess the cost of scaffolding, painting, plastering, height of structure is within bylaws etc.

4. PLANNING AND ORGANIZATION

Action	Activity
Check for	1. Working condition of theodolite, tripod, tape or chain. 2. Actual length of chain or tape 3. marked reading on verniers, tape readings 4. Straightness of ranging rods and pegs
For design of Instruction	Read the teaching points carefully.

5. SCHEME OF EVALUATION

<table>
<tr><th>Category of skill</th><th>Sub Task</th><th>Weight with competency level individually</th><th>Awarded
(50)</th></tr>
<tr><td>1. Handling of apparatus</td><td>A. Fixing the Theodolite to the tripod
B. Unclamp the upper clamps of the Theodolite and observe the movement of theodolite in horizontal direction and telescope in vertical plane.
C. Carry out the temporary adjustments of Theodolite using foot screws and altitude bubble tube
D. Using the tape or chain measure the horizontal distance, ‘D’ between the Theodolite and the object whose height is to be measured
E. Identifying the situations of using ranging rod and pegs</td><td><table><tr><td>A</td><td>1</td></tr><tr><td>B</td><td>3</td></tr><tr><td>C</td><td>3</td></tr><tr><td>D</td><td>2</td></tr><tr><td>E</td><td>1</td></tr><tr><td>Total</td><td>10</td></tr></table></td><td></td></tr>
<tr><td>2.Manipulation Of apparatus</td><td>A. Bisecting the top accurately and measuring the angle of elevation in face left and right observations
B. Bisecting the bottom accurately and measuring the angle of depression in face left and right observations
C. Reading values carefully</td><td><table><tr><td>A</td><td>B</td><td>C</td><td>Tot</td></tr><tr><td>5</td><td>5</td><td>5</td><td>15</td></tr></table></td><td></td></tr>
<tr><td>3.Precise Operation/Activity</td><td>A. Convert all measurements into single unit viz, distance and angles
B. Measuring the distance between theodolite and object
C. Calculating the average angle of elevation.
D. Calculating the average angle of depression.
E. Calculating the Height of the object</td><td><table><tr><td>A</td><td>2</td></tr><tr><td>B</td><td>5</td></tr><tr><td>C</td><td>5</td></tr><tr><td>D</td><td>3</td></tr><tr><td>E</td><td>5</td></tr><tr><td>Tot</td><td>20</td></tr></table></td><td></td></tr>
</table>

4. Values	A. Co-operation B. Co-ordination C. Communication D. Sharing E. Leadership	5	
Total		50	

6. ASSESSMENT QUESTIONS (Only suggestive)

1. Calculate the horizontal distance between Theodolite and the object.
2. Tabulate observations and calculate the average angle of elevation and average angle of depression.
3. Determine height of the object.

7. VIVA QUESTIONS

(Only suggestive) The teacher may add questions depending upon the Context of examination

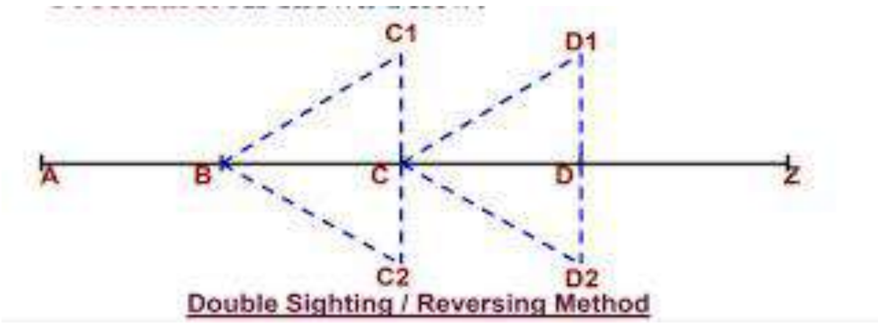
1. How to calculate the angle of elevation?
2. How to calculate the height of the object?
3. What is the difference between level and Theodolite?
4. What are verniers A, B, C, and D?
5. What is the difference between a compass and a theodolite?
6. What is telescope normal position?
7. What is face left and face right observations
8. What is the least count of theodolite?
9. What are clamp screws and when to use them?
10. When to use a tangent screw? What is the prerequisite of operating a tangent screw?

PROLONG A GIVEN SURVEY LINE BY DOUBLE TRANSITING METHOD

A. THEORY:

A theodolite is an instrument used in surveying to measure horizontal and vertical angles.it is also used for levelling, indirect measure of distances and prolonging a line etc. The line of sight of theodolite can be rotated through 180^{o} in vertical plane about its horizontal axis. If a line is prolonged with high precision double sighting method is adopted.

B. PROCEDURE:



- Fix the ranging rod at station A on survey line AB
- Fix the tripod at station B and approximately level by adjusting the legs, then legs fixed firmly into the ground.
- Lift theodolite carefully from the box and fix it on tripod stand
- Temporary adjustments were carried out.
- With the face of instrument left, focus ranging road at station A and tight both the upper and lower clamp screws.
- Transit the telescope and set a point C_1 ahead in line AB.
- Now change the face of the instrument right by loosening the lower clamp, then revolve the telescope in the horizontal plane and focus (back sight) on A, Bisect A exactly by using the lower clamp & its tangent screw.
- Transit the telescope and establish a point C_2 in line beside the point C_1.
- The exact position of the true point C must be midway between C_1 and C_2.

- Measure C_1, C_2 and establish a point C exactly mid-way, which lies on the true prolongation of AB.
- Shift the instrument to C, double-sight on B, establish the points D_1 and D_2 and establish the true point D as before.
- Continue the process until the last point Z is established.

C.RESULT

The survey line A,B is prolonged up to Z by double transmitting method.

MEASUREMENT OF HORIZONTAL DISTANCE BETWEEN TWO INACCESSIBLE POINTS BY USING THEODOLITE

A. THEORY

A theodolite is an instrument used in surveying to measure horizontal and vertical angles.it is also used for levelling, indirect measure of distances and prolonging a line etc. The line of sight of theodolite can be rotated through 180^{o} in vertical plane about its horizontal axis.

B. PROCEDURE

Let P and Q be the two inaccessible points which the horizontal distance has to be measure. Select a base line AB on fairly level ground approximately equal to 1/3rd length of PQ (to get well conditioned triangles).

1. **Set up** the theodolite at **A** by making the **temporary adjustments** level it **accurately** with respect to the **altitude bubble**.
2. **Sight** the point **P** by keeping the horizontal circle **reading at zero.**
3. **Loosen** the **upper clamp** and rotate the telescope to **sight Q** and get the horizontal angle **PAQ (Θ_1).**
4. **Sight** the point **Q** by keeping the horizontal circle **reading at zero.**
5. **Loosen** the **upper clamp** and rotate the telescope to **sight B** and get the horizontal angle **QAB (Θ_2).**
6. **Shift** the instrument to **station B** and do the **temporary adjustments**.
7. **Sight** the point **A** by keeping the horizontal circle **reading at zero.**
8. **Loosen** the **upper clamp** and rotate the telescope to **sight P** and get the horizontal angle **ABP (Θ_3).**
9. **Sight** the point **P** by keeping the horizontal circle **reading at zero**.
10. **Loosen** the **upper clamp** and rotate the telescope to **sight Q** and get the horizontal angle **PBQ (Θ_4).**
11. **Measure** the horizontal distance between and **A and B** using tape accurately.

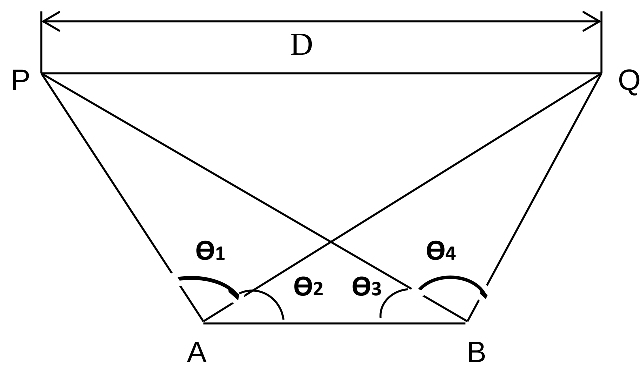


Fig 1.f1

B. OBSERVATIONS AND CALCULATIONS

Horizontal angle < **PAQ** $= \Theta_1$

Horizontal angle < **QAB** $= \Theta_2$

Horizontal angle < **ABP** $= \Theta_3$

Horizontal angle < **PBQ** $= \Theta_4$

Horizontal distance between A and B = d

From the Fig1.f1

From Δ ABP

$<APB = 180° - (\Theta_1 + \Theta_2 + \Theta_3)$

Applying the sine rule

$$= \frac{AB}{\sin(180° - (\Theta_1 + \Theta_2 + \Theta_3))} = \frac{PB}{\sin(\Theta_1 + \Theta_2)} = \frac{PA}{\sin\Theta_3}$$

$$PB = \frac{d}{\sin(180° - (\Theta_1 + \Theta_2 + \Theta_3))} \times \sin(\Theta_1 + \Theta_2)$$

$$PA = \frac{d}{\sin(180° - (\Theta_1 + \Theta_2 + \Theta_3))} \times \sin\Theta_3$$

Again From Δ AQB

$<AQB = 180° - (\Theta_2 + \Theta_3 + \Theta_4)$

Applying the sine rule

$$= \frac{AB}{\sin(180° - (\Theta_2 + \Theta_3 + \Theta_4))} = \frac{QA}{\sin(\Theta_3 + \Theta_4)} = \frac{QB}{\sin\Theta_2}$$

$$QA = \frac{d}{\sin(180° - (\theta_2 + \theta_3 + \theta_4))} \times \sin(\theta_3 + \theta_4)$$

$$QB = \frac{d}{\sin(180° - (\theta_1 + \theta_2 + \theta_3))} \times \sin \theta_2$$

Horizontal distance between P and Q :

(a) From ΔPAQ

By applying cosine rule

$$PQ^2 = PA^2 + QA^2 - 2.PA.QA.\cos\theta_1$$

PA, QA, and θ_1 are known PQ can be calculated

(b) From ΔPQB

By applying cosine rule

$$PQ^2 = PB^2 + QB^2 - 2.PB.QB.\cos\theta_4$$

PB, QB, and θ_4 are known PQ can be calculated

C.RESULT

Horizontal distance between two inaccessible points P and Q = D

Measurement Of Magnetic Bearing Of Survey Line

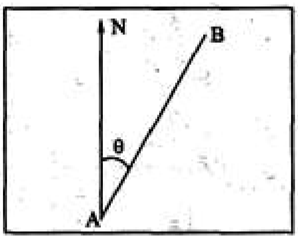
A. THEORY

Bearing of survey line

The **bearing** of a point is the number of degrees in the angle measured in a clockwise direction from the north **line** to the **line** joining the centre of the compass with the point. A **bearing** is used to represent the direction of one point relative to another point

.

B. PROCEDURE



1. To measure the magnetic bearing or a line AB , the theodolite should be provided with either a circular or a trough compass.
2. Centre and level the instrument accurately on station A. Vernier A is set at 0° and vernier *B* at 180°. The upper clamp is fixed.
3. Loosen the lower plate and also release the magnetic needle of trough or circular compass. Swing the telescope in horizontal plane about its vertical axis until the magnetic needle points N-S graduations of the compass box scale.
4. Clamp the lower plate. Using the lower tangent screw bring the needle exactly against the zero graduation. At this time the telescope is said to be perfectly oriented along the magnetic meridian.
5. Now, release the upper clamp, turn the telescope clockwise, the ranging rod at B is bisected with the help of upper tangent screw.
6. Read both the verniers. The mean of two readings is the required magnetic bearing of the line A*B.*
7. Change the face of the instrument and repeat the above procedure, get bearing of the line *AB,* once again. The mean of magnetic bearings observed on both faces, is the accurate value of the magnetic bearing of line A*B.*

Vernier Transit theodolite

Trough compass

B. OBSERVATIONS AND TABULATIONS

a) Length of the survey line= 12 m

Inst.at	Sighted to	Face Left Swing Right							Face Right Swing Right							Average Bearing of AB	Remarks
		A 0	'	"	B '	"	Mean	Bearing of AB	A 0	'	"	B '	"	Mean	Bearing of AB		
A	N	0	0	0	0	0			0	0	0	0	0				
	B	45	34	20	34	20	$45^{0}34'20''$	$45^{0}34'20''$	45	34	00	34	00	$45^{0}34'00''$	$45^{0}34'00''$	**$45^{0}34'10''$**	

C. RESULT

The Bering of survey line AB is **$45^{0}34'10''$**

D.INFERENCE:

snAverage value of Cd =0.62

C.SPECIMEN CALCULATIONS

Inst. at	Sighted to	Face Left Swing Right							Face Right Swing Right							Average Bearing of AB	Remarks
		A 0	‘	“	B ‘	“	Mean	Bearing of AB	A 0	‘	“	B ‘	“	Mean	Bearing of AB		
A	N	0	0	0	0	0			0	0	0	0	0				
	B	45	34	20	34	20	45^{0}34’ 20”	45^{0}34’20”	45	34	00	34	00	45^{0}34’ 00”	45^{0}34’00”	**45^{0}34’10”**	

Perform the task of theodolite traversing (closed), to Compute latitudes and departures, and the area of closed traverse.

A. PRINCIPLE

In theodolite traversing, the directions are measured in the form of bearings, deflection angle, angle to the right, interior angles or azimuths using a theodolite and distance with a tape, electric distance measurement (EDM) equipment or by a tachometer. Bearings are measured by theodolite fitted with a compass by loose needle method or fast needle method.

If the angles measured by deflection angles method, angle to the right, traverse they are called deflection angle traverse.

It is specially used in an urban survey where triangulation is not possible.

The theodolite is an intricate instrument used mainly for accurate measurement of horizontal and vertical angles up to 10″ or 20″, depending upon the least count of the instrument.

