POORNIMA INSTITUTE OF ENGINEERING & TECHNOLOGY, JAIPUR

DEPARTMENT OF FIRST YEAR

Lab Manual and Student Guide

Basic Civil Engineering Lab

1FY3-27/2FY3-27

Branch	**Common to all**	**Name of Lab**	**BCE Lab**
Session	**2019-20**	**Subject Code**	**1FY3-27/2FY3-27**
Year	**I**	**Faculty**	
Semester	**I/II**	**Lab Assistant**	

Document No.	PIET/I Year/2019-20/Odd-Even	Created By	
Authorized By (HOD)	Sama Jain		

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LAB RULES

Responsibilities of Users

Users are expected to follow some fairly obvious rules of conduct:

- Enter the lab on time and leave at proper time.
- Wait for the previous class to leave before the next class enters.
- Keep the bag outside in the respective racks.
- Utilize lab hours in the corresponding.
- If you notice a problem with any part of equipment or related to the room please report it to lab staff immediately. Do not attempt to fix the problem yourself.
- Handle the all the equipments with care specially the delicate ones.
- Operate the equipments as per the instructions only to avoid any harm.
- Leave the labs at least as nice as you found them.

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DO's & DONT's

DO's

- Do take concentrate in your lab.
- Do learn your shoulder responsibility.
- Do keep your mind in the experiments.
- Do become acquainted with the function of the machine.
- Do learn sincerely from the instructions.
- Do wear proper uniform.
- Do keep the instruments back to their place after use.
- Do clean the equipments after use.
- Do read the instructions before carrying out experiments.

DONT's

- Do not touch the moving parts of the machine.
- Do not work in haphazard way.
- Do not waste time in talking to each other.
- Do not play with electric instruments.
- Do not handle instruments lightly.
- Do not leave running machine unattended.
- Do not touch instruments which are new to you.

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SYLLABUS

RAJASTHAN TECHNICAL UNIVERSITY, KOTA

I & II Semester

Common to all branches of UG Engineering & Technology

1FY3-27/ 2FY3-27: Basic Civil Engineering Lab

Credit: 1
0L+0T+2P

Max. Marks: 50 (IA:30, ETE:20)

1. Linear Measurement by Tape:
   a) Ranging and Fixing of Survey Station along straight line and across obstacles.
   b) Laying perpendicular offset along the survey line
2. Compass Survey: Measurement of bearing of linesusing Surveyor's and Prismatic compass
3. Levelling: Using Tilting/ Dumpy/ Automatic Level
   a) To determine the reduced levels in closed circuit.
   b) To carry out profile levelling and plot longitudinal and cross sections for road by Height of Instrument and Rise & Fall Method.
4. To study and take measurements using various electronic surveying instruments like EDM, Total Station etc.
5. To determine pH, hardness and turbidity of the given sample of water.
6. To study various water supply Fittings.
7. To determine the pH and total solids of the given sample of sewage.
8. To study various Sanitary Fittings.

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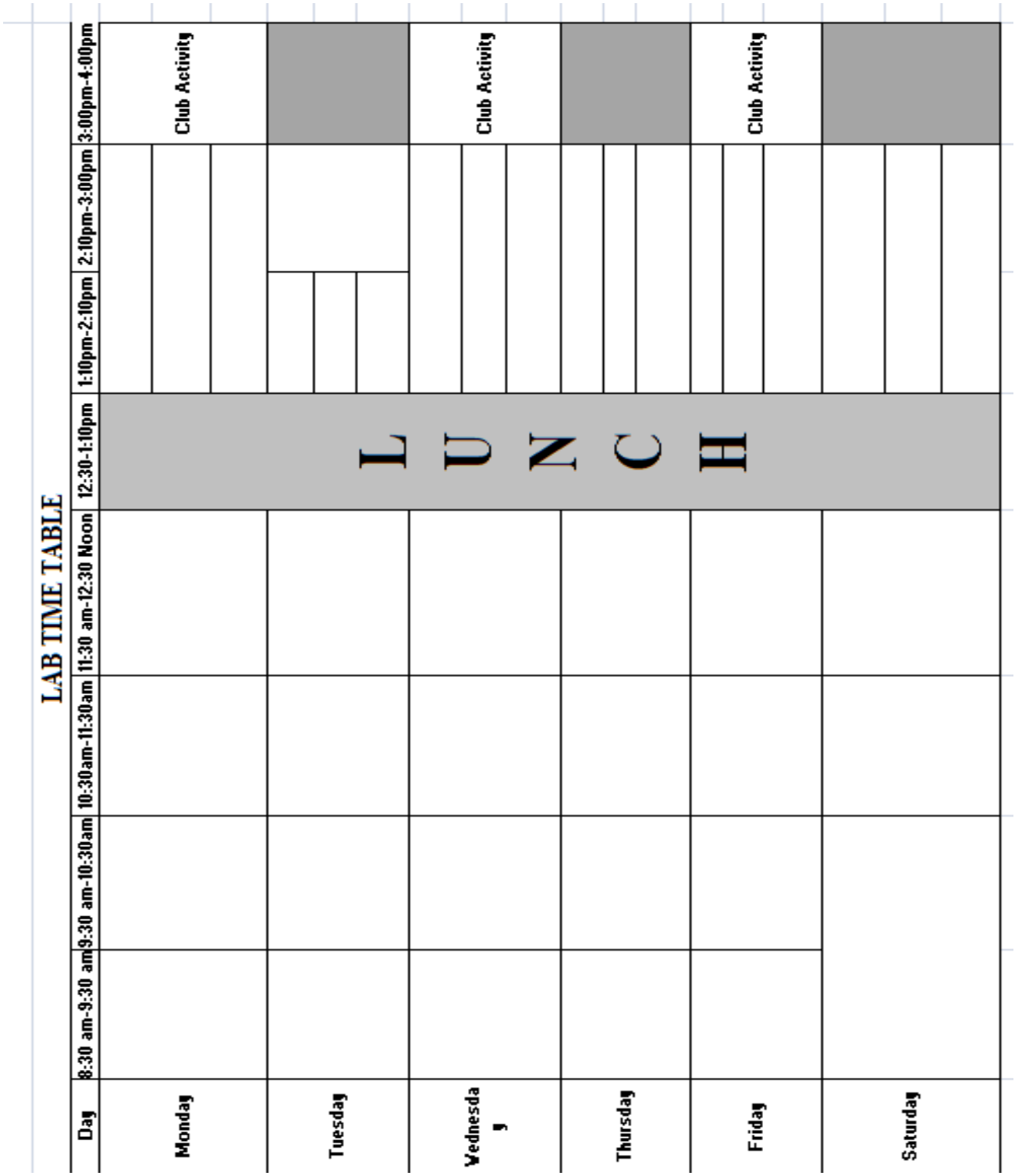
TIME TABLE



