SURVEY PRACTICE – Vol. I

INSTRUCTION MANUAL

for

III Semester B.E. Civil Engineering

Compiled and Edited
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Department of Civil Engineering

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Vision and Mission of the Department of Civil Engineering

VISION

- "To produce engineers having professional and leadership qualities with capacity to take up research and professional assignments in Civil Engineering and allied fields with focus on interdisciplinary and innovative approach and to compete in civil engineering profession at the global level".

MISSION

- To impart quality and real time education to contribute to the field of Civil Engineering.
- To impart soft skills, leadership qualities and professional ethics among the graduates to handle projects independently.
- To develop graduates to compete at the global level.
- To deal with the contemporary issues and to cater to the societal needs.

Programme Educational Objectives (PEOs)

PEO1	To impart quality education and knowledge in contemporary science and technology to meet the challenges in the field of Civil Engineering and to serve the society.
PEO2	To impart the knowledge of analysis and design using the codes of practice and software packages.
PEO3	To inculcate the sense of ethics, morality, creativity, leadership, professionalism, self-confidence and independent thinking.
PEO4	To motivate the students to take up higher studies and innovative research projects.

Programme Specific Outcomes (PSOs)

PSO1	The student has the ability to apply the knowledge of Physics, Chemistry, Mathematics, Programming Skills and Soft Skills to solve Civil Engineering problems.
PSO2	The student has the proficiency in streams of Civil Engineering to visualise and execute the systems for sustainable living.
PSO3	The student has the practical knowledge and experimental skills to tackle Civil Engineering problems using technical and management skills, exhibiting professional ethics to meet the societal needs.
PSO4	The programme enables the faculty to develop academic proficiency by involving in research & innovation, interaction with industry and professional bodies through technical advice and Continuing Education Programs (CEP) to meet the needs of the user system.

PROGRAMME OUTCOMES (POs)	
Engineering Graduates will be able to:	
P01	Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems – (**Engineering knowledge)**
P02	Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences – **(Problem analysis)**
P03	Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations – (**Design/development of solutions**)
P04	Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions – (**Conduct investigations of complex problems**)
P05	Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations – (**Modern tool usage**)
P06	Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice – (**The engineer and society**)
P07	Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development – (**Environment and sustainability**)
P08	Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice – (**Ethics**)
P09	Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings – (**Individual and team work**)
P10	Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions – (**Communication**)
P11	Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments – (**Project management and finance**)
P12	Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change – (**Life-long learning**)

FOREWORD

Survey Practice – I trains students in planimetric and relief survey over small areas. Students attain the skill of measurement of lengths, bearings and elevation. Theoretical concepts are covered in CV330: Fundamentals of Surveying.

The instruction manual guides the students to solve field problems.

Students are advised to take care of the following.

- Check the instrument before taking to the field.
- Do not operate any instrument without proper knowledge.
- Do not overtighten any adjusting screws.
- Do not shout in the field. Follow the standard signals.
- Record the measurements appropriately in the standard format.
- Do not use the survey equipment for any purpose other than it is meant for.
- Ensure your safety in the field.

The authors thank Mr. Naveen Kumar H.V. for his excellent effort in type setting and bringing out the instruction manual in the present format.

Madhava Rao V.

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CONTENTS

Exercise No. 1

Aim: Study of different types of chain and tape used in surveying.

Theory: Chain - different types- Least count and standard length- components of chain.

Tape - different types- Least count and standard length.

Instruments/ Accessories used: Different types of chain and tape.

Exercise:

a) Observe different types of chains and tapes. Write neat sketches showing the components. Record least count and standard length.
b) Learn folding and unfolding of chains.
c) Inspect old chains and identify the defects including length. Record the defects.

Observations:

Chain:

Type of chain	Least count	Standard length

Tape:

Type of tape	Least count	Standard length

Defects in chain:

Type of chain	Length	Standard length	Other defects

Remarks:

Exercise No. 2

Aim: To measure distance between two points using direct ranging method.

Theory: Ranging- Direct ranging and indirect ranging, Signals used during ranging.