B.THEORY

A traverse is a series of connected lines whose lengths and directions are to be measured and process of surveying to find such measurements is called traversing

A Traverse may be open or closed

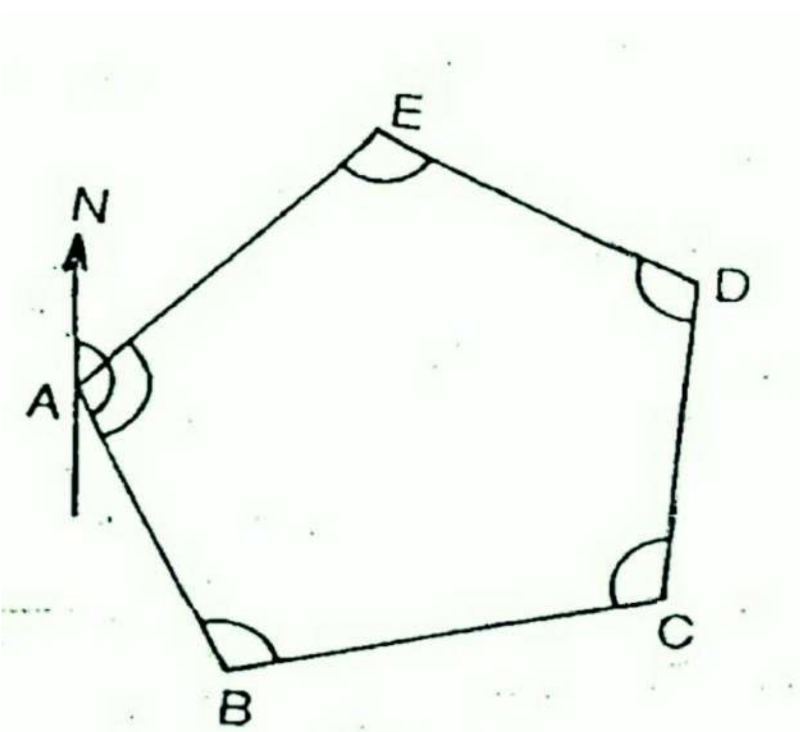
Methods of traversing are chain,compass,theodolite,plane table

In theodolite traversing ,the linear measurements are done by using chain or stadia method and angular measurements are done by theodolite

This method is very accurate compared to other method

C.PROCEDURE:

- Set up the instrument at A and level it accuarately
- Set up vernier the zero of the horiztontal circle
- Release the magnetic needle and loosen the lower clamp
- Rotate the instrument till magnetic needle points to north now clamp the lower clamp
- With the help of lower tangent screw bring the line of sight along magnetic meridian
- Now loose the upper clamp and point towards B with the help of upper tangent screw bisect B accurately read both verniers the mean of two readings recorded as fore bearing of line AB
- Measure the linear distance between two points along traverse AB with chain/tape
- Now shift instrument to B
- Repeat above steps in station B,C,D,E



D . OBSERVATIONS AND CALCULATIONS

Observations:

S.no	Inst at	Sighted to	Length of line (m)	Fore bearing (whole circle bearing)
1.	A	B		
2.	B	C		
3.	C	D		
4.	D	E		
5.	E	A		

Calculations:

S.no	line	Whole circle bearing	Reduced bearing	Latitude	Departure
1	AB				
2	BC				
3	CD				
4	DE				
5	EA				
				ΣL	**ΣD**

Measurement of Latitude and Departure

Latitude of a line = L cos θ
Departure of a line = L sin θ

Where :

L = Length of a line

θ = Reduced bearing of a line

Check for closure error:

The algebraic sum of all latitudes should be equal to zero

The algebraic sum of all departures should be equal to zero

The sign of $\sum D$ and $\sum L$ will define the quadrant in which the closing error lies

Balancing the traverse :

(1) Bowditch's Rule:

By this rule, the total error in latitude and that in departure is distributed in proportion to the lengths of the sides.

Correction to latitude or departure of any side

$$= \text{total error in latitude or departure} \times \left(\frac{\text{length of that side}}{\text{perimeter of traverse}}\right)$$

$$\text{Correction to latitude (CL)} = \sum L` \text{ X } \frac{1}{\sum 1}$$

$$\text{Correction to departure (CD)} = \sum D` \text{ X } \frac{1}{\sum 1}$$

Where :

CL = Correction to latitude of any side

CD = Correction to departure of any side

$\sum L'$ = Total error in latitude

$\sum D'$ = Total error in departure

$\sum l$ = length of perimeter of the traverse

Area of traverse by co-ordinates method:

Line	Corected Latitude	Corrected Departure	Station	Independent coordinates	
				North (y)	East (x)
AB					
BC					
CD					
DE					
EA					

This can be done by taking the coordinates of A as (+100,+100).

Formula :

In terms of X and Y coordinates

$$2(\text{Area}) = X_A(Y_E - Y_B) + X_B(Y_A - Y_C) + X_C(Y_B - Y_D) + X_D(Y_C - Y_E) + X_E(Y_D - Y_A)$$

- In general, if we have ‘n’ stations, we get

$$\text{Area} = \tfrac{1}{2}\{y_1(x_2 - x_4) + y_2(x_3 - x_1) + y_3(x_4 - x_2) + \ldots\ldots + y_n(x_1 - x_{n-1})\}$$

E.GRAPH

NIL

F.RESULT

1. **AREA OF CLOSED TRAVERSE -----------------------------------SQ.METERS**

G.INFERENCE

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DETERMINATION OF HORIZONTAL AND VERTICAL DISTANCE OF AN OBJECT WHOSE BASE IS ACCESSIBLE (USING TRIGNOMETRIC LEVELLING)

A. THEORY

The Theodolite 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.

B. PROCEDURE

1. Setting up the instrument at station P.
2. Performing all temporary adjustments.
3. Bring the line of collimation horizontal
4. Entering the initial readings in the tabular form.
5. Swing the telescope and take staff reading over the given B.M.
6. Swing the telescope towards the object.
7. Releasing the vertical clamp screw, sight the top of the object Q1, and clamp the vertical clamp screw.
8. Reading C and D verniers and enter the readings.
9. Repeating the above procedure with the face right observation.
10. Calculating the average of the two observations will be vertical angle.
11. Measure the Horizontal distance between the instrument station and the object.
12. Determining the vertical height of an object and R.L top and bottom of an object using appropriate equations and using formula $h = d \tan\alpha$

C. OBSERVATIONS AND TABULATIONS

Vertical Angle, = α =
Height of Instrument (m) = h1 =
Horizontal Distance, D (measured with tape /chain in m) =

From Triangle AQQ': $h = D \tan\alpha$

R.L. of Q (m) = R.L of P + h' + D $\tan\alpha$, if R.L of P is Known

D.RESULT

Horizontal Distance = D =

Vertical Distance = V =

R.L of point Q = ……………….. ….. m

E.INFERENCE

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SIGNATURE OF THE STUDENT

DATE:

SIGNATURE OF THE FACULTY

DATE:

Determine the horizontal and vertical distance of an object whose base is inaccessible when the two instrument stations and the object are in the same vertical plane.

DETERMINATION OF HORIZONTAL AND VERTICAL DISTANCE OF AN OBJECT WHOSE BASE IS INACCESSIBLE WHEN THE TWO INSTRUMENT STATIONS AND THE OBJECT ARE IN THE SAME VERTICAL PLANE.

A) OBJECTIVE:

To perform the set of tasks in order to determine the horizontal and vertical distance of an object whose base is inaccessible when the two instrument stations and the object are in the same vertical plane.

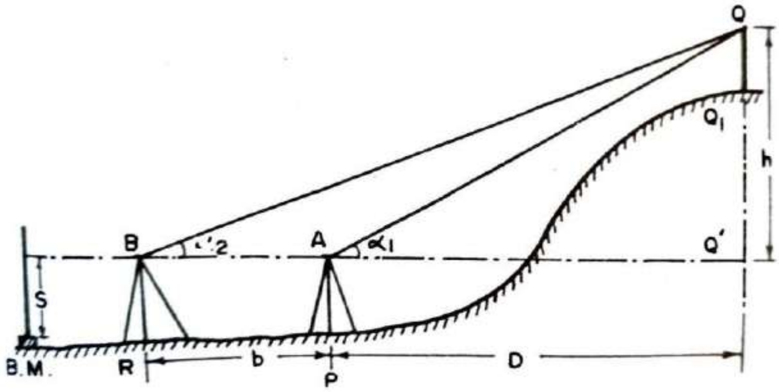
B) PROCEDURE:

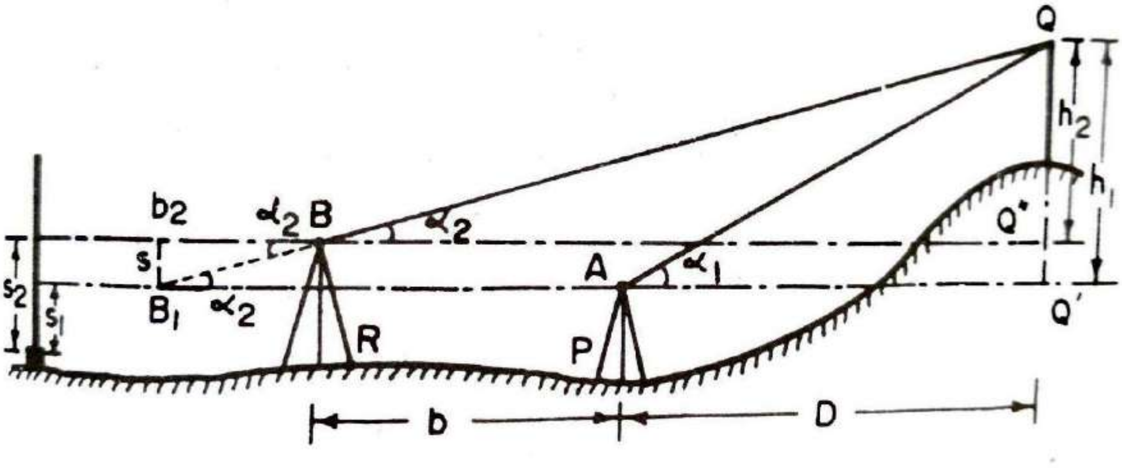
a) Instrument axes at the same level

1. Set up theodolite over the station P.
2. Direct the telescope towards the top of the object Q.
3. Bisect Q accurately and clamp both the plates.
4. Read both verniers C and D and determine the vertical angle Q'AQ.
5. Determine again the vertical angle Q'AQ with face right.
6. Find the mean value α1 of the angle Q'AQ.
7. Transit the telescope and mark the station R on the ground in the line such that P,Q and R are in the same vertical plane.
8. Measure the distance 'b' between P and R accurately with tape.
9. Set the vertical vernier to zero.
10. With the altitude bubble central, take a back sight on the staff held on bench mark. Let 'S' be the staff reading.
11. Shift the instrument station to R and set it such that the line of collimation is at the same level of the line of collimation at the station P. In other words, staff reading on bench mark should be 'S' when the altitude bubble is central.
12. Sight the point Q and measure the vertical angle Q'BQ.
13. Determine again the vertical angle Q'BQ with face right.
14. Find the mean value α1 of the angle Q'BQ.

C) SKETCH:

a) Instrument axes at the same level





b) Instrument axes at the different level

D) OBSERVATIONS AND TABULATIONS:

Horizontal Distance between two instrument stations b = 10 m.

Staff reading on bench mark taken from A and B, S = 1.650 m.

Reduced level of the bench mark R.L = + 150.000 m.

S. No.	Inst. Station	Sight to	Face of observation	Vernier C ° ' "	Vernier D ° ' "	Mean of C & D Angle ° ' "	Average Vertical Angle ° ' "	Remarks
1	P	q	Left	28°10' 20"	0°10' 00"	28°10' 10"	28°10' 20"	Angle of Elevation (+α1)
2	P	A	Right	28°10' 20"	0°10' 40"	28°10' 30"		Angle of Elevation (+α1)
3	P	B	Left	18°10' 40"	0°10' 20"	18°10' 30"	18°10' 25"	Angle of Elevation (+α2)
4	P	B	Right	18°10' 20"	0°10' 20"	18°10' 20"		Angle of Elevation (+α2)

E) SPECIMEN CALCULATION:

a) Instrument axes at the same level:

Calculate the horizontal distance between P and Q, $D = b \tan \alpha 2 / (\tan\alpha 1 - \tan\alpha 2)$

$D = 10 \tan 18^0 10'25'' / (\tan 28°10'\,20'' - \tan 18°10'\,25'')$

$D = \underline{\;15.836\; m}.$

Calculate the height of the object, $h = b \sin\alpha 1 \sin\alpha 2 / \sin(\alpha 1 - \alpha 2)$

$h = 10 \sin 28°10'\,20'' \sin 18°10'\,25'' / \sin(28°10'\,20'' - 18°10'\,25'')$

$h = \underline{8.481\ m}.$

Calculate reduced level of Q = Reduced level of BM + S + h

= 150.000 + 1.650 + 8.481

= *160.131 m.*

b) Instrument axes at the different level:

Horizontal Distance between two instrument stations b = *10 m.*

Reduced level of the bench mark R.L = *+ 150.000 m.*

If S_1 *and* S_2 *are the corresponding staff readings on staff kept at Bench mark, the difference in levels of the instrument axes will be* $S_2 - S_1$.

Staff reading $S_1 = 1.650$ *m*

Staff reading $S_2 = 1.550$ *m*

$s = S_2 - S_1$

$= 1.650 - 1.550 = 0.10$ *m*

Calculate the horizontal distance between P and Q,

$D = (b \pm s \cot \alpha 2) \tan \alpha 2 / (\tan\alpha 1 - \tan\alpha 2)$ *{assuming instrument axis at A is lower}*

$D = (10 + 0.10 \times \cot 18°10'\,25'') \tan 18°10'\,25'' / (\tan 28°10'\,20'' - \tan 18°10'\,25'')$

$\underline{D = 16.318\ m}.$

Calculate the height of the object, $h_1 = (b \pm s \cot \alpha 2) \sin\alpha 1 \sin\alpha 2 / \sin(\alpha 1 - \alpha 2)$

{assuming instrument axis at A is lower}

$h_1 = (10 + 0.10 \times \cot 18°10'25'') \sin 28°10'20'' \sin 18°10'25'' / \sin(28°10'20'' - 18°10'25'')$

$h_1 = \underline{8.740\ m.}$

Calculate reduced level of Q = Reduced level of BM + $S_1 + h_1$

= 150.000 + 1.650 +8.740

= <u>*160.39 m.*</u>

F) <u>RESULT:</u>

<u>a) Instrument axes at the same level:</u>

Horizontal distance between P and Q, D = <u>_15.836_m.</u>

Height of the object, h = <u>8.481 m</u>.

Reduced level of Q = <u>160.131 m</u>.

<u>b) Instrument axes at the different level:</u>

Horizontal distance between P and Q, D = <u>_16.318_m.</u>

Height of the object, h = <u>8.740 m</u>.

Reduced level of Q = <u>160.390 m</u>.

G) <u>INFERENCE:</u>

To Perform the different tasks for determining the horizontal and vertical distances of an object whose base is inaccessible when the instrument stations and objects are not in same vertical plane.

A. PRINCIPLE

A. Whenever the instrument stations are not possible to keep in same vertical plane as per the field conditions, then two instrument stations are taken such that it forms a well conditional triangle with the object i.e. third point

B. From three points (two instrument station and object station) we will get two well conditioned triangles. By applying sine rule, the elevation of the object whose base is inaccessible can be found out.

C. THEORY

Trigonometric levelling is defined as process of determining of difference of elevations and horizontal distances of both accessible and inaccessible points by observing vertical angles and measuring horizontal distances.

Normally the vertical angles are measured by using theodolite and the horizontal distances ae measured directly or computed.

Trignometric levelling is adopted in three cases. 1. When the base of the object is accessible and height of an object cannot be measured directly 2. When the base of the object is inaccessible due to obstacle between instrument station and object.

3. when the base of the object is inaccessible due to undulating ground.

D. PROCEDURE:

- Set the instrument at P and level it accurately with respect to the altitude bubble.

- Measure the angle of elevation α_1 to Q.