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Zero Lab

Basic Civil Engineering Lab (1FY3-27/2FY3-27)

Name of the lab with code: Basic Civil Engineering Lab- 1FY3-27/2FY3-27

1) Self-Introduction:

a) Name :

b) Qualification :

c) Designation :

d) E-mail ID :

a) Introduction of Students:

An interactive session will be held with the students wherein they will be asked to introduce themselves, covering the following points:-

b) Academics Merit/ Weak

c) Co-curricular Activity

d) Day Scholar/ Hosteller

e) Medium Hindi/ English

f) Family Background Urban/ Rural

g) Learning Style seeing/ hearing/ doing

4). Introduction to Lab:-

This lab will help students to learn the basic concepts of civil engineering. The lab will contain the basic of surveying and environmental engineering. The lab would help to understand the construction practices and environmental issues along with making a background to resolve it technically.

5) Lab Outcomes –

Course (Lab) Objective

In this laboratory, the main idea is to focus on the practical implementation of the course. In this section, Student would be able to understand how any construction project executes along with the environmental implications for sustainable development. The laboratory includes the practical study

helps to understand the fundamentals of surveying and environmental engineering. This course aims to provide the interconnectivity of civil engineering with other disciplines of engineering in order to help students to become professionals.

Lab (Course) Outcomes

At the end of the lab course student will be able to:

CO.1 To know about Linear Measurement

CO.2 To understand about Compass Survey and levelling.

CO.3 To understand the concept of electronic surveying instruments like EDM, Total Station etc.

CO.4 To analyze quality of water by different parameters in water.

CO.5 To know about water supply Fittings and Sanitary Fittings.

Mapping of Cos with POs

CO's / PO's	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO.1	3	2	-	-	-	1	-	-	-	-	-	1
CO.2	3	3	2	-	-	1	-	2	-	-	-	1
CO.3	3	2	2	-	-	-	-	-	-	-	-	1
CO.4	3	2	1	2	-	-	-	-	-	1	-	1
CO.5	3	1	2	2	-	1	3	-	-	1	-	1
Average	3	2	1.4	0.8	-	0.6	0.6	0.4	-	0.4	-	1

COs	PSO1	PSO2	PSO3	PSO4
CO.1	-	-	-	-
CO.2	-	-	3	-
CO.3	-	-	3	-
CO.4	-	-	3	-
CO.5	-	-	3	-
Average	-	-	2.4	-

6) Relevance with Branch

Civil Engineering is the Base of all engineering branches. Initially Civil, Engineering starts the work on ground, then only other engineering branches comes into working. Not only every branch but every human being is directly connected to Civil engineering, every person needs a home, drinking water, transportation (Highways, Railways and Air ways), Education (school, college and university) Hospital, hotel and a work place (Office, Industry and laboratory). Civil engineering branch is the basic branch needed by everyone and this civil works directly or indirectly connected to other branches of civil engineering.

7) Overview of Experiments/Syllabus

Exp no.	Experiment Name	CO's
1.	Zero Lab , Introduction to surveying 1. Linear Measurement by Tape: a. Ranging and Fixing of Survey Station along straight line and across obstacles. b. Laying perpendicular offset along the survey line.	1
2.	Compass Survey: Measurement of bearing of lines using Surveyor's and Prismatic compass	2
3.	Leveling: Using Tilting/ Dumpy/ Automatic Level a. To determine the reduced levels in closed circuit. b. To carry out profile leveling and plot longitudinal and cross sections for road by Height of Instrument and Rise and Fall method.	2
4.	To study the various electronic surveying instruments like EDM, Total Station etc.	3
5.	To determine pH, hardness and turbidity of the given sample of water.	4
6.	To study various water supply fittings	5
7.	To determine the pH and total solids of the given sample of sewage.	4
8.	To study various sanitary fittings.	5

8) Lab Plan

Total number of turns required : 08

Experiment Number	Turns	Scheduled Day
Exp. 1	1	Day 1
Exp. 2	1	Day 2
Exp. 3	1	Day 3
Exp. 4	1	Day 4
Exp. 5	1	Day 5
Exp. 6	1	Day 6
Exp. 7	1	Day 7
Exp. 8	1	Day 8

(a) Relation with other labs:

The objective of the laboratory is learning. The experiments are designed to make a check in different activities of construction and to make an exposure to the site works. Conduct the experiments with interest and an attitude of learning for controlling the quality.

b) Connection with previous year and next year & theory Subjects:

This is first year lab so there is no direct relation with previous year, however Civil engineering is directly or indirectly part of life of every one. This lab provides the basic understanding necessary for any construction and its techniques for different construction work to student of engineering & technology so that they can assure stability and save money in construction individually.

Lab schedule per week:

Two hours per batch per week

6) Books / Websites-

Text Books:

1. Basic Civil Engineering, Dr. B.C. Punmia, Ashok Kumar Jain, Arun Kr. Jain.

2. Basic Civil Engineering ,S S Bhavikatti, New age international publisher.

Reference Books:

3. Surveying Volume- I, S.K.Duggal, Mc Graw Hill.

4. Sewage Disposal and air pollution engineering, S.K. Garg, Khanna publishers.

5) University Examination System:-

Sr. No.	Name of the Exam	Max. Marks	% of passing marks	Syllabus coverage (in %)	Conducted by
1	I Mid Term Exam	30	40	60%	PIET
2	II Mid Term Exam	30	40	40%	PIET
3	University (End) Term Exam.	30	40	100%	RTU

Marks Division

Mid Term – I & II		
Experiment	Viva	Total
15	5	20
Attendance & Performance		
Performance	Attendance	Total
15	5	20
End-Term Practical 30 Marks		
Performance	Viva	Total
15	05	30

Internal Assessment System

Total Marks –

Attendance	Discipline	Performance	Record	Viva	Total
5	5	10	15	15	50

Place: PIET, Jaipur

Date:

LAB PLAN / ROTOR PLAN

NAME OF LAB: BCE-LAB CODE: 1FY3-27/2FY3-27

S.No.	Experiment	Mode of Conduct(Activity)	Turn/Week	Mid Term (I or II)
1	Linear Measurement by Tape: a) Ranging and Fixing of Survey Station along straight line and across obstacles. b)Laying perpendicular offset along the survey line	**Actual in field**		**Mid Term I**
2	Compass Survey: Measurement of bearing of linesusing Surveyor's and Prismatic compass	**Actual in field**		**Mid Term I**
3	Levelling: Using Tilting/ Dumpy/ Automatic Level a) To determine the reduced levels in closed circuit. b) To carry out profile levelling and plot longitudinal and cross sections for road by Height of Instrument and Rise & Fall Method.	**Actual in field, case study**		**Mid Term I**
4	To study and take measurements using various electronic surveying instruments like EDM, Total Station etc.	**Virtual lab**		**Mid Term I**
5	To determine pH, hardness and turbidity of the given sample of water.	**Actual in lab**		**Mid Term II**
6	To study various water supply Fittings.	**Actual in lab, PPT**		**Mid Term II**

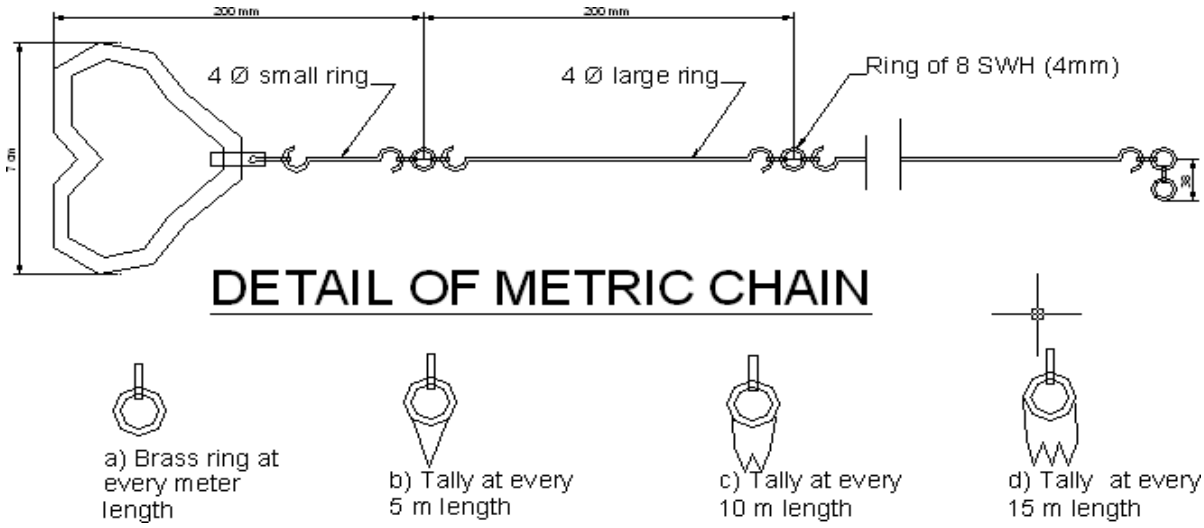
7	To determine the pH and total solids of the given sample of sewage.	**Virtual lab**		**Mid Term II**
8	To study various Sanitary Fittings.	**Actual in lab, PPT**		**Mid Term II**

Lab Activities- Virtual Lab, Mini Project, Case Study, Presentations and Applications based experiments, Survey.

EXPERIMENT NO –1(A)

OBJECTIVE: - Ranging and Fixing of Survey Station along straight line and across obstacles.

APPARATUS:- : Chain, Arrows, Tapes, Ranging Rods, Offset Rods, Cross staff or optical square, Plumb bob, wooden mallet, pegs.



THEORY:

By the various methods of determining distance the most accurate and common method is the method of measuring distance with a chain or tape is called Chaining. For work of ordinary precision a chain is used. But where great accuracy is Required a steel tape is invariably used.

The term chaining was originally applied to measure Distance with a chain. The term chaining is used to denote measuring distance with either chain or tape, In the process of chaining, The survey party consists of a leader (the surveyor at the forward end of the chain) a follower (the surveyor at the rare end of the chain and an assistant to establish intermediate points).

The accuracy to which measurement can be made with chain and tape varies with the methods used and precautions exercised. The precision of chaining. For ordinary work, ranges from 1/1000 to 1/30,000 and precise measurement such as Baseline may be of the order of 1000000.

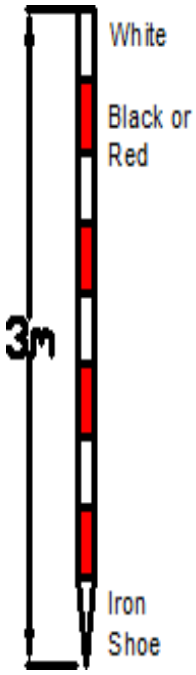
The chain is composed of 100 or 150 pieces of galvanized mild steel were 4mm in diameter called links. The end of each link is bent into a loop and connected together by means of three oval rings which afford flexibility To the chain and make it less liable to become kinked. The ends of chain are provided with brass handles for dragging the chain on the ground, each with a swivel Joints so that the chain can be turned round without twisting. The length of the A link is the distance between the centres of the two consecutive middle rings. The end links include the handles metallic rings indicators of distinctive points of the Chain to facilitate quick reading of fractions of chain in surveying

measurements.

RANGING RODS:

The ranging rods are used for marking the positions of Stations conspicuously and for ranging the lines. lo order to make these visible at a distance, they are painted alternately black and white, or red and white or red White and black successively. The adjustment of the chain should as far as possible be affected symmetrically on either side of the middle so as that the position of central tag remains unaltered. In measuring the length of survey line also called as chain line. It is necessary that the chain should be laid out on the ground in a straight line between the end stations.

PROCEDURE:



Two men are required for chaining operation; The chain man at the forward end of chain is called the leader while the other man at the rear end is known as the follower. Duties of leader &follower

Leader: -

1. To put the chain forward
2. To fix arrows at the end of chain
3. To follow the instruction of the followers.

Follower:-

1. To direct the leader to the line with the ranging rod.
2. To carry the rear end of the chain.
3. To pick up the arrows inserted by the leader.

Chaining

1. The follower holds the zero handle of the chain against the peg &directs the leader to be in line of the ranging rod.
2. The leader usually with to arrows drags the chain alone the line.
3. Using code of signals the follower directs the leader as required to the exactly in the line.
4. The leader then fixes the arrows at the end of chain the process is repeated.

Ranging

1. Place ranging rods or poles vertically behind each point
2. Stand about 2m behind the ranging rod at the beginning of the line.
3. Direct the person to move the rod to right or left until the three ranging rods appear exactly in the straight line.
4. Sight only the lower portion of rod in order to avoid error in non-vertically.
5. After ascertaining that three rods are in a straight line, ask the person to fix up the rod.