Instruments/ Accessories used: Chains

Ranging rods- 3

Arrows

Exercise:

- Identify the ends of the survey line whose length is to be measured using direct ranging technique. Fix arrows at the ends and hold ranging rods at the ends.
- Unfold the chain from the starting point. Hold another ranging in between the two at distance less than chain length. Direct the third ranging to move to the position such that the ranging roads are in a line. Align the chain to pass through ranging rod at the starting point (0 - chainage) and intermediate ranging rod. Fix an arrow at the end of the chain.
- Repeat the procedure to get intermediate point.
- Count the number of chain length and part of the chain at the end, to get the total length of the survey line.
- Repeat measurement in the reverse direction.

Observations and calculation:

1. Least count of chain: _____

2. Standard length of chain: _____

3. AB = _____ m

4. BA = _____ m

5. Average length of survey line = _____ m

Remarks:

Exercise No. 3

Aim: To set out perpendiculars to survey line using

a) Geometrical methods

b) Instrumental methods

Theory: a) Geometrical methods for setting out perpendicular to survey line.

b) Description of instrument used to set out perpendicular with neat sketches and basic principle of working.

Instruments/ Accessories used: Chains, tapes, Ranging rods, Arrows, wooden cross staff, open cross staff, French cross staff, Indian optical square, prism square.

Exercise:

- Set out a survey line and setout perpendicular to it using different geometrical methods (briefly explain the procedure).
- Set out a survey line and setout perpendicular to it using different Instrumental methods (briefly explain the procedure).

Exercise No. 4

Aim: To set out triangle, rectangle, hexagon in the field using chain/tape and other accessories.

Problem:

1. Set out a triangle ABC with AB= 15m, BC= 8m and AC= 9m. Measure the height of the triangle. Compare the area of the triangle with theoretical area.
2. Set out a rectangle ABCD with AB= 10m, AD=5m. Measure the closing side CD and diagonal AC and BD.
3. Set out regular hexagon of side 5m and extend the same to get hexagon of 10m. Measure closing sides. Compare area with theoretical value.

Instruments/ accessories used: Chain, Tape, Ranging roads, Wooden cross staff, Arrows.

Exercise:

Briefly explain the procedure of setting out geometrical figures.

Observation and calculation:

Figure	**Check**	**Measured dimension**	**Practical area**	**Theoretical area**	**% error in area**
1. Triangle	-	h =			
2. Rectangle	CD= AC= BD=	AC= BD=	-	-	-
3. Hexagon	AF=	h =			

Remarks:

Exercise No. 5

Aim: To study compass used in surveying

Theory: Bearing of a line- magnetic and true bearing , WCB system and RB system, Prismatic compass- parts, Centering and Leveling.

Instruments/ accessories used:

- Prismatic compass and surveyors compass with tripod stand
- Arrows

Exercise:

I.

- Observe the prismatic compass. Note the name and function of each and every part
- Learn to center and level the instrument.
- Measure the bearing of lines from a station to objects around. Record the observation**.**

II.

- Observe surveyors compass. Prepare a comparative statement between prismatic and surveyors compass.

Observation:

Least count of compass = _____

Instruments at	Sighted to	Line	Bearing

Exercise No. 6

Aim: To measure the bearing of legs of a hexagonal traverse.

Theory: Check for closed traverse, Local attraction, Identification and Correction.

Instruments/ accessories used:

- Compass with stand.
- Tape.
- Ranging rods.
- Arrows.

Exercise:

- Identify the hexagonal traverse ABCDEF (Fix arrows).
- Measure the length of legs of the traverse.
- Set up Compass over 'A' and measure fore bearing of AB and back bearing of FA.
- Shift the compass to 'B'. Measure the back bearing of AB and fore bearing of BC.
- Repeat the procedure to measure the bearings of all other legs.

Remarks: Discuss about checks, observational error.