- Sight the point R with reading on horizontal circle as zero,

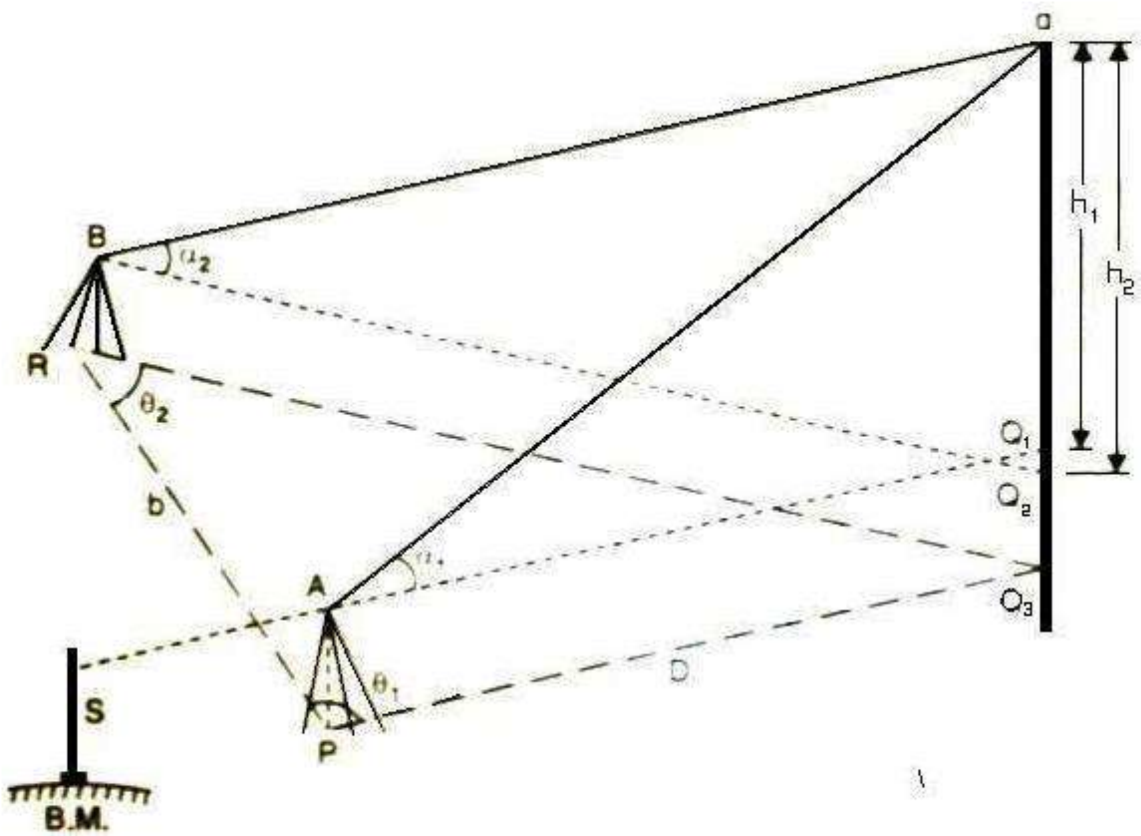
  and measure the angle RPQ i.e., θ_1 at P.

Take the back sight 's' on the staff kept at B.M.

Shift the instrument to R and measure angle of elevation α2 by sighting to Q and horizontal angle PRQ θ2 i.e. θ_2 at R

S1 = Back sight on BM from A

S2 = Back sight on BM from B



Notations

Let , P and R be the two instrument station not in the same vertical plane as that of Q

Q_1= projection of Q on the horizontal line thought A,

Q_2= projection of Q on the horizontal line thought B,

AQ_1= horizontal line though A,

BQ_2= horizontal line though B,
AQQ_1 is the vertical plane simultaneously,
BQQ_2 is the vertical plane simultaneously

PRQ_3 is a horizontal plane
θ_1= Horizontal angle measured at P,
θ_2= Horizontal angle measured at R,
α_1= vertical angle measure at A,
α_2= vertical angle measure at B.

<u>OBSERVATIONS AND CALCULATIONS</u>

$$\text{From } PRQ_3 \quad PQ_3R = 180 - (\theta_1 + \theta_2) = \pi - (\theta_1 + \theta_2)$$

$$\text{From } AQQ_1 \quad QQ_1 = h_1 = D\tan\alpha_1 \quad \text{------}1$$

From the sine rule

$$\frac{PQ_3}{\sin\theta_2} = \frac{RQ_3}{\sin\theta_1} = \frac{RP}{\sin[\pi - (\theta_1 + \theta_2)]} = \frac{b}{\sin(\theta_1 + \theta_2)}$$

$$PQ_3 = \frac{b\sin\theta_2}{\sin(\theta_1 + \theta_2)} \quad \text{--------}2$$

$$RQ_3 = \frac{b\sin\theta_1}{\sin(\theta_1 + \theta_2)} \quad \text{--------}3$$

$$h_2 = RQ_3 \tan \alpha_2 = \frac{b \sin \theta 1 \tan \alpha 2}{\sin (\theta 1 + \theta 2)}$$

$$\text{Then R.L of } Q = \text{R.L of B.M} + s_2 + h_2 .$$

F.GRAPH

NIL L_1

G.RESULT

1. **The horizontal distance of an object from the instrument station is -------metre**

2, The Reduced level of the object Q fom the TBM is -------- metre.

L_2

H.INFERENCE

DETERMINATION OF TACHEOMETRIC CONSTANT 'K' & 'C'

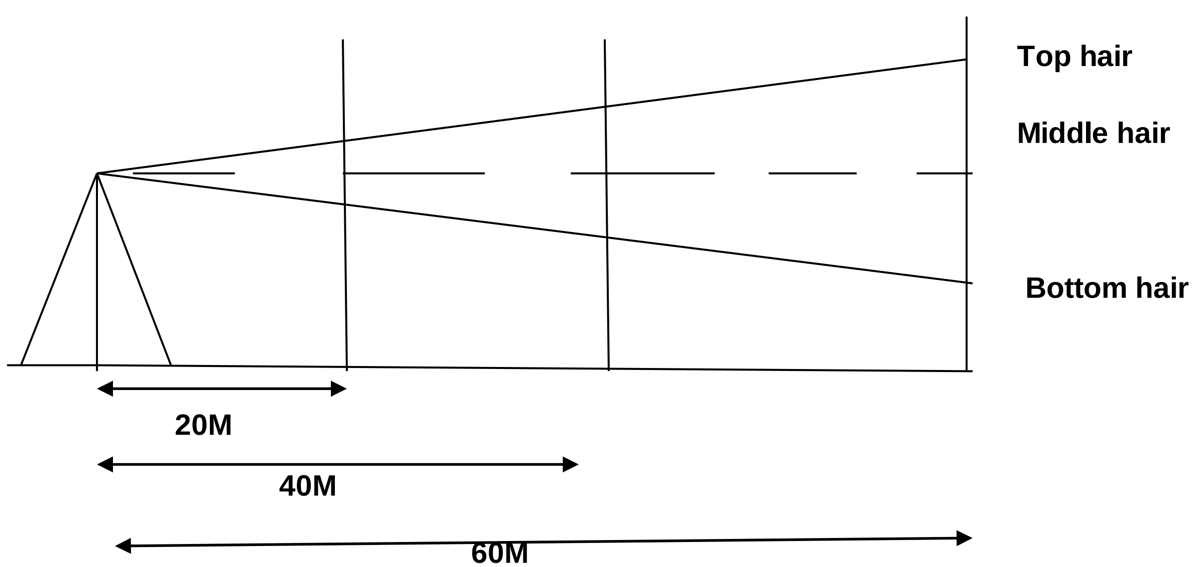
A Theory

Tacheometer is a transit **theodolite** fitted with a stadia diaphragm.

The stadia interval factor (k) and the stadia constant (C) are known as Tacheometric constants. Before using the Tacheometer it is requested to determine these constants.

B Procedure

1. **Fix** the **theodolite** to the **tripod stand**.
2. **Centre** the **theodolite** over **selected station** from where the **chain line** is run.
3. **Level** the **theodolite** using **foot screws** until both the **plate and attitude bubble** are at the **centre.**
4. **Unfold** and **stretch** a **metric chain or tape** of **20m/30m** from the centre of the **tripod.**
5. **Set** the **vernier C & D** on the vertical circle at **0'0'0".**
6. **Drive** the **pegs/arrows** at **20m,40m & 60m** on the **chain line.**
7. **Hold** vertically the **leveling staff** on the stations of **20m,40m & 60m** on the **chain line.**
8. **Sight** the **staff** through the **telescope**
9. **Observe** the **stadia hair readings** for very **staff station**.
10. **Record** the **readings** along with the **distance** of the station from the instrument.
11. **Calculate** the **staff intercept** for every observation.
12. **Substitute** the **staff intercept** and **horizontal distance** in **distance equation**
13. **Formulate** three **equations of** distance for **20m,40m & 60m**.
14. **Solve** these **equations** for the values of **'K' & 'C'.**



C. OBSERVATIONS AND TABULATION

SlNo	Distance D (M)	Stadia Hair Reading (M)			Staff intercept S (m) Bottom - Top
		Top	Middle	Bottom	
1	20	0.95	1.00	1.15	0.2
2	40	0.85	1.05	1.25	0.4
3	60	0.75	1.00	1.35	0.6

D = KS+C

20=K X0.2+C ------------(1)

40=K X04+C-------------(2)

60=K X0.6+C------------(3)

Solving (1) &(2)

40=0.4 K + C

20=0.2 K + C

subtracting

20=0.2 K + C

Solving K=100

C=0

Solving (2) &(3)

60=0.6 K + C

40=0.4K +C

20=0.2 K + C

Solving K=100

C=0

Solving (3) &(1)

60=0.6 K + C

20=0.2 K + C

40=0.4 K + C

Solving K=100
C=0

Average of above three values of K & C

D. RESULT K=100

C=0

E.INFERENCE

Determination of horizontal distance and elevation by principle of stadia tacheometry (considering angle of elevation)

A. THEORY

When the horizontal distance and elevation are determined by principle of stadia tacheometry (considering angle of elevation) this method is used.

B. PROCEDURE

1.Set up the theodolite exactly over selected station point “Q”.And do the **temporary adjustments**.

2.With the help of **vertical clamp screw and vertical tangent screw,** set 0^0, reading on Vernier “C” and note the reading of Vernier “D”.

3.Release the **telescope clamp screw** and sight the telescope towards point “P” exactly using **telescope clamp screw & vertical tangent screw.**

5. Note the **three readings of bisected by upper, middle and lower cross hairs. Also note down the reading on Vernier C & Vernier D.**

6.Similarly repeat the procedure by changing **left**.

7. The **average vertical angle** is determined by taking **average of the two angles obtained with face left and face right**.

8. Calculate the horizontal distance by the formula

$$D = \frac{f}{i}(S\cos\ \theta)\ \cos\ \theta + (f + d)\ \cos\ \theta$$

$$D = \frac{f}{i} \times S\cos^2\ \theta + (f + d)\ \cos\ \theta$$

9. Calculate vertical distance between instrument axis and central hair by the formula

$$V = \frac{f}{i} \times \frac{S \times \sin 2\theta}{2} + (f + d) \sin \theta$$

$$V = D \tan \theta$$

10. calculate R.L of Staff station by the formula

$$\text{RL of } P = \text{RL of instrument axis} - V - h \cos \theta$$

C. OBERVATIONS AND TABULATIONS

Face left swing right						Face right swing left				
Instrument at	Sighted to	C	D	Mean	Vertical angle	C	D	Mean	Vertical angle	Average Vertical angle

D. SPECIMEN CALCULATIONS

E. RESULT

G.INFERENCES

H. PRECAUTIONS

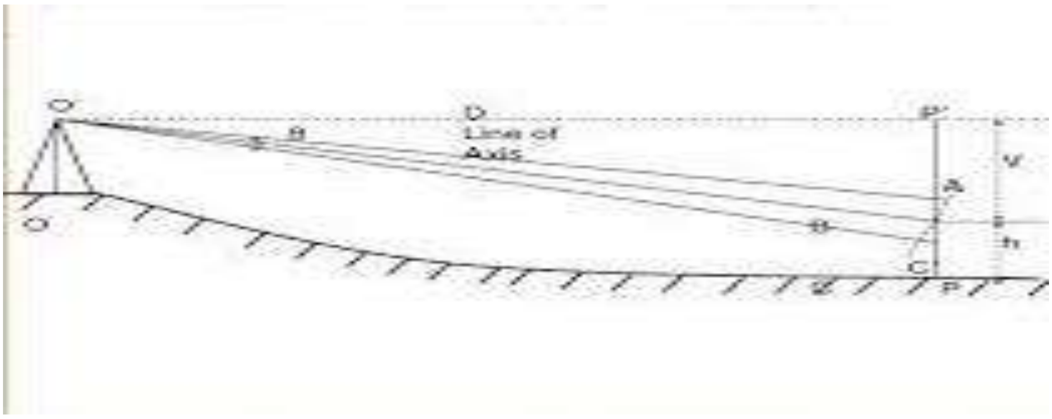
1. Note down the readings carefully.

Determination of Horizontal Distance and Elevation by principle of stadia Tacheometry (considering angle of depression)

A. THEORY:

A Tacheometry is an instrument used in surveying to measure horizontal distances and elevations of different stations without using a chain or tape.

B. PROCEDURE:



- Fix the Theodolite on station O
- Fix the tripod at station O and approximately level by adjusting the legs, then legs fixed firmly into the ground.
- Lift theodolite carefully from the box and fix it on tripod stand
- Temporary adjustments were carried out.
- With the face of instrument left, focus leveling staff at station P and tight both the upper and lower clamp screws.
- Transit the telescope and focus towards the leveling staff.
- Adjust the focusing screw and use transit screws if necessary for clear vision.
- By observing C and D verniers note the vertical angle of depression.
- Also note down the corresponding staff readings.
- The horizontal distance
- $D = L \cos\Theta$
- $= (k\,s \cos\Theta + C) \cos\Theta$
- $D = k\,s \cos^2\Theta + C \cos\Theta$ . . . . . . (1)
- $V = L \sin \Theta$
- $= (k\,s \cos\Theta + C) \sin\Theta$
- $= k\,s \cos\Theta \,.\, \sin\Theta + C \sin\Theta$

- $V = k\, s\, \sin^2\Theta/2 + C \sin\Theta$........ (2)
- Thus equations (1) and (2) are the distance and Vertical component formulae for inclined line of sight.
- R.L of Station P= RL of Line of axis – V- h

C.RESULT

The horizontal distance and elevation of the given station are determined by using Stadia tachometry.