RESULT:

By Chaining and ranging the total distance is found to be ……

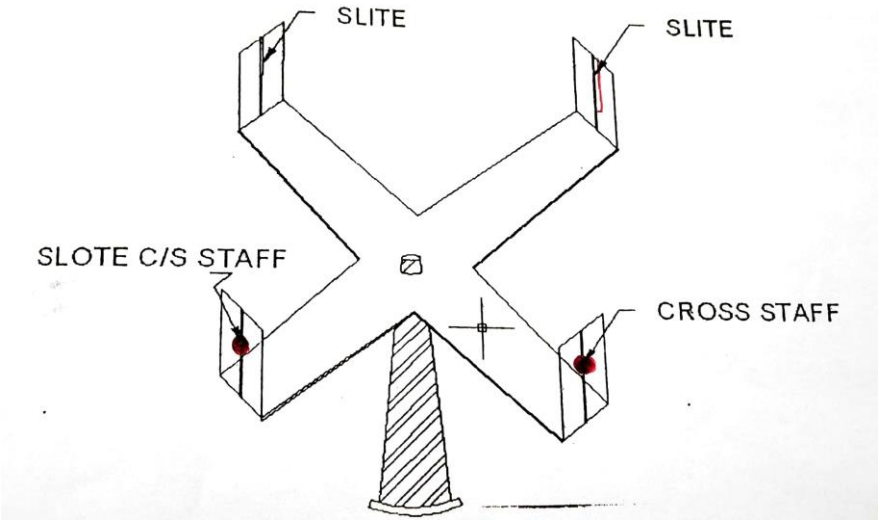
EXPERIMENT NO –1(B)

OBJECTIVE: - Laying perpendicular offset along survey line.

APPARATUS: Chain, ranging rod, arrows, cross staff, metallic tape.

THEORY: Cross staff is the simplest instrument used for setting out perpendicular i.e. taking offsets from chain line, it is easier and quick method but not very accurate. If the accuracy of the work desired should be carried out by theodolite.

The simplest type consist of two parts (i) head (ii) leg the head is made up of wooden block octagon or round in shape about 15 cm side or diameter and 4 cm deep. On it are scribed two lines at right angles to another. The head is fixed on a wooden staff pole about 3 cm diameter and 1.2-1.5 m length. The conical metal shoe is provided at the end so that it can be driven in to the ground.



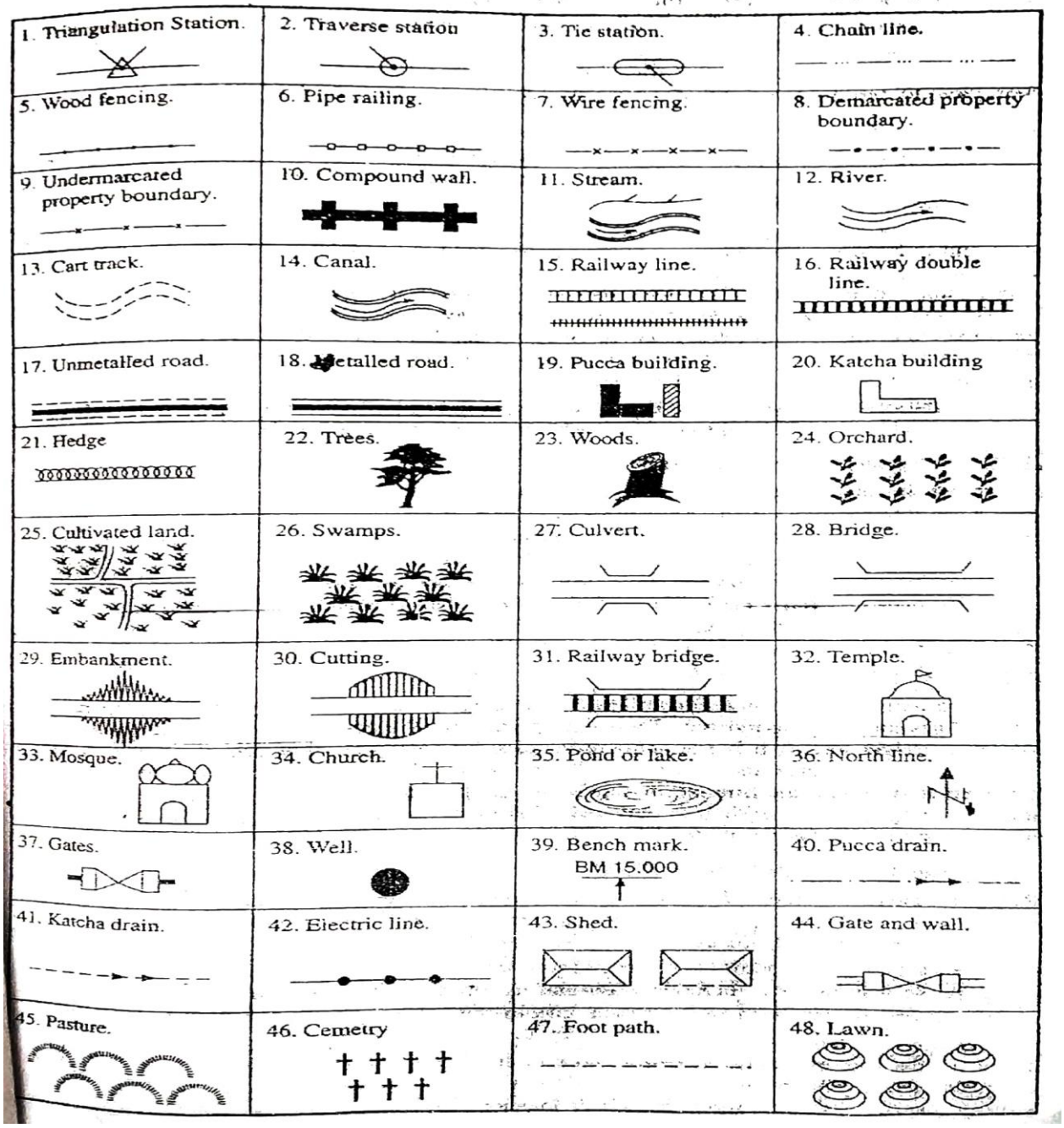
CROSS STAFF

PROCEDURE:

1. To find the foot of the perpendicular distance from the object, the cross staff is held in position and one pair of slit is directed towards ranging rod fixed at the forward and chain line. The observer then looks through the other pair of slit and sees whether the particular object is bisected or not. If not cross staff is moved to and fro till the necessary bisection is obtained. Before noting down the chainage of the pot perpendicular care must be taken to see that one pair of slit is in the direction or not. While shifting the position of cross staff it may get twisted and hence care is necessary.