Observations and calculations:

Least count of compass: _____

Line	Length	FB	BB	FB ~ BB

$\angle A$ =

$\angle B$ =

$\angle C$ =

$\angle D$ =

$\angle E$ =

$\angle F$ =

$\angle A + \angle B + \angle C + \angle D + \angle E + \angle F$ =

Theoretical Sum of all the angle = $(2n - 4)\ 90^o$

$= (2 \times 6 - 4)\ 90^o$

$= 720^o$

Stations at which local attraction is suspected initially = _____

Exercise No. 7

Aim: To set out rectangle, pentagon and hexagon in the field using compass and other accessories.

Problems:

- ABCDA is a rectangular boundary of a building with AB=10m, BC=8m. The bearing of line AB is 30º. Compute the bearing of all other sides and set out in the field.
- ABCDEA is a regular pentagon of side 10 m. The bearing of line AB is 45º. Compute the bearing of all other sides and set out in the field.
- ABCDEFA is a regular hexagon of side 10 m. The bearing of line CD is 120º. Compute the bearing of all other sides and set out in the field.

Instruments and accessories:

- Compass with stand.
- Tape.
- Ranging rods.
- Arrows.

Exercise:

- Show the computation of bearing.
- Explain the procedure of setting out briefly.

Remarks: Discuss about checks.

Exercise No. 8

Aim: To determine the distance between two inaccessible points using compass and other accessories.

Instruments / Accessories:

- Compass with tripod stand.
- Tape.
- Ranging rods.
- Arrows.

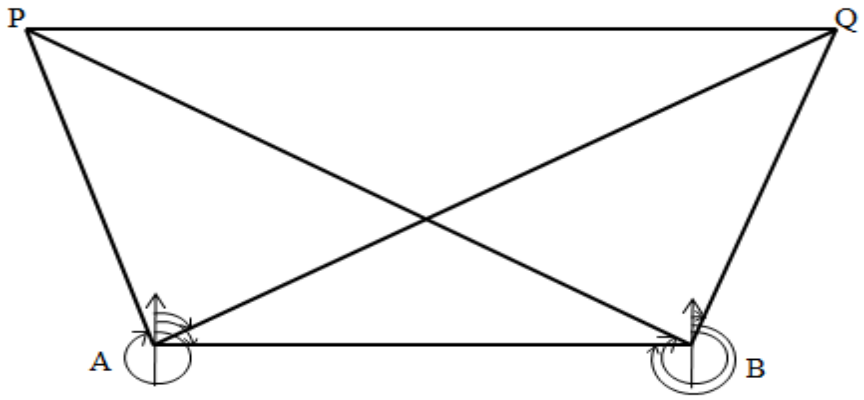
Exercise:

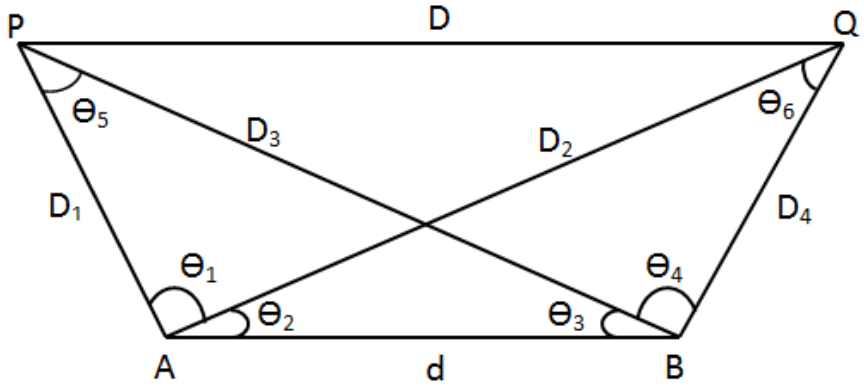
- Identify the inaccessible points P and Q.
- Mark points A and B on the ground at a known distance apart such that all triangles formed are well conditioned. Record the distance AB.
- Set up the compass over 'A' and measure bearings of AP, AQ and AB.
- Set up the compass over 'B' and measure the bearing of BA, BP and BQ.