OFFSETS FROM LONG CHORD METHOD

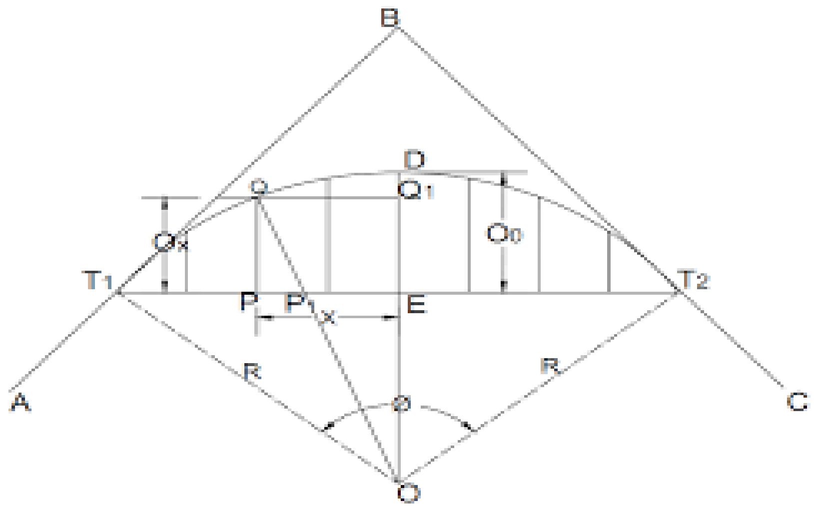
OBJECTIVE

Performing the set of tasks in setting out simple circular curve by offsets from long chord method

EQUIPMENT /RESOURSES

1. Chain – 1 No.,
2. Tape – 01 No.,
3. Ranging rods – 02 No
4. Arrows – 10 No.
5. Cross staff - 01 No
6. Lime

FIELD SKETCH:



1. TASK ANALYSIS

A. KNOWLEDGE

- Unfolding chain and joining Tangent points (Long Chord)
- Fixing ranging rods at Tangent points points
- Erecting mid ordinate on long chord using cross staff.
- Joining Tangent points with mid ordinate using tape.
- Erecting mid ordinate at mid-point of long chord using cross staff.
- Erecting Ordinates on both sides of the mid ordinate on long chord.

B.SKILLS

Category of Skill	Sub task
1. Handling of apparatus	• Unfolding the chain and making it into straight. • Fixing the Ranging rods at station. • Driving arrows / Pegs at required points. • Using Cross staff to mark Perpendicular Offsets. • Using tape to measure the horizontal distance.
2.Manipulation of apparatus	• Stretching the chain in between Points T1 and T2 mark the long chord. • Bisect the long chord to obtain the point E. • Using cross staff mark the perpendicular offset DE. • Using cross staff mark the ordinates at regular intervals on both sides of mid ordinate on long chord. • Joining the points T_1DT_2 to get the smooth Curve.
3. Precise operation /activity	• Calculating the Length of long chord,using the formula, L = 2R sin Ø /2 • Calculating the mid ordinate of the long chord, using the formula, $O_o = R - \sqrt{R^2 - (\frac{L}{2})^2}$ • Calculating the ordinates at regular intervals on both sides of mid ordinate, using the formula, $O_x = \sqrt{R^2 - x^2} - (R - Ox)$
4. Safety of the Equipment	• Unfolding the chain on level and smooth ground to avoid detaching of links and tallies. • Holding the ranging rod at certain height above the ground so as to avoid touching its tip to ground while carrying. • Driving ranging rods firmly into the ground so as to avoid falling on to the ground frequently and loosing its verticality • Avoiding driving of cross staff, ranging rods, arrows on stones/rocks.

2. TEACHING POINTS

S. No.	Teaching points	Suggestive Duration (Min.)
1.	Description about A. Deflection Angle B. Tangent Points C. Long Chord D. Mid ordinates	5
2.	Using of Chain &Tape in the field	
3.	Using of Ranging rods and Arrows in the field	
4.	Calculating the length of long chord	10
5.	Calculating the mid ordinate of long chord	
6.	Calculating the ordinates on long chord on both sides of mid ordinates.	
7.	**Procedural precautions** • Care should be taken while measuring horizontal distance • Care should be taken while folding and unfolding the chain. • Care should be taken while erecting ranging rods vertically • Care should be taken while bisecting the chords • Care should be taken while placing the Arrows. • Care should be taken while erecting perpendiculars with cross staff	
	Total	15

3. NEED AND SCOPE OF THE EXPERIMENT

The curves required in the horizontal plane are known as Horizontal Curves. Whenever the direction of a road or railway line is to be changed, curves are provided between the intersecting straights. This is necessary for smooth and safe movement of the vehicles and for the comfort of passengers.

4. PLANNING AND ORGANIZATION

Action	Activity
Check for	1. All Links and Tallies in the chain. 2. Actual length of Chain and Tape 3. Opened links in chain and Tape. 4. Marked readings on Tape. 5. Straightness of Ranging rods .
For design of Instruction	Read the teaching points carefully.

5. SCHEME OF EVALUATION

Category of skill	Sub Task	Weight with competency level individually	Awarded (50)
1. Handling of apparatus	A. Unfolding the chain B. Fixing the Ranging rods at stations C. Driving arrows / pegs at required points. D. Using Cross staff to mark perpendicular offsets E. . Folding the Chain	A 2 B 2 C 2 D 2 E 2 Total 10	
2.Manipulation Ofapparatus	A. Stretching the chain in between Points T1 and T2 mark the long chord Bisect the long chord to obtain the point D B. Bisect the long chord to obtain the point E. C. Using cross staff mark the perpendicular offset DE D. Using cross staff, mark the ordinates at regular intervals on both sides of mid ordinate on long chord. E. Joining the points T_1DT_2 to get the smooth Curve.	A 3 B 3 C 3 D 3 E 3 Total 15	

3.Precise Operation/Activity	A. Calculating the Length of long chord using the formula, $L = 2R \sin \text{Ø}/2$ B. Calculating the mid ordinate of the long chord, using the formula $DE = R(1-\cos(\text{Ø}/2))$ or $O_0 = R - \sqrt{R^2 - (\frac{L}{2})^2}$ C. Calculating the ordinates at regular intervals on both sides of mid ordinate, using the formula, $O_x = \sqrt{R^2 - x^2} - (R - Ox)$	A: 5 B: 5 C: 10 Tot: 20	
4. Values	A. Co-operation B. Co-ordination C. Communication D. Sharing E. Leadership	5	
Total		50	

6. ASSESSMENT QUESTIONS(Only suggestive)

1. Give the formula for calculating the length of Long Chord.
2. Give the formula for calculating the mid ordinate.
3. Determine the Ordinates from long chord at various Intervals.
4. List the linear methods of setting out a simple curve.
5. Give the formula for calculating the ordinates by offsets from long chord method.

7. VIVA QUESTIONS

(Only suggestive) The teacher may add questions depending upon the Context of examination

1. What are the significance of curves?
2. What are the Various Methods of Setting out the curves?
3. What are the various elements of the Curves?
4. How to calculate the Chainage of T_1 and T_2?
5. What is the procedure for Setting of Curve by Offsets from long Chord method?
6. What is simple curve?
7. . Is the simple curve radius uniform through out?

SETTING OUT A CURVE BY SUCCESSIVE BISECTION OF ARCS

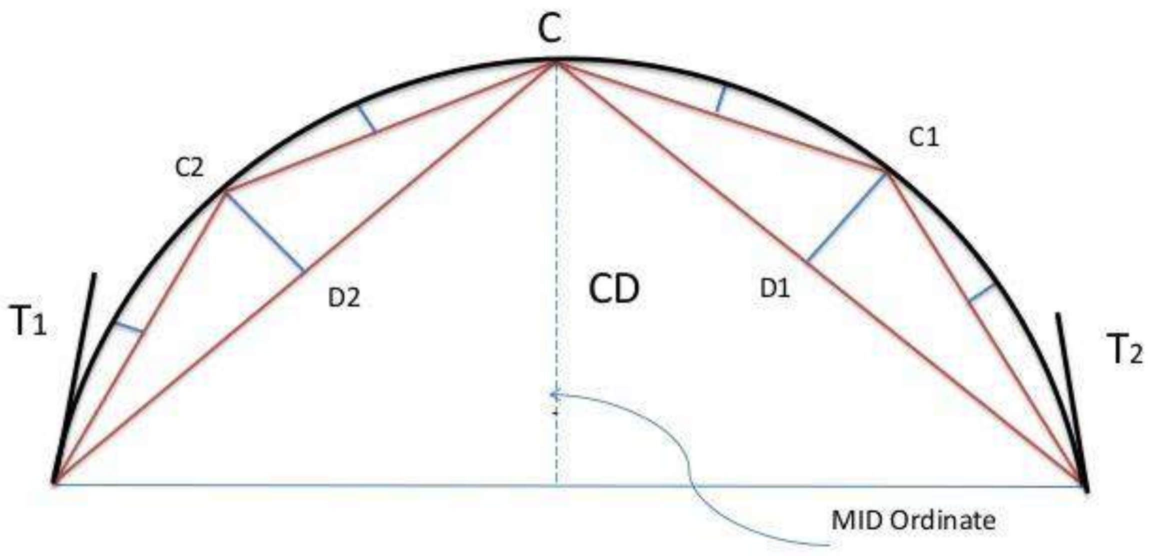
OBJECTIVE

Performing the set of tasks in setting out simple circular curve by the method of successive bisection of arcs using chain and tape.

EQUIPMENT /RESOURSES

1. Chain – 1 No.,
2. Tape – 1 No.,
3. Arrows – 10 No.,
4. Ranging Rods – 02 No.,
5. Cross staff – 01 No.

FIELD SKETCH:



1. TASK ANALYSIS

A. KNOWLEDGE

- Unfolding chain and joining Tangent points (Long Chord)
- Fixing ranging rods at Tangent points points.
- Erecting mid ordinate on long chord using cross staff.
- Joining Tangent points with mid ordinate using tape.
- Erecting mid ordinate on sub chord using cross staff.
- Joining the points T_1, C_1, C_2………T_2 to Obtain smooth Curve.

B.SKILLS

Category of Skill	Sub task
1. Handling of apparatus	• Unfolding the chain and making it into straight • Fixing the Ranging rods at stations • Driving arrows / pegs at required points. • Using Cross staff to mark perpendicular offsets
2.Manipulation of apparatus	• Stretching the chain in between Points T_1 and T_2 mark the long chord. • Bisect the long chord to obtain the point D. • Using cross staff mark the perpendicular offset DC. • Using tape join T_1 and T_2 with C. • Bisecting the sub chords T_1C and T_2C • Using cross staff mark the perpendicular offset D_1C_1 and D_2C_2 • Joining T_1,C, C_1, C_2,……T_2.can obtain smooth curve
3. Precise operation /activity	• Calculating the mid ordinate of the long chord, using the formula • DC = R(1-cos (θ/2)) (or) $R-\sqrt{R^2-(\frac{L}{2})^2}$. • Calculating the mid ordinate of sub chord, using the formula • $D_1C_1 = D_2C_2$= R(1-cos (θ/4)) • Calculating the mid ordinate of sub chord, using the formula • $D_3C_3 = D_4C_4$= R(1-cos (θ/8))

4. Safety of the Equipment	• Unfolding the chain on level and smooth ground to avoid detaching of links and tallies. • Holding the ranging rod at certain height above the ground so as to avoid touching its tip to ground while carrying. • Driving ranging rods firmly into the ground so as to avoid falling on to the ground frequently and loosing its verticality. • Avoiding driving of cross staff, ranging rods, arrows on stones/rocks.

2. TEACHING POINTS

S. No.	Teaching points	Suggestive Duration (Min.)
1.	Description about A. Deflection Angle B. Tangent Points C. Long Chord D. Sub Chord E. Mid ordinates	5
2.	Using of Chain &Tape in the field	
3.	Using of Ranging rods and Arrows in the field	
4.	Calculating the length of long chord if necessary	10
5.	Calculating the mid ordinate of long chord	
6.	Calculating the mid ordinate of sub chords	
7.	**Procedural precautions** • Care should be taken while measuring horizontal distance. • Care should be taken while folding and unfolding the chain. • Care should be taken while erecting ranging rods vertically. • Care should be taken while bisecting the chords. • Care should be taken while placing the Arrows. • Care should be taken while erecting perpendiculars with cross staff	
	Total	15

3. NEED AND SCOPE OF THE EXPERIMENT

The curves required in the horizontal plane are known as Horizontal Curves. Whenever the direction of a road or railway line is to be changed, curves are provided between the intersecting straights. This is necessary for smooth and safe movement of the vehicles and for the comfort of passengers.

4. PLANNING AND ORGANIZATION

Action	Activity
Check for	1. All links and tallies in chain. 2. Opened links and rings in chain. 3. Actual length of chain and tape. 4. marked readings on tape. 5. Straightness of ranging rods.
For design of Instruction	Read the teaching points carefully.

5. SCHEME OF EVALUATION

<table>
<tr><th>Category of skill</th><th>Sub Task</th><th>Weight with competency level individually</th><th>Awarded

(50)</th></tr>
<tr><td>1. Handling of apparatus</td><td>A. Unfolding the chain
B. Fixing the Ranging rods at stations
C. Driving arrows / pegs at required points.
D. Using Cross staff to mark perpendicular offsets
E. Folding the Chain</td><td><table><tr><td>A</td><td>2</td></tr><tr><td>B</td><td>2</td></tr><tr><td>C</td><td>2</td></tr><tr><td>D</td><td>2</td></tr><tr><td>E</td><td>2</td></tr><tr><td>Total</td><td>10</td></tr></table></td><td></td></tr>
</table>

<table>
<tr>
<td>2.Manipulation of apparatus</td>
<td>A. Stretching the chain in between Points T_1 and T_2 mark the long chord.Bisect the long chord to obtain the point D.
B. Using cross staff, mark the perpendicular offset DC.
C. Using tape join T_1 and T_2 with C.
D. Bisecting the sub chords T_1C and T_2C
E. Joining C, C_1, C_2,…….to obtain smooth curve</td>
<td><table><tr><td>A</td><td>3</td></tr><tr><td>B</td><td>3</td></tr><tr><td>C</td><td>3</td></tr><tr><td>D</td><td>3</td></tr><tr><td>E</td><td>3</td></tr><tr><td>Tot</td><td>15</td></tr></table></td>
<td></td>
</tr>
<tr>
<td>3.Precise Operation/Activity</td>
<td>A. Calculating the Length of long chord
B. Calculating the mid ordinate of the long chord, using the formula DC = R(1-cos (θ/2)) (or) $R-\sqrt{R^2-(\frac{L}{2})^2}$.
C. Calculating the mid ordinate of sub chord, using the formula
$D_1C_1 = D_2C_2= R(1-\cos(\theta/4))$
D. Calculating the mid ordinate of sub chords, using the formula
$D_3C_3 = D_4C_4= R(1-\cos(\theta/8))$</td>
<td><table><tr><td>A</td><td>5</td></tr><tr><td>B</td><td>5</td></tr><tr><td>C</td><td>5</td></tr><tr><td>D</td><td>5</td></tr><tr><td>Tot</td><td>20</td></tr></table></td>
<td></td>
</tr>
<tr>
<td>4. Values</td>
<td>A. Co-operation
B. Co-ordination
C. Communication
D. Sharing
E. Leadership</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td colspan="2">Total</td>
<td>50</td>
<td></td>
</tr>
</table>

6. **ASSESSMENT QUESTIONS**(Only suggestive)

1. Give the formula for calculating the length of Long Chord.
2. Give the formula for calculating the mid ordinate.
3. Give the formula for calculating the mid ordinates for Sub chords .
4. List the linear methods of setting out a simple curves.
5. Give the formula for calculating by successive bisection of Arcs or Chords

7. VIVA QUESTIONS

(Only suggestive) The teacher may add questions depending upon the Context of examination

1. What is the significance of curves?
2. What are the Various Methods of Setting out the curves?
3. What are the various elements of the Curves?
4. How to calculate the Chainage of T_1 and T_2?
5. What is the procedure for Setting of Curve by Successive bisection of arc method?
6. What is simple curve?
7. Is the simple curve radius uniform through out?