2. To set a perpendicular to the chain line at a given point one pair of slit is oriented in the direction of chain line by looking through the other pair of slit ranging rod fixed at the forward and by looking through the other pair of slits ranging rod is fixed in the direction of the line of sight provided by the pair.

The signs or symbols for the revealation of the above surface features are presented as follows:



RESULT:

Various perpendicular distance to the chain line object are created using cross staff survey are

EXPERIMENT NO- 2

OBJECTIVE:- Compass Survey: Using Surveyor's and Prismatic compass a. Measurement of bearing of lines b. Adjustment of included angles of compass traverse.

APPARATUS: Prismatic compass, ranging rod, chain, tape, peg Tripod stand, small pieces of stones.

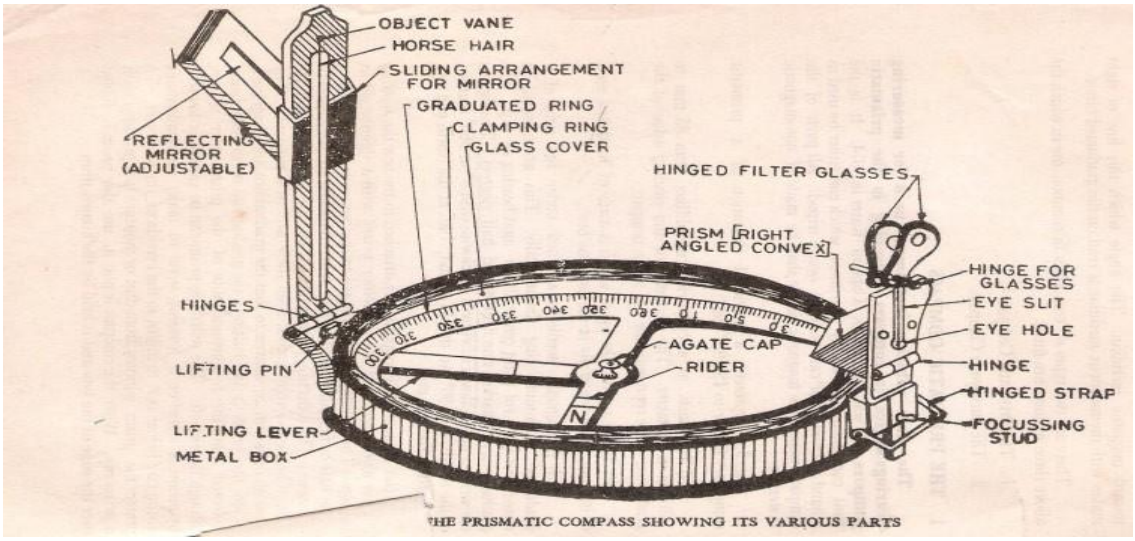
THEORY: The important parts of compass are:-

1) A box with graduated circle.
2) A magnetic needle
3) A line of sight

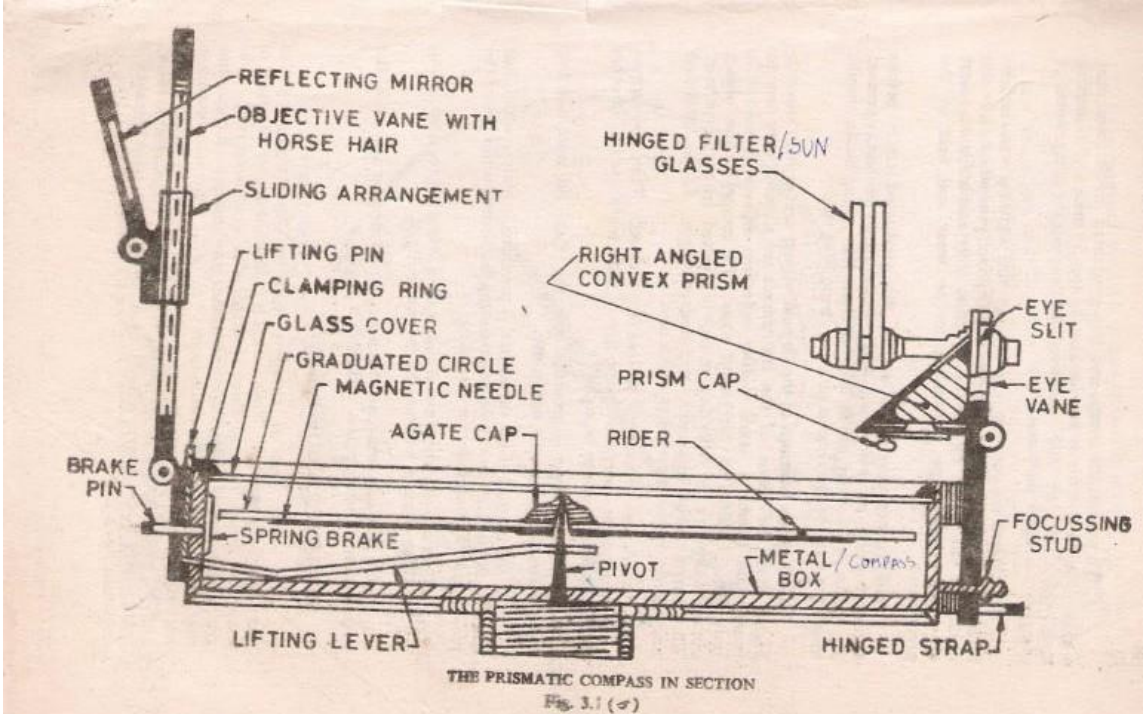
When the line of sight is pointed to point, the magnetic needle of compass points towards north (Magnetic meridian). The angle which this line of sight makes with the magnetic meridian is read on graduated circle.it is known as magnetic bearing of the line.

There are two types of compasses:-

1) Prismatic compass
2) Surveyor’s compass.



THE PRISMATIC COMPASS SHOWING ITS VARIOUS PARTS



THE PRISMATIC COMPASS IN SECTION
Fig. 3.1 (a)

Prismatic Compass:-

Prismatic compass is very valuable instrument. It is usually used for rough survey for measuring bearing and survey lines. The least count of prismatic compass is 30 min.