Observation and calculations:

1. Least count of compass : _____
2. Distance AB = _____m

Instrument at	Sighted to	Line	Bearing
A	P Q B	AP AQ AB	
B	P Q A	BP BQ BA	





Θ_1 = _____

Θ_2 = _____

Θ_3 = _____

Θ_4 = _____

$\Theta_5 = 180 - (\Theta_1 + \Theta_2) - \Theta_3 =$ _____

$\Theta_6 = 180 - (\Theta_3 + \Theta_4) - \Theta_2 =$ _____

From $\triangle^{le}$ ABP

$$\frac{D1}{\sin\Theta 3} = \frac{D3}{\sin(\Theta 1+\Theta 2)} = \frac{d}{\sin\Theta 5}$$

D_1 = _____m

D_3 = _____m

From $\triangle^{le}$ ABQ

$$\frac{D2}{\sin(\theta 3+\theta 4)} = \frac{D4}{\sin\theta 2} = \frac{d}{\sin\theta 6}$$

D_2 = _____m

D_4 = _____m

From $\triangle^{le}$ APQ

$PQ^2 = AP^2 + AQ^2 - 2 \text{ x } AP \text{ x } AQ \text{ x } \cos\theta_1$

$D = \sqrt{D_1^2 + D_2^2 - 2D_1D_2\cos\theta_1}$

OR

From $\triangle^{le}$ BPQ

$PQ^2 = BP^2 + BQ^2 - 2 \text{ x } BP \text{ x } BQ \text{ x } \cos\theta_4$

$D = \sqrt{D_3^2 + D_4^2 - 2D_3D_4\cos\theta_4}$

Exercise No. 9

Aim: To study the accessories used in plane table survey.

Theory: Plane table survey – Advantages and Disadvantages – Accessories used in plane table survey and their explanation.

Instruments / Accessories:

- Plane table with tripod stand.
- Spirit level.
- Trough compass.
- U- Fork with plumb bob.
- Telescopic Alidade.
- Plane Alidade.

Exercise:

a) Study the various accessories used in plane table survey.

b) Learn to level the plane table.

c) Draw north line using trough compass.

d) Learn to mark plane table station using U- fork and plumb bob.

Exercise No. 10

Aim: To locate points on the ground by

i) Method of radiation.
ii) Method of intersection.

In plane table survey

Theory: Method of plotting in plane table survey – Method of radiation and Method of intersection.

Instruments / Accessories:

- Plane table with tripod stand.
- Spirit level.
- Trough compass.
- U- Fork with plumb bob.
- Plane Alidade.

Exercise: I. Method of radiation:

- Fix the drawing sheet to the table and level it. Mark north line. Transfer the plane table position. Select the scale.
- Identify the points to be located.
- Place ranging rod over the point and sight it through alidade. Draw the radial line. Measure the distance between the plane table position and the point on the ground. Scale the distance and mark the point on the plane table. Repeat the procedure for all the points.

II. Method of intersection:

- Identify the points to be located (P & Q).
- Identify points A and B on the ground and measure the distance between A and B.
- Setup the plane table over 'A' and level it. Draw north line. Transfer 'A' on to the sheet (a).
- Pivoting about 'a', sight 'B' and draw a line. Knowing the length AB mark 'b' (taking into consideration of scale).
- Pivoting about 'a', draw radial lines towards P and Q.
- Shift the instrument to 'B' such that 'b' is over 'B'. Orient the table by back sighting.
- Pivoting about 'b' draw radial lines towards P and Q.
- Mark 'p' and 'q'. (point of intersection of radial lines from 'a' and 'b')

Exercise No. 11

Aim: To find solution for three - point problem by Bessel's graphical method.

Theory: Method of resection and State three - point problem.

Instruments / Accessories:

- Plane table with tripod stand.
- Spirit level.
- Trough compass.
- U- Fork with plumb bob.
- Plane Alidade.