Setting out a simple Circular curve by Radial offsets from tangents

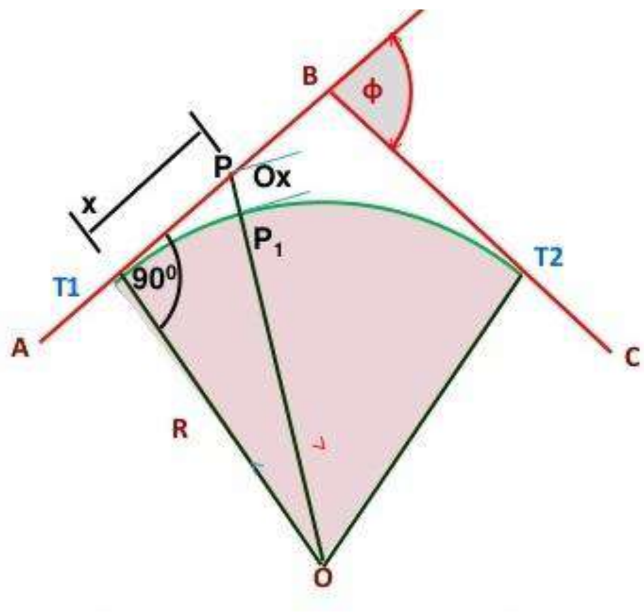
OBJECTIVE

Performing the set of tasks in setting out of a simple circular curve in the field using chain and tape by the method of Radial offsets erected from tangents.

EQUIPMENT /RESOURSES

1. Chain – 1 No.,
2. Tape – 01 No.,
3. Ranging rods – 06 No
4. Arrows – 10 No.
5. Cross staff - 01 No

FIELD SKETCH:



1. TASK ANALYSIS

A. KNOWLEDGE

- Unfolding the chain, the tangents T_1B, T_2B are Identified.
- Offsets are erected Radial to the tangents.
- The Toe points are fixed on the radial Offsets.
- Joining the Toe points the required curve may be obtained.

B.SKILLS

Category of Skill	Sub task
1. Handling of apparatus	• Unfolding the chain and making it into straight. • Fixing the Ranging rods at station. • Driving arrows / Pegs at required points. • Using Cross staff to mark Perpendicular Offsets. • Using tape to measure the radial distance.
2.Manipulation of apparatus	• Stretching the chain in between Points T1 and B mark the Tangent Length. • Offsets O_{x1}, O_{x2}, O_{x3}........are erected radially to the tangent T_1B with tape to get P_1, P_2, P_3...... points on the curve. • Joining the points P_1, P_2, P_3,... to get the smooth curve.
3. Precise operation /activity	• Calculating the Length of tangent, $T_1B = R \tan Ø/2$ • Calculating the radial Offsets O_{x1}, O_{x2}, O_{x3}........ , are calculated using the formula, $O_x = \sqrt{R^2 + x^2} - R$ • Check should be made by measuring the apex distance, which should be equal to R[sec Ø/2 - 1]
4. Safety of the Equipment	• Unfolding the chain on level and smooth ground to avoid detaching of links and tallies. • Holding the ranging rod at certain height above the ground so as to avoid touching its tip to ground while carrying. • Driving ranging rods firmly into the ground so as to avoid falling on to the ground frequently and loosing its verticality • Avoiding driving of cross staff, ranging rods, arrows on stones/rocks.

2. TEACHING POINTS

S. No.	Teaching points	Suggestive Duration (Min.)
1.	Description about A. Tangent Length B. Chainage of T_1 C. Chainage of T_2 D. Curve length	5
2.	Using of Chain &Tape in the field	
3.	Using of Ranging rods and Arrows in the field	
4.	Calculating the Tangent Length	10
5.	Calculating the radial offsets from the tangents	
6.	Checking the apex distance to get the accuracy	
7.	**Procedural precautions** • Care should be taken while measuring Tangent length • Care should be taken while folding and unfolding the chain. • Care should be taken while erecting ranging rods vertically • Care should be taken while setting the radial offsets • Care should be taken while placing the Arrows. • Care should be taken while erecting perpendiculars with cross staff	
	Total	15

3. NEED AND SCOPE OF THE EXPERIMENT

The curves required in the horizontal plane are known as Horizontal Curves. Whenever the direction of a road or railway line is to be changed, curves are provided between the intersecting straights. This is necessary for smooth and safe movement of the vehicles and for the comfort of passengers.

4. PLANNING AND ORGANIZATION

Action	Activity
Check for	1. All Links and Tallies in the chain. 2. Actual length of Chain and Tape 3. Opened links in chain and Tape. 4. Marked readings on Tape. 5. Straightness of Ranging rods .
For design of Instruction	Read the teaching points carefully.

5. SCHEME OF EVALUATION

Category of skill	**Sub Task**	**Weight with competency level individually**	**Awarded (50)**
1. Handling of apparatus	A. Unfolding the chain B. Fixing the Ranging rods at stations C. Driving arrows / pegs at required points. D. Using tape to mark the radial offsets E. . Folding the Chain	A 2 B 2 C 2 D 2 E 2 Total 10	
2.Manipulation Ofapparatus	**A.** Stretching the chain in between Points T1 and B mark the Tangent Length. **B.** Offsets O_{x1}, O_{x2}, O_{x3}........are erected radially to the tangent T_1B with tape to get P_1, P_2, P_3...... points on the curve. **C.** Check the apex distance using tape to checkthe accuracy of work. D. Joining the points P_1, P_2, P_3,... to get the smooth curve.	A 2 B 9 C 2 D 2 Total 15	
3.Precise Operation/Activity	A. Calculating the Length of tangent, $T_1B = R \tan Ø/2$ B. Calculating the radial Offsets O_{x1}, O_{x2}, O_{x3}........ , are calculated using the formula, $O_x = \sqrt{R^2 + x^2} - R$ C. Check should be made by measuring the apex distance, which should be equal to R[sec Ø/2 - 1]	A 5 B 10 C 5 Tot 20	
4. Values	A. Co-operation B. Co-ordination C. Communication D. Sharing E. Leadership	5	
Total		50	

6. ASSESSMENT QUESTIONS(Only suggestive)

1. List the linear methods of setting out a simple curve.
2. Give the formula for calculating the Radial offsets.
3. In Radial & Perpendicular methods which method do you feel is more simple and nearer to the actual situation?
4. How many parameters are required for laying the curve by the method of tangents?
5. If two roads AB & BC are intersecting at (180 – Ø) angle, then where would you start laying the curve between them and why?
6. Find the degree of curve setup by you in the field.

7. VIVA QUESTIONS

(Only suggestive) The teacher may add questions depending upon the Context of examination

1. What are the significance of curves?
2. What are the Various Methods of Setting out the curves?
3. What are the various elements of the Curves?
4. How to calculate the Chainage of T_1 and T_2?
5. What is the procedure for Setting of Curve by Radial offsets method?
6. What is simple curve?
7. . Is the simple curve radius uniform through out?

Setting out a simple circular curve by perpendicular offsets from tangents

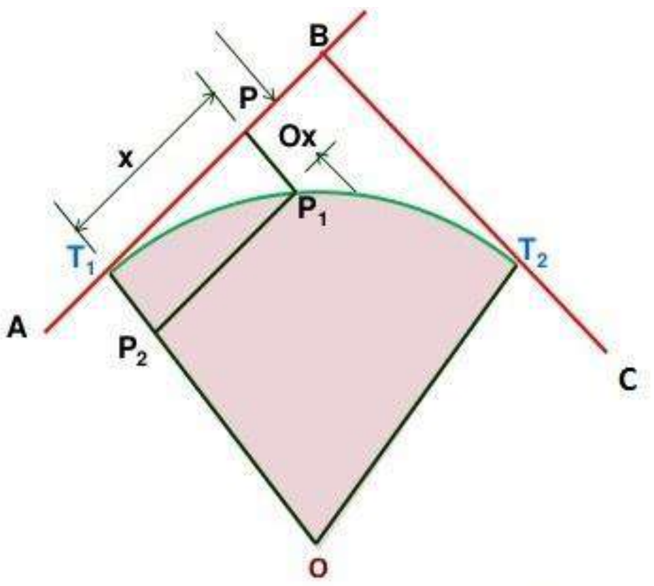
OBJECTIVE

Performing the set of tasks in setting out simple circular curve in the field using chain and tape by the method of perpendicular offsets erected from tangents.

EQUIPMENT /RESOURSES

1. Chain – 1 No.,
2. Tape – 01 No.,
3. Ranging rods – 02 No
4. Arrows – 10 No.
5. Cross staff - 01 No

FIELD SKETCH:



1. TASK ANALYSIS

A. KNOWLEDGE

- Unfolding chain , the tangent length T_1B is marked.
- Using compass or theodolite mark the deflection angle to obtain other tangent T_2B.
- Using cross staff erect perpendiculars to the tangents
- Offset lengths are calculated.
- Offset lengths fixed on perpendiculars.
- Joining the toe points of offset lengths required curve may obtained

B.SKILLS

Category of Skill	Sub task
1. Handling of apparatus	• Unfolding the chain and making it into straight. • Fixing the Ranging rods at station. • Driving arrows / Pegs at required points. • Using Cross staff to mark Perpendicular Offsets. • Using tape to measure the perpendicular distance.
2.Manipulation of apparatus	• Stretching the chain in between Points T1 and B mark the tangent length. • Using compass mark the deflection angle to obtain other tangent T_2B. • Using cross staff mark the perpendicular offsets from tangents at regular intervals. • Using tape mark the calculated ordinates on perpendicular offsets. • Joining the toe points of the offsets , smooth Curve may be observed.
3. Precise operation /activity	• Calculating the Length of tangent , L = *R tan Ø/2* • Length of the curve, CL = $\frac{\Pi R Ø}{180}$ • Chainage of T_2 = Chainage of T_1 + Curve Length • Calculating the perpendicular offsets at regular intervals, from tangents $O_o = R - \sqrt{(R^2 - x^2)}$
4. Safety of the Equipment	• Unfolding the chain on level and smooth ground to avoid detaching of links and tallies. • Holding the ranging rod at certain height above the ground so as to avoid touching its tip to ground while carrying. • Driving ranging rods firmly into the ground so as to avoid falling on to the ground frequently and loosing its verticality • Avoiding driving of cross staff, ranging rods, arrows on stones/rocks.

2. TEACHING POINTS

S. No.	Teaching points	Suggestive Duration (Min.)
1.	Description about A. Deflection Angle B. Tangent Points C. Tangent lengths D. Perpendicular offsets	5
2.	Using of Chain &Tape in the field	
3.	Using of Ranging rods and Arrows in the field	
4.	Calculating the length of tangent	10
5.	Calculating the perpendicular off sets	
7.	**Procedural precautions** • Care should be taken while measuring perpendicularl distance • Care should be taken while folding and unfolding the chain. • Care should be taken while erecting ranging rods vertically • Care should be taken while bisecting the chords • Care should be taken while placing the Arrows. • Care should be taken while erecting perpendiculars with cross staff	
	Total	15

3. NEED AND SCOPE OF THE EXPERIMENT

The curves required in the horizontal plane are known as Horizontal Curves. Whenever the direction of a road or railway line is to be changed, curves are provided between the intersecting straights. This is necessary for smooth and safe movement of the vehicles and for the comfort of passengers.

4. PLANNING AND ORGANIZATION

Action	Activity
Check for	1. All Links and Tallies in the chain. 2. Actual length of Chain and Tape 3. Opened links in chain and Tape. 4. Marked readings on Tape. 5. Straightness of Ranging rods .
For design of Instruction	Read the teaching points carefully.

5. SCHEME OF EVALUATION

<table>
<tr><th>Category of skill</th><th>Sub Task</th><th>Weight with competency level individually</th><th>Awarded

(50)</th></tr>
<tr><td>1. Handling of apparatus</td><td>A. Unfolding the chain
B. Fixing the Ranging rods at stations
C. Driving arrows / pegs at required points.
D. Using Cross staff to mark perpendicular offsets
E. . Folding the Chain</td><td><table><tr><td>A</td><td>2</td></tr><tr><td>B</td><td>2</td></tr><tr><td>C</td><td>2</td></tr><tr><td>D</td><td>2</td></tr><tr><td>E</td><td>2</td></tr><tr><td>Total</td><td>10</td></tr></table></td><td></td></tr>
<tr><td>2.Manipulation Ofapparatus</td><td>A. Stretching the chain in between Points T1 and T2 mark the long chord Bisect the long chord to obtain the point D
B. Bisect the long chord to obtain the point E.
C. Using cross staff mark the perpendicular offset DE
D. Using cross staff, mark the ordinates at regular intervals on both sides of mid ordinate on long chord.
E. Joining the points T_1DT_2 to get the smooth Curve.</td><td><table><tr><td>A</td><td>3</td></tr><tr><td>B</td><td>3</td></tr><tr><td>C</td><td>3</td></tr><tr><td>D</td><td>3</td></tr><tr><td>E</td><td>3</td></tr><tr><td>Total</td><td>15</td></tr></table></td><td></td></tr>
<tr><td>3.Precise Operation/Activity</td><td>• Calculating the Length of tangent , L = R tan Ø/2
• Length of the curve, CL = $\frac{\Pi R \text{Ø}}{180}$
• Chainage of T_2 = Chainage of T_1 + Curve Length
• Calculating the perpendicular offsets at regular intervals, from tangents $O_o = R - \sqrt{(R^2 - x^2)}$</td><td><table><tr><td>A</td><td>5</td><td></td></tr><tr><td>B</td><td>5</td><td></td></tr><tr><td>C</td><td>3</td><td></td></tr><tr><td>D</td><td>07</td><td></td></tr><tr><td>Tot</td><td>20</td><td></td></tr></table></td><td></td></tr>
<tr><td>4. Values</td><td>A. Co-operation
B. Co-ordination
C. Communication
D. Sharing
E. Leadership</td><td>5</td><td></td></tr>
<tr><td colspan="2">Total</td><td>50</td><td></td></tr>
</table>

6. ASSESSMENT QUESTIONS(Only suggestive)

1. How many parameters are required for laying the curve by the method of tangents.
2. Give the formula for calculating the perpendicular offset.
3. Which method do you feel more simple and nearer to actual situation

   a) Perpendicular offsets b) radial offsets.

4. List the linear methods of setting out a simple curve.
5. Find the degree of curve set up by you.

7. VIVA QUESTIONS

(Only suggestive) The teacher may add questions depending upon the Context of examination

1. What are the significance of curves?
2. What are the Various Methods of Setting out the curves?
3. What are the various elements of the Curves?
4. How to calculate the Chainage of T_1 and T_2?
5. What is the procedure for Setting of Curve by perpendicular Offsets from tangents?
6. What is simple curve?
7. . Is the simple curve radius uniform through out?