It consists of circular box of 10cm-12 cm dia. of non magnetic material. pivot is fixed at the centre of box and is made up of hard steel with a Sharp pivot. graduated aluminum is attached to the needle. It is graduated in clockwise direction from 00 to 3600.the figures are written in inverted. Zero Is written at south end and 180 at north end and 270 at the east. Diametrically opposite are fixed to the box. The sighting vane consists of a hinged metal frame in the centre of which is stretched a vertical Horse hair fine silk thread of which is stretched a vertical hair. it presses against a lifting pin which lift the needle of the pivot and holds it against the glass lid. Thus preventing the wear of the pivot point to damp the oscillations of the needle when about to take reading and to bring to rest quickly, a light spring is brought lifted Inside the box. the face of the prism can be folded out the edge of the box when North end is used Sometime the sighting vanes is provided with a hinge mirror Which can be placed upward or downwards on the frame and can be also Slided along it is required. The mirror can be made inclined at any angle so that Objects which are too high or too low can be sighted directly by reflecting.

BEARING OF LINES: A bearing of a line is a horizontal angle made by the survey line with some reference direction or meridian. Meridian may be

1) A true meridian

2) A magnetic meridian

3) An arbitrary or assumed meridian

True meridian: The true geographical meridian passing through a point is a line of intersection of earth's surface by a plane containing north south pole and given point. They are not parallel to each other at different places.

Magnetic meridian:-the direction indicate by a free suspended and a properly balanced magnetic needle Free from all other attractive forces. The direction of magnetic meridian can be established with the help of Magnetic compass.

Arbitrary meridian: Any direction is assumed to be the Reference meridian to Carry out small survey.

Whole Circle Bearing: In whole circle bearing system, the bearing of a line is always measured clockwise from the north point of the reference meridian towards the line right round the circle. The angle thus measured between the reference meridian and the line is called Whole circle bearing of the line. Angles measured will have value between 0 to 360 degrees.

Reduced bearing (R.B): In this system of bearing of a line is measured clockwise or anticlockwise from north or south direction whichever is nearer to the line towards east or west. The concept of reduced bearing facilitates computations in traverse surveying.

Conversion of W.C.B. in R.B

Case	WCB between	R.B.	QUADRANT
1	00 TO900	WCB	N-E
2	900 TO -1800	180-WCB	S-E
3	1800 TO -2700	WCB-1800	S-W
4	2700 TO 3600	360-WCB	N-W

Conversion of R.B in W.C.B.

Case	R.B in quadrant	Rule of W.C.B.	W.C.B between
1	N-E	WCB=R.B	00 TO900

2	S-E	WCB =180-R.B	900 TO -1800
3	S-W	WCB =R.B+180	1800 TO -2700
4	N-W	WCB =360-R.B	2700 TO 3600

Adjustment of the Prismatic Compass

The compass may be held in hand but for better results it should be fitted at the top of tripod having ball and socket arrangement. The adjustment of a compass is done in the following three steps.

1) Centering: - The compass fitted over the tripod Is lifted bodily and placed approximately on the station peg by spreading the leg of a tripod equally, The centre of the compass is checked by dropping a small piece of stone from the centre of the bottom of the compass so that it falls on the top of the station peg. A plumb bob may be used to judge the centering either bt attaching it with a hook providing at the bottom or otherwise by holding it by hand.

2) Levelling:-After the compass is centred, it is leveled by means of ball and soket arrangement so that the graduated circle may swing freely.It can be checked roughly by placing a round pencil on the top of the compass, when the pencil does not move, that is roughly the horizontal position.

3) Focusing the prism: - The prism attached is moved up and down so that grauation on the graduated circle should become sharp and clear.

LOCAL ATTRACTION:

Sometimes .the magnetic needle does not point towards magnetic North or South. The reason being that the needle may be under the influence of external attractive forces which are produced due to magnetic substances Thus the deflection of the needle from its original position, due to the presence of some magnetic substances is known as local attraction. To detect local attraction at a particular place, fore and back bearing of each line are taken. Then difference comes out to be 180° there is no local attraction at either station. On the other hand of the difference is other than 180°,the bearing may be rechecked to find out the discrepancy may not be due to the presence of iron substance near to the compass. If the difference still remains the local attraction exists at on or both the stations.

Elimination of Local attraction:-

1st method: - In this method, the bearing of the other lines are corrected and calculated on the basis of the a line which has the difference between its fore bearing and back bearing equal to 180°. The magnetic of the error is formed due to local attraction by drawing a sketch of observed and correct bearing of the line at each station. The error will be negative when the observed bearing is less than the corrected one and the correction will be positive and vice versa.

If however, there is no such line in which the difference of fore bearing and back bearing is equal to 180°, the correction should be made from the mean value of the bearing of that line in which the difference between the fore and the back bearing is the least.

If the bearings are observed in quadrantal system, the correction should be applied in proper direction by drawing a neat sketch roughly.

2nd Method: - This method is more general as the bearing at a station locally affected may be incorrect but include angles calculated from these bearing will be correct since the amount of the error will be the same for all the bearing observed from that station. Thus starting from the unaffected line and using these included angles the correct bearing of all other lines can be calculated.

Note: - The sum of the internal included angles must be equal to (2n-4) right angles where n=number of sides of a closed traverse.

PROCEDURE:

1. Four ranging rods are fixed at different points i.e. A, B, C, D, E etc. such that it should be mutually visible and may be measured easily.
2. Measure the distance betweenthem.
3. At point A the prismatic compass is set on the tripod Stand, centering and leveling is then properly done.
4. The ranging rod at B is ranged through sighting slits and objective vane attached with horse hair and reading on prismatic compass is noted down.
5. It is fore bearing of line AB. Then the prismatic compass is fixed at B and ranging rod at C and A are sighted. And reading is taken as forbearing of BC and back bearing Of AB.
6. Repeat the same procedure at the stations C, D etc.