Exercise:

- Identify the points A, B, C on the ground and locate the points a, b, c on the paper by method of radiation or intersection.
- Set the plane table over any convenient point. Let it be 'P'.
- Position of 'p' on the plan is plotted with respect to three well defined points a, b & c whose position is already known to us on the plan.
- Keep the alidade along b a unclamp the table and rotate until 'A' is sighted. Clamp the table.
- Pivoting the alidade about 'b' sight to 'C'. draw the ray xy along the edge of the alidade.
- Keep the alidade along a b unclamping the table, rotate the table until 'B' is sighted. Clamp the table.
- Pivoting the alidade about 'a' sight to 'C'. draw the ray along the edge of the alidade to intersect the ray xy in c'. join cc'.
- Keep the alidade along c'c and rotate the table till C is bisected. Clamp the table. The table is correctly oriented.
- Pivoting the alidade with respect to 'a' sight 'A' and draw a line . similarly pivoting the alidade with respect to 'b' sight to 'B' and pivoting the alidade with respect to 'c' sight to 'C'. All the lines will intersect at a single point i.e; 'p' which is the position of the plane table required on plan.

Exercise No. 12

Aim: To study Dumpy level and levelling Staff.

Theory: Levelling, Types of levelling, Dumpy level and its parts, Levelling staff- types, Least count of levelling staff, Permanent and Temporary adjustments of dumpy level.

Instruments / Accessories: Dumpy level, Levelling staff.

Exercise:

a) Study the parts of a dumpy level mounted on tripod stand. The function of different parts of dumpy level and levelling staff.
b) Study levelling staff and record least count.
c) Perform temporary adjustments of dumpy level.
d) Learn to record staff readings.

Exercise No. 13

Aim: To find the difference in elevation between two points.

Theory: Bench mark – Types, Simple levelling.

Instruments / Accessories: Dumpy level, Levelling staff.

Exercise:

I. a) Identify the points A and B between which difference in elevation is required.
b) Setup dumpy level at a convenient position.
c) Take staff readings on A and B.

II. a) Identify the points A and B (bottom of chejja).
b) Set up dumpy level at a convenient position.
c) Take staff reading on A and B (Staff inverted).

III. a) Identify B.M; points A and B
b) Set up the dumpy level at a convenient position. Perform temporary adjustments.
c) Take staff readings B.M, A and B.
d) Compute the R.L.

Observation and calculations:

a) Staff readings on 'A' = _____ m
Staff readings on 'B' = _____ m
Difference in elevation between A and B = _____ m

b) Staff readings on 'A' = _____ m
Staff readings on 'B' = _____ m
Difference in elevation between A and B = _____ m

c)

B.S	I.S	F.S	H.I	R.L	Remarks

Arithmetic checks:

Exercise No. 14

Aim: To conduct fly levelling to determine reduced level of points and also to conduct fly back levelling to check the accuracy of work.

Theory: Methods of booking, arithmetic checks, Dumpy level, levelling staff.

Instruments / Accessories: Dumpy level, levelling staff.

Exercise:

a) Identify the bench mark and points which RL are required.
b) Establish dumpy level in a convenient position.
c) Take staff readings on bench mark and other points.
d) Take change point wherever necessary.

Observation and calculations:

I. H.I method.

B.S	I.S	F.S	H.I	R.L	Remarks

II. Rise and Fall method.

B.S	I.S	F.S	Rise	Fall	R.L	Remarks

Arithmetic checks:

Exercise No. 15

Aim: To conduct reciprocal levelling to find difference in elevation between two points and also find error due to line of collimation not being horizontal.

Theory: reciprocal levelling and relevant derivation.

Instruments / Accessories: Dumpy level, levelling staff.

Exercise:

a) Identify the points A and B where difference in elevation is required.
b) Set up the instrument at A and record staff readings on A (a_1) and B (b_1).
c) Set up the instrument at B and record staff readings on B (b_2) and A (a_2).

Observation and calculations:

Instrument at	**Staff reading in**	
A	**Close to A**	**at B**
	a_1 =	b_1 =
B	**Close to B**	**at A**
	a_2 =	b_2 =

Difference in elevation between A and B $= \dfrac{(a1 \sim b1) + (a2 \sim b2)}{2}$

=

Error in line of collimation $= \dfrac{(b1 - a1) + (b2 - a2)}{2}$

=