Setting out a simple circular curve by offsets from extended chords

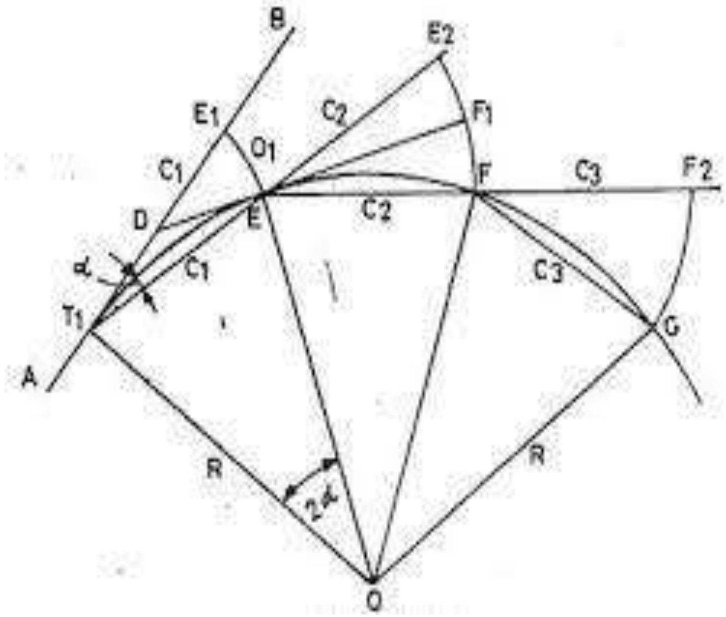
OBJECTIVE

Performing the set of tasks in setting out of a simple circular curve in the field using chain and tape by the method of Extended chords.

EQUIPMENT /RESOURSES

1. Chain – 1 No.,
2. Tape – 01 No.,
3. Ranging rods – 02 No
4. Arrows – 10 No.
5. Cross staff - 01 No

FIELD SKETCH:



1. TASK ANALYSIS

A. KNOWLEDGE

- Unfolding chain , the tangent length T_1B is marked.
- Using cross staff erect perpendiculars to the tangents
- Offset lengths are calculated.
- Offset lengths fixed on perpendiculars.
- Joining the toe points of offset lengths required curve may obtained

B.SKILLS

Category of Skill	Sub task
1. Handling of apparatus	• Unfolding the chain and making it into straight to mark tangents. • Fixing the Ranging rods at station. • Driving arrows / Pegs at required points. • Using tape marking chords. • prolonging the chords using chain. • Using Cross staff ,to mark Perpendicular Offsets on chords. • Using chain to mark arc on perpendicular offset.
2.Manipulation of apparatus	• Stretching the chain in between Points T_1 and A mark the tangent length. • Marking the calculated chord length C_1 on tangent using tape. • Using cross staff mark the perpendicular offset at C_1 to denote the toe point E. • Positioning of chain be changed into direction T_1E and prolonged it to beyond E to a value of C_2. • Joining the toe points of the offsets , smooth Curve may be observed.
3. Precise operation /activity	• Calculating Length of first sub-chord (C_1) • Calculating length of last sub-chord (Cn) • Calculating No.of full chords • Length of first off set $O_1= (C_1^2)/2R$ • Second offset for full chord $= O_2 = C_2 (C_1+ C_2)/2R$ • Similarly O_3 to $O_{n-1} = C^2 /R$ • Last offset for final sub-chord $= C_n(C_{n-1}+ C_n)/2R$
4. Safety of the Equipment	• Unfolding the chain on level and smooth ground to avoid detaching of links and tallies. • Holding the ranging rod at certain height above the ground so as to avoid touching its tip to ground while carrying. • Driving ranging rods firmly into the ground so as to avoid falling on to the ground frequently and loosing its verticality • Avoiding driving of cross staff, ranging rods, arrows on stones/rocks.

2. TEACHING POINTS

S. No.	Teaching points	Suggestive Duration (Min.)
1.	Description about A. Deflection Angle B. Tangent Points C. Tangent lengths D. Sub chords E. Offsets	5
2.	Using of Chain &Tape in the field	
3.	Using of Ranging rods and Arrows in the field	
4.	Calculating the length of tangent	10
5.	Calculating the perpendicular off sets	
7.	**Procedural precautions** • Care should be taken while measuring perpendicularl distance • Care should be taken while folding and unfolding the chain. • Care should be taken while erecting ranging rods vertically • Care should be taken while placing the Arrows. • Care should be taken while erecting perpendiculars with cross staff	
	Total	15

3. NEED AND SCOPE OF THE EXPERIMENT

The curves required in the horizontal plane are known as Horizontal Curves. Whenever the direction of a road or railway line is to be changed, curves are provided between the intersecting straights. This is necessary for smooth and safe movement of the vehicles and for the comfort of passengers.

4. PLANNING AND ORGANIZATION

Action	Activity
Check for	1. All Links and Tallies in the chain. 2. Actual length of Chain and Tape 3. Opened links in chain and Tape. 4. Marked readings on Tape. 5. Straightness of Ranging rods .
For design of Instruction	Read the teaching points carefully.

5. SCHEME OF EVALUATION

<table>
<tr><th>Category of skill</th><th>Sub Task</th><th>Weight with competency level individually</th><th>Awarded

(50)</th></tr>
<tr><td>1. Handling of apparatus</td><td>A. Unfolding the chain
B. Fixing the Ranging rods at stations
C. Driving arrows / pegs at required points.
D. Using Cross staff to mark perpendicular offsets
E. . Folding the Chain</td><td>A 2
B 2
C 2
D 2
E 2
Total 10</td><td></td></tr>
<tr><td>2.Manipulation Ofapparatus</td><td>A. Stretching the chain in between Points T_1 and A mark the tangent length.
B. Marking the calculated chord length C_1 on tangent using tape.
C. Using cross staff mark the perpendicular offset at C_1 to denote the toe point E.
D. Positioning of chain be changed into direction T_1E and prolonged it to beyond E to a value of C_2.
E. Joining the toe points of the offsets, smooth Curve may be observed.</td><td>A 3
B 3
C 3
D 3
E 3
Total 15</td><td></td></tr>
<tr><td>3.Precise Operation/Activity</td><td>A. Calculating Length of first sub-chord (C_1)
B. Calculating length of last sub-chord (Cn)
C. Calculating No.of full chords
D. Length of first off set $O_1 = (C_1^2)/2R$
E. Second offset for full chord $= O_2 = C_2 (C_1 + C_2)/2R$
F. Similarly O_3 to $O_{n-1} = C^2 /R$
G. Last offset for final sub-chord $= C_n(C_{n-1} + C_n)/2R$</td><td>A 3
B 3
C 2
D 3
E 3
F 3
G 3
Tot 20</td><td></td></tr>
<tr><td>4. Values</td><td>A. Co-operation
B. Co-ordination
C. Communication
D. Sharing
E. Leadership</td><td>5</td><td></td></tr>
<tr><td colspan="2">Total</td><td>50</td><td></td></tr>
</table>

6. ASSESSMENT QUESTIONS(Only suggestive)

1. How many parameters are required for laying the curve by the method of tangents.
2. List the linear methods of setting out a simple curve.
3. The tangent length is the distance from…………to……………..
4. How do you calculate chainage of second tangent point.
5. The angle between tangents is called…………………

7. VIVA QUESTIONS

(Only suggestive) The teacher may add questions depending upon the Context of examination

1. What are the significance of curves?
2. What are the Various Methods of Setting out the curves?
3. What are the various elements of the Curves?
4. What is the procedure for Setting of Curve by extended chords method?
5. What is simple curve?

Data Sheet : 4.20

Setting of curve by offsets from Extended chords

OFFSETS FROM EXTENDED CHORDS

SETTING OUT OF CURVE BY USING ONE THEODOLITE

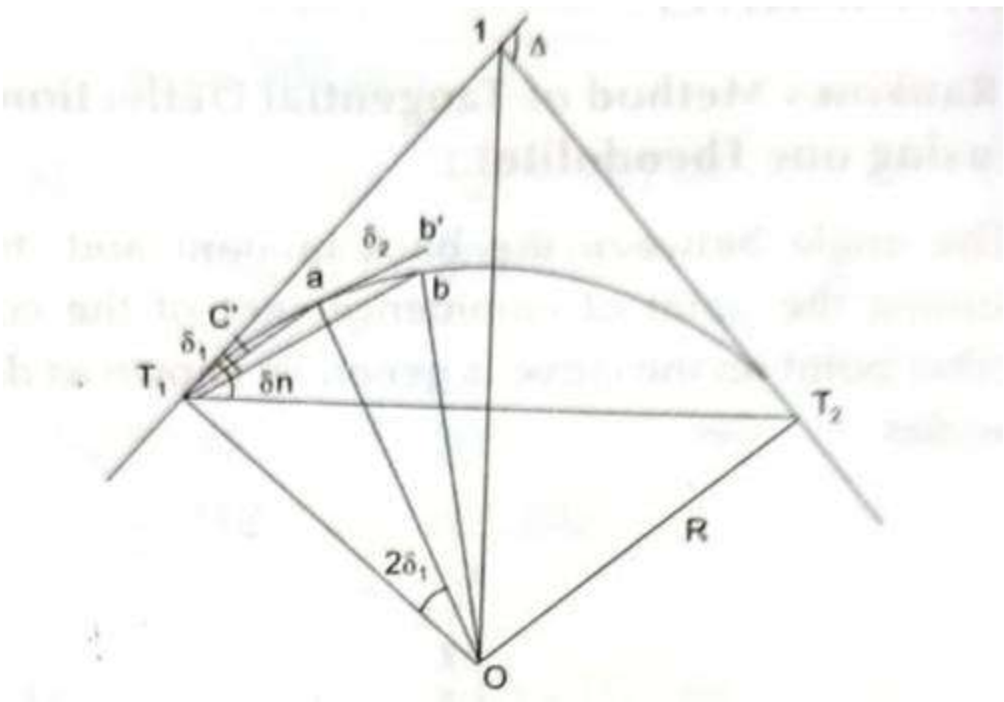
OBJECTIVE

To perform the set of tasks in Setting out of the curve by using one Theodolite (Rankine's Deflection angle method).

EQUIPMENT /RESOURSES

1. Theodolite – 1 No.,
2. Tripod – 1 No.,
3. Tape (or chain) – 01 No.,
4. Plumb bob – 01 No.,
5. Ranging rods – 03 No.
6. Pegs – 08 No.

<u>FIELD SKETCH:</u>



1. TASK ANALYSIS

A. KNOWLEDGE

- Approximate centering and levelling of tripod
- Identification and functioning of parts of theodolite
- Temporary adjustments of theodolite
- Focusing and Elimination of parallax
- To read the vernier readings

B.SKILLS

Category of Skill	Sub task
1. Handling of apparatus	• Identifying the point of commencement and set up the tripod and approximately center over the point and level it (use tripod bubble if available) • Fixing the Theodolite to the tripod • Unclamping the upper clamps of the Theodolite and observe the movement of theodolite in horizontal direction. • Carrying out the temporary adjustments of Theodolite using foot screws and altitude bubble tube • Using the tape or chain to measure the tangent length and chord length
2.Manipulation of apparatus	1) Setting the horizontal circle should be zero by using the upper clamp and upper tangent screw 2) Setting the point of intersection by sighting the object and place the arrow 3) Setting the center point of the curve by using tape with arrow 4) Measuring the chord length by using chain or tape 5) bisecting the ranging rod along the deflection angles
3. Precise operation /activity	1. setting the deflection angles in the theodolite by using upper clamp and upper tangent screw 2. bisecting the deflection angles through chain and tape and fix the arrow on point of curve 3. placing the points on curve reaching up to point of tangency 4. checking the deflection angle at the point of tangency
4. Safety of the Equipment	• Unclamping of clamp screws for properly placing the theodolite into safety box • Unfixing of theodolite to tripod • Placing the theodolite in safety box properly identifying the position • Clamping the clamp screws to avoid the movement of parts in safety box.

2. TEACHING POINTS

S. No.	Teaching points	Suggestive Duration (Min.)
1.	Description about setting of point of commencement, point of intersection and center point of curve.	5
2.	Measuring the chord length on the line of deflection angle	
3.	Placing the arrows	
4.	Calculating the elements of curve	10
5.	Calculating the deflection angles according to chord length	
6.	Setting the deflection angles in the theodolite	
7.	**Procedural precautions** • Care should be taken while setting the deflection angle • Care should be taken in operating clamps and screws. • Bisection of the object should be precise • Proper care should be taken in measuring the chord length along the deflection angle line and fix the arrow	
	Total	15

3. NEED AND SCOPE OF THE EXPERIMENT

When the alignment is changed in horizontal or vertical direction curve should be needed. In highways and railways horizontal curves are used.

4. PLANNING AND ORGANIZATION

Action	Activity
Check for	1. Working condition of theodolite, tripod, tape or chain. 2. Actual length of chain or tape 3. marked reading on verniers, tape readings 4. Straightness of ranging rods and pegs
For design of Instruction	Read the teaching points carefully.

5. SCHEME OF EVALUATION

Category of skill	Sub Task	Weight with competency level individually	Awarded (50)
1. Handling of apparatus	A. Fixing the Theodolite to the tripod B. Unclamp the upper clamps of the Theodolite and observe the movement of theodolite in horizontal direction and telescope in vertical plane. C. Carry out the temporary adjustments of Theodolite using foot screws and altitude bubble tube D. Using the tape or chain measure the chord length along the deflection angle line E. Identifying the situations of using ranging rod and pegs	A 1 B 3 C 3 D 2 E 1 Total 10	

<table>
<tr>
<td>2.Manipulation Of apparatus</td>
<td>A. Setting the horizontal circle should be zero by using the upper clamp and upper tangent screw

B. Setting the point of intersection by sighting the object and place the arrow

C. Setting the center point of the curve by using tape with arrow

D. Measuring the chord length by using chain or tape

E. bisecting the ranging rod along the deflection angles</td>
<td><table><tr><td>A</td><td>2</td></tr><tr><td>B</td><td>3</td></tr><tr><td>C</td><td>2</td></tr><tr><td>D</td><td>3</td></tr><tr><td>E</td><td>5</td></tr><tr><td>Tot</td><td>15</td></tr></table></td>
<td></td>
</tr>
<tr>
<td>3.Precise Operation/Activity</td>
<td>A. setting the deflection angles in the theodolite by using upper clamp and upper tangent screw

B. bisecting the deflection angles through chain and tape and fix the arrow on point of curve

C. placing the points on curve reaching up to point of tangency

D. checking the deflection angle at the point of tangency</td>
<td><table><tr><td>A</td><td>5</td></tr><tr><td>B</td><td>5</td></tr><tr><td>C</td><td>5</td></tr><tr><td>D</td><td>5</td></tr><tr><td>Tot</td><td>20</td></tr></table></td>
<td></td>
</tr>
<tr>
<td>4. Values</td>
<td>A. Co-operation
B. Co-ordination
C. Communication
D. Sharing
E. Leadership</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td colspan="2">Total</td>
<td>50</td>
<td></td>
</tr>
</table>

6. VIVA QUESTIONS

a) What are T_1 and T_2 , name them.
b) When setting of deflection angle which clamp is used.