OBSERVATION TABLE:

Sr. no	Line	Observed bearing	Local attraction	error	Correction	Corrected bearing	Included angle
A	AB						
B	AD						
	BC						
C	BA						
	CD						
D	CB						
	DA						
	DC						

SAMPLE CALCULATION:-

Error = observed bearing –corrected bearing, Check =$(2n-4)x90^0$

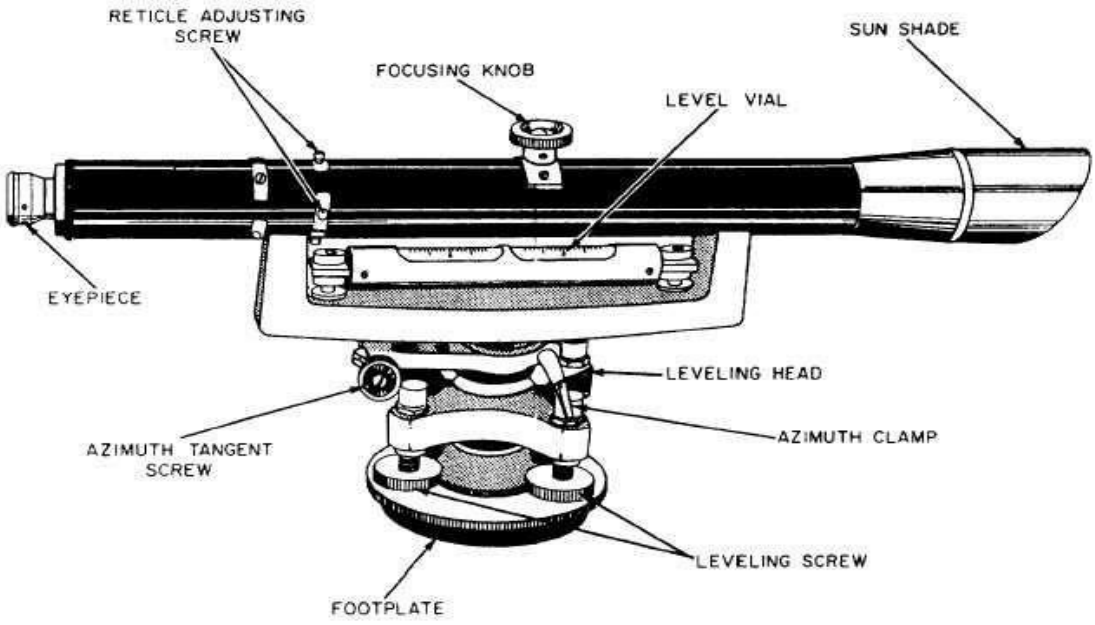
RESULT:

The prismatic compass is studied and bearing of lines of traverse are Observed, the correction due to local attraction at affected station is done and corrected bearings are written in tabular form.

EXPERIMENT NO-3(A)

OBJECTIVE:- To determine the reduced levels in closed circuit by using Tilting/ Dumpy/ Automatic Level

APPARATUS: Dumpy level, leveling staff



Dumpy Level

THEORY:

Leveling: The art of determining and representing the relative height or elevation of different object/points on the surface of earth is called leveling. It deals with measurement in vertical plane.

By leveling operation, the relative position of two points is known whether the points are near or far off. Similarly, the point at different elevation with respect to a given datum can be established by leveling.

Leveling Instruments:- The instrument which are directly used for leveling operation are:- Level, Leveling staff

Level: - An instrument which is used for observing staff reading on leveling staff kept over different points after creating a line of sight is called a level.

The difference in elevation between the point then can worked out. A level essentially consists of the following points:

1. Levelling Heads

2. Limb plate
3. Telescope
4. Bubble tube
5. Tripod stand

Telescope consists of two tubes, one slide into the other and fitted with lens and diaphragm having cross hairs. it creates a line of sight by which the reading on the staff is taken The essential parts of a telescope are

1)body 2) object glass 3)Eye-piece 4) Diaphragm 5) Ray shade 6) The rack and pinion arrangement 7) Focusing screw 8) Diaphragm screw.

Dumpy level:

The dumpy level is simple, compact and stable instrument. The telescope is rigidly fixed to its supports. Hence it cannot be rotated about its Longitudinal axis or cannot be removed from its support. The name dumpy is because of its compact and stable construction. The axis of telescope is perpendicular to the vertical axis of the level. The level tube is permanently placed so that its axis lies in the same vertical plane of the telescope but it is adjustable by means of captain head not at one end.

The ray shade is provided to protect the object glass. A clamp and slow motion screw are provided in modern level to control the movement of spindle,

about the vertical axis. The telescope has magnifying power of about thirty diameters.

The level tube is graduated to 2mm divisions and it has normally a sensitiveness of 20 seconds of are per graduation. The telescope may be internally focusing or external Focusing type.

Adjustment of the level

The level needs two type of adjustment

1) Temporary adjustment and

2) Permanent adjustment

Temporary adjustments of dumpy level

These adjustments are performed at each set-up the level before taking any observation.

A) Setting up the level:- this includes

1) Fixing the instrument in the tripod:- the tripod legs are well spread on the ground with tripod head nearly level and at convenient height. Fix up the level on the tripod.

2) Leg adjustment:- Bring all the foot screws of the level in the centre of their run .Fix any two legs firmly into the ground by pressing them with hand and move the third leg to leg to right or left until the

main bubble is roughly in the centre. Finally the legs is fixed after centering approximately both bubbles. This operation will save the time required for leveling.

B) Levelling: - Levelling is done with the help of foot screws and bubbles. The purpose of levelling is to make the vertical axis truly vertical. The method of leveling the instrument depends upon whether there are three foot screws or four foot screws. In all modern instruments three foot screws are provided and this method only is described.

1) Place the telescope parallel to pair of foot screws.

2) Hold these two foot screw between the thumb and first finger of each hand and turn them uniformly so that the thumbs move either toward each other until the bubble is in centre.

3) Turn the telescope through 90°so that it lies over the third foot screw.

4) Turn this foot screw only until the bubble is centred.

5) Bring the tescope back to its original position without reversing the eye piece and object glass ends.

6) Again bring the bubble to the centre of its run and repeat these operation until the bubble remains in the centre of its run in both position which are at right angle to each other.

7) Now rotate the instrument through 180°,the bubble should remain in centre provided the instrument is in adjustment: if not ,it needs permanent adjustment.

c) Focusing the eye piece:- To focus the eye piece, hold a white paper in front of the object glass ,and move the eye piece in or out till the cross hairs are distinctly seen. Care should be taken that the eye piece is not wholly taken out , sometimes graduation are provided at the eye piece and that one can always remember the particular graduation position to suit his eyes,This will save much time of focssing the eye piece.

(d) Focusing the object glass: - Direct the telescope to the leveling staff and on looking through the telescope, turn the focusing screw until the image appears clears and sharp. The image is thus formed inside the plane of cross hairs, Parallax,if any is removed by exact focusing. It may be noted that parallax is completely eliminated when there is no change in staff reading after moving the eye up and down.

Reduced Levels

The system of working out the reduced level of the points from staff reading taken in the field is called as reduced level (R.L) of a points is the elevation of the point with reference to the same datum.