SETTING OUT OF THE CURVE BY USING TWO THEODOLITES

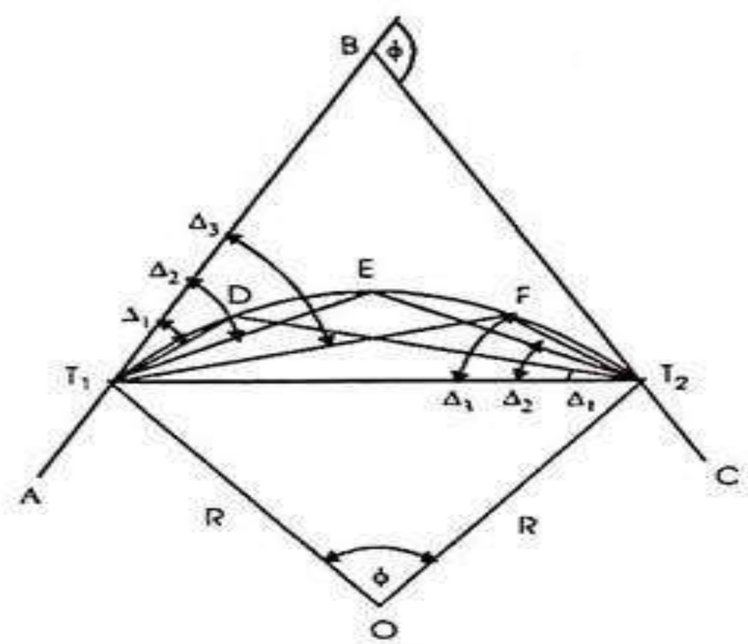
OBJECTIVE

To perform the set of tasks in setting out of the curve using two theodolites.

EQUIPMENT /RESOURSES

1. Theodolites - 2 Nos
2. Tripods - 2 Nos
3. Plumb bob - 1 No
4. Ranging rods - 3 Nos
5. Pegs - 10 Nos

FIELD SKETCH:



1. TASK ANALYSIS

A. KNOWLEDGE

- Calculation of necessary data required to set out a curve from the given information.
- Preparation of the table of deflection angles for first sub chord, normal chord and the last sub chord.
- Identification of Tangent points in the field.
- Performing all the temporary adjustments required for the theodolite.
- Setting the required deflection angles exactly in the instrument.

- Coordination is required with the surveyor at other instrument station and with helper.
- Basic terminology required – Back Tangent, Forward Tangent, point of Intersection, Angle of Intersection, Point of Commencement, Point of Tangency, Tangent Distance, Length of the Curve, Long Chord, Mid ordinate, Normal Chord and Sub Chord.

B. SKILLS

Category of Skill	Sub Task
1. Handling of Instrument	A. Setting up of the tripod stand on the ground with required height. B. Taking the instrument from the box and fixing it on the tripod stand. C. Adjusting the tripod stand legs and fix firmly in to the ground by pressing the legs. D. Adjusting the legs of tripod to place the instrument over the station point approximately.
2. Manipulation of Instrument	E. Setting up of the theodolites over tangent points. F. Performing all the temporary adjustments accurately. G. Sighting and bisecting the ranging rods by turning the telescope and by focussing.
3. Precise Operation / Activity	A. Calculating the values of deflection angles from the given data. B. Setting the horizontal angle to read Zero degrees using horizontal circle clamp. C. Fixing the exact required deflection angle in the instrument by the two people. D. Giving instructions to the helper (ranging rod holder) for his movement accordingly from both the instrument stations. E. Placing the pegs at exact located points by the two instrument people.

2. TEACHING POINTS

S. No	Teaching points	Suggestive Duration (minutes)
1.	Importance of curve setting using two theodolites, especially where the ground is undulating. (Chain & Tape methods are very difficult to use).	5
2.	Explanation on Calculation & Tabulation of deflection angles, used for curve setting.	
3.	Instruments to be used for the activity.	
4.	Explaining the procedure to be followed to perform the activity (It may be done in the field)	5
5.	Precautions	5
	Procedural Precautions 1. Care should be taken in handling the instrument. 2. Precise calculations must be required. 3. Care should be taken in setting the angles in theodolites, only then curve will be perfect. 4. Pegs should be marked at exact points. 5. Two surveyors must be careful enough in performing the activity. 6. Helpers should follow the instructions carefully.	
	Total	15

3. NEED AND SCOPE OF THE EXPERIMENT

1. To set out a simple curve using two theodolites.
2. This method is very useful in the absence of chain or tape and also when ground is not favourable for accurate chaining.
3. This is simple and accurate method but requires essentially two instruments and two surveyors to operate upon them, so it is not as commonly used as the method of deflection angles.

4. PLANNING AND ORGANIZATION

Action	Activity
Check for	• The accuracy of the theodolites used • The bubble position (It should be centre of its run while performing the task). • The deflection angles set in the two theodolites each time.
For design of instruction	• Read teaching points carefully

5. SCHEME OF EVALUATION

<table>
<tr><th>Category of skill</th><th>Sub task</th><th>Weight with competency level individually</th><th>Awarded (50)</th></tr>
<tr><td>1. Handling of Instrument</td><td>A. Setting up of the tripod stand on the ground.
B. Taking the instrument from the box and fixing it on the tripod stand.
C. Adjusting the tripod stand legs and fix firmly in to the ground by pressing the legs.
D. Adjusting the legs of tripod to place the instrument over the station point approximately.</td><td><table><tr><td>A</td><td>B</td><td>C</td><td>D</td><td>Tot</td></tr><tr><td>2</td><td>2</td><td>3</td><td>3</td><td>10</td></tr></table></td><td></td></tr>
<tr><td>2. Manipulation of Instrument</td><td>A. Setting up of the theodolites over tangent points.
B. Performing all the temporary adjustments accurately.
C. Sighting and bisecting the ranging rods by turning the telescope and by focussing.</td><td><table><tr><td>A</td><td>B</td><td>C</td><td>Tot</td></tr><tr><td>5</td><td>5</td><td>5</td><td>15</td></tr></table></td><td></td></tr>
<tr><td>3. Precision</td><td>A. Calculating the values of deflection angles from the given data.
B. Setting the horizontal angle to read Zero degrees using horizontal circle clamp.
C. Fixing the exact required deflection angle in the instrument by the two people.</td><td><table><tr><td>A</td><td>B</td><td>C</td><td>Tot</td></tr><tr><td>10</td><td>5</td><td>5</td><td>20</td></tr></table></td><td></td></tr>
<tr><td>4. Values</td><td>A. Co-operation
B. Co-ordination
C. Communication
D. Sharing
E. Leadership</td><td><table><tr><td></td></tr><tr><td>5</td></tr></table></td><td></td></tr>
<tr><td></td><td>TOTAL</td><td>50</td><td></td></tr>
</table>

6. VIVA QUESTIONS

(Only suggestive. The teacher may add questions depending upon the Context of Examination)

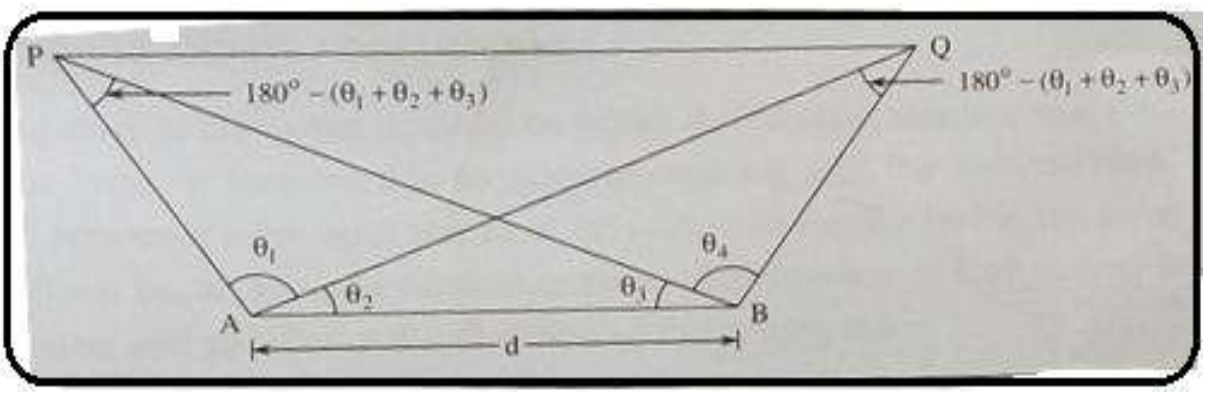
1. What is the data required for setting out a simple curve using two theodolites?
2. What type of measurement involves in Setting out a curve by two theodolite method?
3. Which process can be used for setting a small curve?
4. In Rankine's method, it is assumed that the length of arc is equal to its chord. True or False?
5. Rankine's method can be applied for setting curves of large radius. True or False?
6. The angle between the back tangent and forward tangent of a curve is known as --------------------.
7. The angle by which the forward tangent deflects from the back tangent of a curve is called -------------------.

Plot the Data Observed in Measuring the Horizontal Distance between Two Inaccessible Points Using Theodolie and Obtained the Inaccessible distance from the Plot

A. THEORY:

Theodolite is a instrument is used to measure the horizontal distance between two inaccessible points and obtain the distance between two inaccessible distance from the plot.

B. PROCEDURE:



Let P and Q be the in accessible points the distance from P to Q is to be determined.

Let at'd' = Distance between two instrument station.

From at (A) = The angles Θ_1 and Θ_2 can be measured.

From at (B) = The angle Θ_3 and Θ_4 can be measured.

With above information using the formulas in experiment no 4.7. The distance can be obtained. All the measurements can be plotted to a suitable scale and confirm.

1. Set up the Theodolite at A by making the temporary adjustments level it accurately with respect to the altitude bubble.
2. Sight the point P by keeping the horizontal circle reading at zero.
3. Loosen the upper clamp and rotate the telescope to sight Q and get the horizontal angle PAQ (Θ_1).
4. Sight the point Q by keeping the horizontal circle reading at zero.

5. Loosen the upper clamp and rotate the telescope to sight B and get the horizontal angle QAB (Θ_2).

6. Shift the instrument to station B and do the temporary adjustments

7. Sight the point A by keeping the horizontal circle reading at zero.

8. Loosen the upper clamp and rotate the telescope to sight P and get the horizontal angle ABP (Θ_3).

9. Sight the point P by keeping the horizontal circle reading at zero.

10. Loosen the upper clamp and rotate the telescope to sight Q and get the horizontal angle PBQ (Θ_4).

11. Measure the horizontal distance between and A and B using tape accurately.

12. After Measuring the distance between Two Inaccessible points A and B. Plot the data on a drawing sheet according to the given Scale.

B. OBSERVATIONS AND CALCULATIONS

Horizontal angle < **PAQ** = $\boldsymbol{\Theta_1}$

Horizontal angle < **QAB** = $\boldsymbol{\Theta_2}$

Horizontal angle < **ABP** = $\boldsymbol{\Theta_3}$

Horizontal angle < **PBQ** =$\boldsymbol{\Theta_4}$

Horizontal distance between A and B =d

From the Fig1.f1

From Δ ABP

$<APB = 180° - (\Theta_1 + \Theta_2 + \Theta_3)$

<u>Applying the sine rule</u>

$$= \frac{AB}{\sin(180° - (\Theta_1 + \Theta_2 + \Theta_3))} = \frac{PB}{\sin(\Theta_1 + \Theta_2) \sin\Theta_3} = \frac{PA}{\sin\Theta_3}$$

$$PB = \frac{d}{\sin(180° - (\Theta_1 + \Theta_2 + \Theta_3))} \times \sin(\Theta_1 + \Theta_2)$$

$$PA = \frac{d}{\sin(180° - (\Theta_1 + \Theta_2 + \Theta_3))} \times \sin\Theta_3$$

Again From Δ AQB

$<AQB = 180° - (\Theta_2 + \Theta_3 + \Theta_4)$

Applying the sine rule

$$= \frac{AB}{\sin(180° - (\Theta_2 + \Theta_3 + \Theta_4))} = \frac{QA}{\sin(\Theta_3 + \Theta_4)} = \frac{QB}{\sin\Theta_2}$$

$$QA = \frac{d}{\sin(180° - (\Theta_2 + \Theta_3 + \Theta_4))} \times \sin(\Theta_3 + \Theta_4)$$

$$QB = \frac{d}{\sin(180° - (\Theta_1 + \Theta_2 + \Theta_3))} \times \sin\Theta_2$$

Horizontal distance between P and Q:

(a) From ΔPAQ

By applying cosine rule

$$PQ^2 = PA^2 + QA^2 - 2.PA.QA.\cos\Theta_1$$

PA, QA, and $\Theta_1$are known PQ can be calculated

(b) From ΔPQB

By applying cosine rule

$$PQ^2 = PB^2 + QB^2 - 2.PB.QB.\cos\Theta_4$$

PB, QB, and Θ_4 are known PQ can be calculated

C.RESULT: Plot the data observed in measuring the horizontal distance between two inaccessible points using Theodolite and obtain the inaccessible distance from the plot

Plot the closed traverse of theodolite, distribute the closing error by Bowditch/transit rule calculate the area of traverse.

To Perform the different tasks for Plot the closed traverse of theodolite, distribute the closing error by Bowditch/transit rule calculate the area of traverse.

A. PRINCIPLE

Plotting means to represent on paper, to a suitable scale, the previously surveyed objects in accordance with their shape and size. Plotting is commenced after the field-work is over.

A. THEORY

A traverse is a series of connected lines whose lengths and directions are measured in the field. Closed traverse should be used to have check on the measured angles and distances.

A suitable scale is chosen before starting the plotting work. The scale depends upon the importance of the work and extent of survey. Leave a suitable margin (2 cm to 4 cm) all round the paper. Select a suitable position of the base line so that the map or plan is shown to the best advantages. The base line should be plotted as accurately as possible because the entire accuracy of the frame-work depends upon it.

Theodolite traverse can be plotted by rectangular co-ordinate method. In this method, the position of different points is plotted on a plan with reference to two lines yy1 (y-axis) and xx1 (x-axis) which are respectively parallel and perpendicular to the meridian (Fig. 5.25). These reference lines are called the axes of the co-ordinates, and the point of their intersection O, called the origin.

B. **PROCEDURE:**

- Set the drawing table and fix the drawing sheet properly.
- Choose a suitable scale before starting the plotting work.

- Select suitable position of the base line so that the entire accuracy of plotting work depends upon it.

- Draw yy1(y-axis) and xx1 (x-axis) which are parallel and perpendicular to the meridian.

- Plot the closed traverse of the known lengths and bearings of a lines on y-axis and x-axis by calculating length to scale assumed.

- After completion of plotting of closed traverse. If any errors are there can be balanced by Bowditch's rule and transit rule.

- Calculate the area of closed traverse by co-ordinates method.

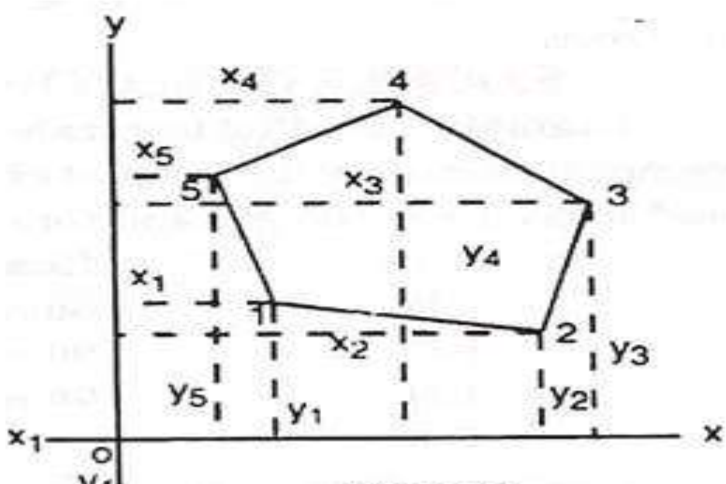


FIG.5.25

OBSERVATIONS AND CALCULATIONS

Balancing a closed traverse survey can be done by two methods.

1. Bowditch's rule
2. Transit's rule

Bowditch's rule

This method is on the assumption that the errors in linear measurements are proportional to root of length and that the errors in angular measurements are inversely proportional to root of length.

The Bowditch's rule is :

Correction to latitude/departure of any side = Total error in latitude/departure $\times \frac{length\ of\ that\ side}{perimeter\ of\ traverse}$

Thus if C_L = correction of latitude of any side

C_D = correction of departure of any side

ΣL = Total error in latitude

ΣD = Total error in departure

Σl = length of the perimeter

l = length of any side.

We have $C_L = \Sigma L \times \frac{l}{\Sigma l}$

$C_D = \Sigma D \times \frac{l}{\Sigma l}$

Transit's rule

The transit rule is applicable where angular measurements are more precise than the linear measurements.

The transit rule is:

Correction to latitude/departure of any side = Total error in latitude/departure $\times \frac{latitude/departure\ of\ the\ line}{Arithemetic\ sum\ of\ latitudes/departures}$

If

L= Latitude of any line.

D= departure of any line

L_T= Arithmetic sum of latitudes

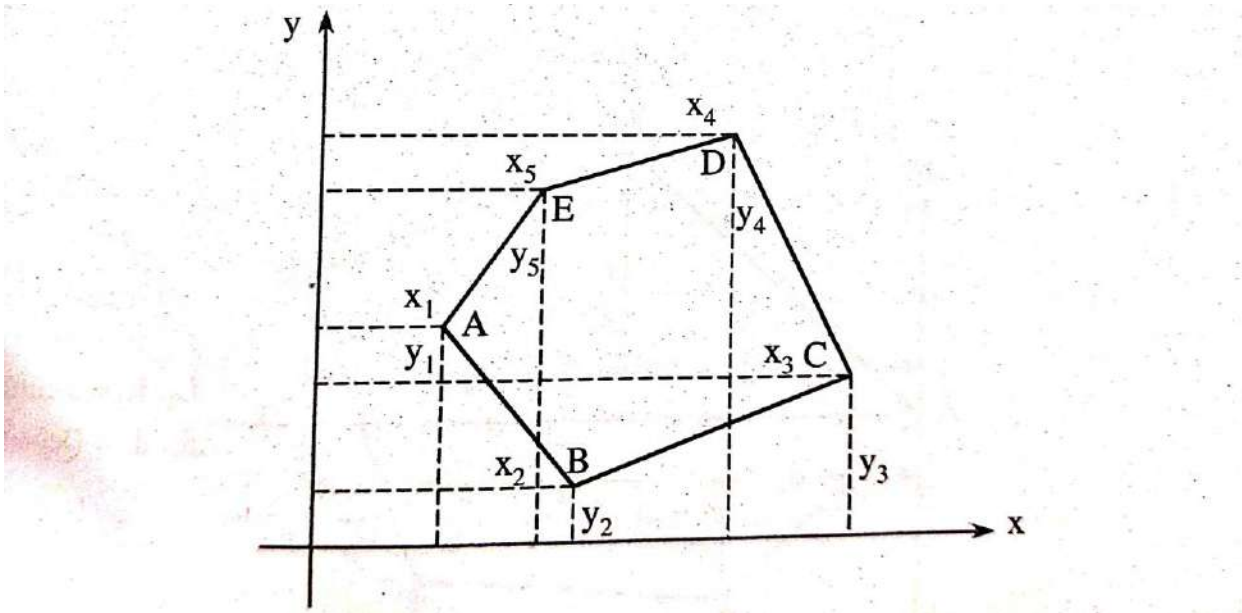
D_T= Arithmetic sum of departures

We have $C_L = \Sigma L \times \frac{L}{LT}$

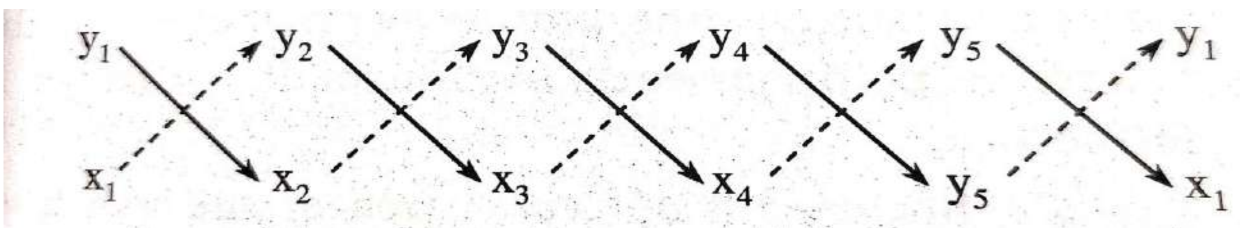
$C_D = \Sigma D \times \frac{D}{DT}$

Area of closed traverse by co-ordinate method

The given consecutive co-ordinates of traverse are converted into independent coordinates with reference to the coordinates of the most westerly station. Thus, whole traverse is transferred to first quadrant. In figure A is the most westerly station.



Then the coordinates are arranged in determinant form as follows



The sum of the products of coordinates joined by solid lines,

$$\Sigma P = (y_1x_2 + y_2x_3 + y_3x_4 + y_4x_5 + y_5x_1)$$

The sum of products of coordinates joined by dotted lines,

$$\Sigma Q = (x_1 y_2 + x_2 y_3 + x_3 y_4 + x_4y_5 + x_5y_1)$$

Double area = $\Sigma P - \Sigma Q$

Required area = $= \frac{1}{2} (\Sigma P - \Sigma Q)$

F.GRAPH

NIL

G.RESULT

1, The area of closed traverse -------- m^2.

H.INFERENCE

____

____

____

____

Plot the Simple curve after setting out the Curve in the Field by Ordinates from long chord method

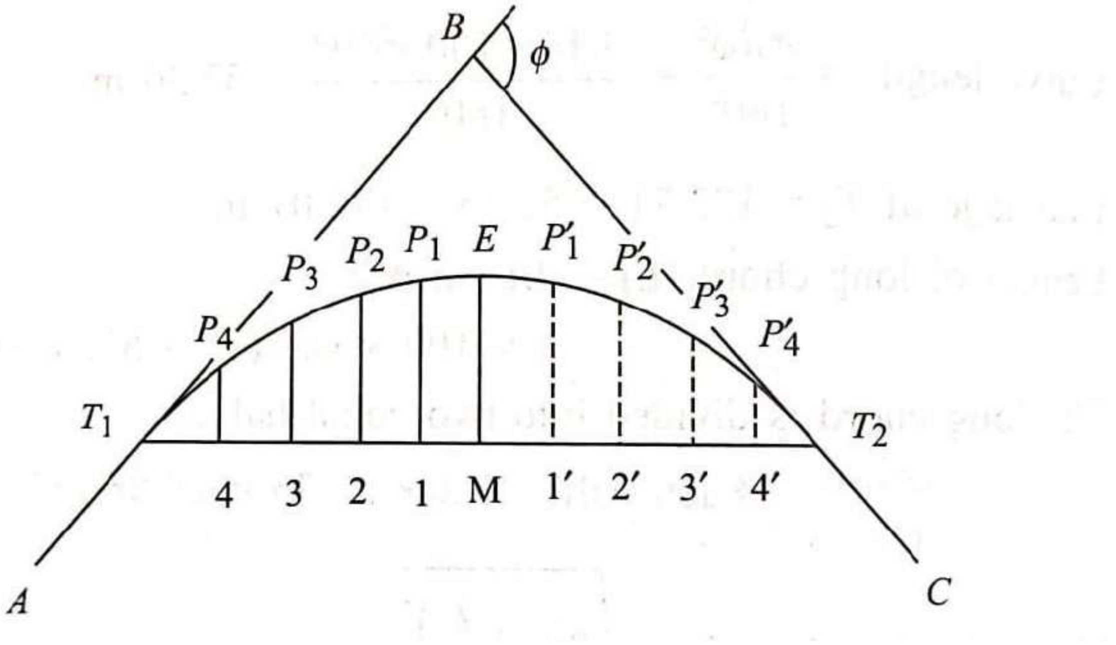
A) OBJECTIVE:

Performing the set of tasks to Plot the Simple curve after setting out the curve in the field by Ordinates from long chord method

B) PROCEDURE

1) Let AB and BC be two tangents meeting at a point B, with defection angle ϕ.
2) The tangents length is calculated from the usual formula, and points T_1 and T_2 are marked on the ground with pegs.
3) The length of the chord, T_1 T_2 is calculated from the usual formula. The long chord is bisected at point M. The curve will be symmetrical on the both sides of M.
4) The ordinates are calculated for the left half at some regular intervals. Points 1 ,2, 3 and 4 are marked with the pegs along the long chord as shown in figure
5) Ordinates O_1, O_2, O_3, and O_4 are calculated from the usual formula
6) Perpendiculars are set out at points 1, 2, 3 and 4. The calculated ordinates O_1, O_2, O_3, and O_4 identified along these perpendiculars and points P_1 ,P_2, P_3 and P_4 are marked with pegs
7) In the right half, points 1', 2', 3' and 4' are marked with the pegs and corresponding ordinates (ordinates for the left half) are set out to mark the points P'_1, P'2, P'_3 and P'_4.
8) All these points P_1, P_2,…. and P'_1, P'_2,…. are on the curve. These points are joined by rope or thread to show the shape of the curve along the alignment.

C) <u>SKETCH:</u>



D) OBSERVATIONS:

Observing the Elements of Curves

E) FORMULAS, CALCULATIONS AND TABULATION :

1. Tangent length, T_1B = *R tan Ø/2*

2. Chainage at T_1 = Chainage at B – Tangent Length.

3. Length of the curve, CL = $\frac{\Pi R Ø}{180}$

4. Chainage of T_2 = Chainage of T_1 + Curve Length

5. Length of the long chord (L) = 2R sin Ø /2

6. The Long Chord is divided into two equal parts

7. Mid Ordinate = $O_o = R - \sqrt{R^2 - (\frac{L}{2})^2}$

Distance from the mid-point of Long chord x in m	**Ordinate O_x**	$O_x = \sqrt{R^2 - x^2} - (R - Ox)$

F) RESULT:

The Calculated Ordinates are marked on the ground and hence the required curve is plotted.

G) INFERENCE:

UNIT TEST –I

Model Question Paper (C-20)

C-309 Surveying –II Practice & Plotting Lab

TIME: 3 hours Total Marks: 60

Instructions: (1) Any one full question of the following shall be allotted to the students on lottery basis.

(2)All the questions are competency based and are for assessing the candidate's psychomotor skills

(3) Underpinning knowledge shall be assessed through viva voce -4 M

1. A. What are the temporary adjustment to be carried out for theodolite?
   8 M (CO1)

   B. Perform temporary adjustments of theodolite.

   CRO. 20 M (CO2)

   C. What are the various permanent adjustments of theodolite?

   CRO 26 M (CO1)

2 A. Note down the readings on main scale and vernier scale of the theodlite.
   8 M (CO1)

   B. Tabulate observations in the field book

   CRO. 20 M (CO2)

   C. Determine the horizontal angle between two accessible points.
   26 M (CO1)

3 A. How do you measure the horizontal angle by repetition theodolite?
   8 M (CO1)

   B. What are the errors eliminated by repetition method?

   CRO. 20 M (CO2)

   C. What are the methods of measurement of horizontal angle?

. 26 M (CO1)

4 A. What is reiteration method in surveying?

6M (CO1)

B. Tabulate observations made for the experiment.

CRO. 10M (CO2)

C. Precision of measurement of horizontal angles by reiteraition (C01)

5 A. Describe the Operation of foot screws for levelling

6M (CO2)

B. Explain the precautions to be taken while shifting the instrument.

CRO. 10M (CO1)

C. Explain Transiting from face left to face right

CRO. 20M (CO1)

6 A. Note down horizontal angle plate readings accurately.

6M (CO1)

B. Drawing the plot in rough and applying the sine and cosine rules to triangles.

CRO. 10M (CO2)

C. Calculating the inaccessible horizontal distance.

CRO. 20M (CO2)

7 A. Identify the component parts of theodolite.

6M (CO2)

B. Note down the observation in standard format

CRO. 10M (CO1)

C. Establish the survey line on the field and measure the magnetic bearing of survey line.

CRO. 20M (CO2)

8 A. What is the necessity of theodolite traversing?

6M (CO1)

B. What are the various methods of traversing?

CRO. 10M (CO1)

C. What are the various methods of traversing?

CRO. 20M (CO2)

UNIT TEST-II

Model Question Paper (C-20)

C-309 Surveying –II Practice & Plotting Lab

TIME: 3 hours Total Marks: 60

Instructions: (1) Any one full question of the following shall be allotted to the students on lottery basis.

(2)All the questions are competency based and are for assessing the candidate's psychomotor skills

(3) Underpinning knowledge shall be assessed through viva voce -6 M

1. A. Note down the face left and face right readings in tabular form.

8 M (CO1)

B. Enter Vertical angles and Calculate the average vertical angle.

CRO. 20 M (CO2)

C. Determine vertical distance and RL of the top and bottom of the object.

CRO 26 M (CO1)

2. A. How to find height of the object.

8 M (CO1)

B. Tabulate observations and calculate the average vertical angle.

CRO. 20 M (CO2)

C. Calculate the horizontal distance between Theodolite and the object.

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26 M (CO1)

3. A. What is the necessity of Trignometric levelling?

8 M (CO1)

B. What are the various methods to find the elevation of the object under different field conditions?

CRO. 20 M (CO2)

C. What are the methods of measurement of horizontal angle?

. 26 M (CO1)

4 A. What is reiteration method in surveying?

6M (CO1)

B. Tabulate observations made for the experiment.

CRO. 10M (CO2)

C. Precision of measurement of horizontal angles by reiteraition (C01)

2 A. Describe the Operation of foot screws for levelling

6M (CO2)

B. Explain the precautions to be taken while shifting the instrument.

CRO. 10M (CO1)

C. Explain Transiting from face left to face right

CRO. 20M (CO1)

3 A. Note down horizontal angle plate readings accurately.

6M (CO1)

B. Drawing the plot in rough and applying the sine and cosine rules to triangles.

CRO. 10M (CO2)

C. Calculating the inaccessible horizontal distance.

CRO. 20M (CO2)

4 A. Tabulate the observations taken in the filed..

8 M (CO2)

B. Fix the distance of 20m,40m &60m with chain.

CRO. 20 M (CO1)

C. Calculate the values of K & C

CRO. 26 M (CO2)

5. A. Describe the Operation of foot screws for leveling

8 M (CO1)

B. Explain the precautions to be taken while shifting the instrument.

CRO. 20 M (CO1)

C. Explain Transiting from face left to face right

CRO. 26 M (CO2)

6. A. How do you calculate PC and PT?

8 M (CO1)

B. Explain the precautions to be taken .How do you find the radius of a circular curve?

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CRO. 20 M (CO1)

C. Explain Transiting from face left to face right & How can we take offsets from tangent for setting out a curve?

CRO. 26 M (CO2)