There are two systems of reduced levels

1) The plane of collimation system (H.I. method)

2) The Rise and fall system

1) The plane of collimation system (H.I. method)

In this system, the R.L. of plane of collimation (H.I) is found out for every set-up of the level and then the reduced levels of the points are worked out with the respective plane of collimation as described below.

1) Determine the R.L. of plane of collimation for the first set up of the level by adding B.S. to the R.L. of B.M. i.e(R.L of plane of collimation= R.L. of B.M.+B.S.)

2) Obtained the R.L. of the intermediate points and first change point by subtracting the staff readings (I.S. and F.S. from the R.L. of plane of collimation (H.I). (R.L. of a point=R.L of plane of collimation H.I.-I.S or F.S)

3) When the instrument is shifted and set up at new position a new plane of collimation is determined by addition of B.S. to the R.L of change point. Thus the levels from two set-ups of the instruments can be correlated by means of B.S. and F.S. taken on C.P.

4) Find out the R.L.s of the successive points and the second C.P. by subtracting their staff readings from this plane of collimation R.L.

5) Repeat the procedure until all the R.Ls are worked out.

OBSERVATION TABLE:-

Station	Reading			R.L. ofplane collimation (H.I)	Reduced Level	Remarks
	B.S	I.S	F.S			

Arithmetical check: The difference between the sum of the back sights and the sum of the fore sights should be equal to the difference between the last and first reduced levels.

i.e $\sum$B.S - $\sum$ F.S.= LAST R.L –FIRST R.L

The Rise and fall system

In this system, there is no need to determine R.L. of plane of collimation .The difference of level between consecutive points are obtained as described below.

1. Determine the difference in staff readings between the consecutive point comparing each point after the first with that immediately proceeding it.
2. Obtained the rise or fall from the difference of their staff reading accordingly to the staff reading at the point is smaller or greater than that of proceeding point.
3. Find out the reduced level of each point by adding the rise to or subtracting fall from the R.L. of a proceeding point.

OBSERVATION TABLE:-

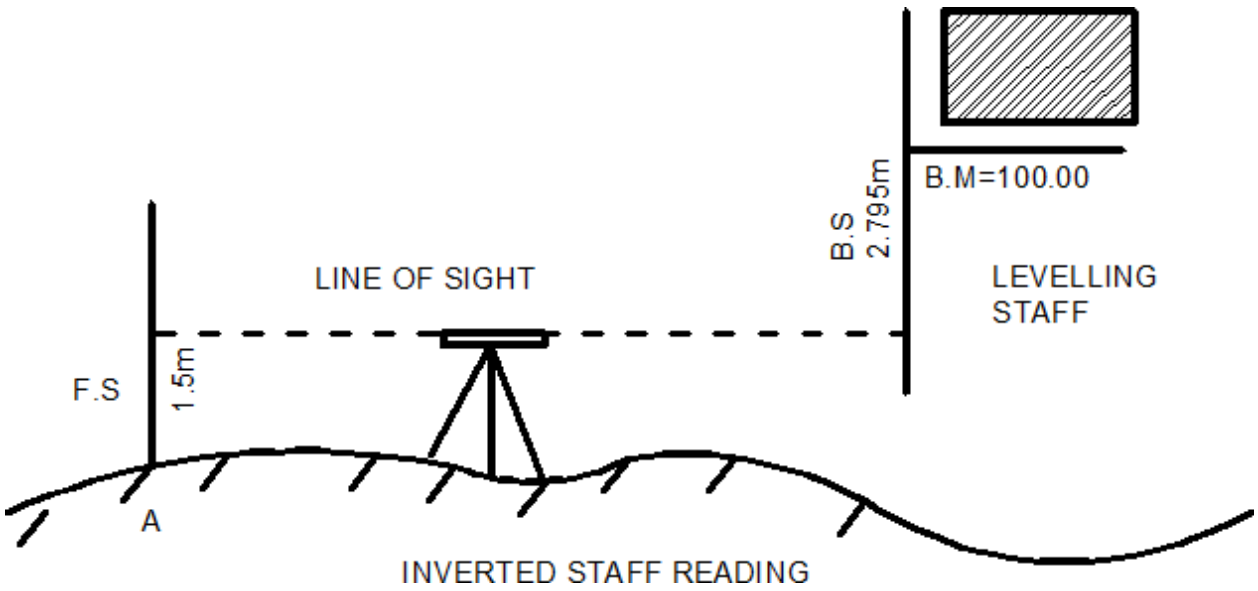
Station	Reading			Rise	Fall	Reduced Level	Remarks
	B.S	I.S	F.S				

Arithmetic check:- The difference between the sum of back sight and the sum of fore sight= difference between the sum of rise and the sum of fall = the difference between the last R.L. and the first R.L.

$\sum B.S - \sum F.S = \sum RISE - \sum FALL = LAST\ RL - FIRST\ RL$

Inverted staff reading

When the B.M of staff station is above the line of collimation (or line of sight) the staff is held inverted on the point and reading is taken .This reading being negative is entered in the level field book with minus sign, or to avoid confusion, 'Staff inverted' should be written in the remarks column against the entry of the reading.



The results are tabulated as below:

B.S.	I.S	F.S	H.I	R.L	Remarks
-2.795			97.215	100.000	B.M.Staff inverted
		1.500		95.715	Point A

When the reading on the inverted staff is a foresight or intermediate sight. it should also be recorded in field book with minus sign

The R.L. of such points may be worked at as: R.L. of the point (where the inverted staff is held)

=R.L. of H.I +F.S. or I.S. reading

RESULT:

The various reduced levels are calculated by rise and fall method and by using height or plane pf collimation method and are shown in observation table.

EXPERIMENT NO-3(B)

OBJECTIVE:- To carry out profile levelling and plot longitudinal and cross sections for road by height of instrument and rise & fall method.

APPARATUS: Dumpy level, leveling staff, ranging rod, tape etc.

THEORY:

Profile leveling: The process of determining elevations at points at short measured intervals along a fixed line is called Longitudinal or profile leveling.

Cross sectioning: It is a method of leveling to know the nature of Ground on either side of the centerline of the proposed route. Levels are taken at right angles to the proposed Direction of the road end at suitable distances and leveling is carried out along this cross Section. During location and construction of highways, Rail tracks sewers and canals strakes or other marks are placed at various aligned points and the undulation of the ground surface along a predetermined line is adjoined. The line of section may be a single straight lines changing directions. Levels are taken at right angles to the proposed Direction of the road end at suitable distances and leveling is carried out along this cross section. Cross section are the sections run at right Angles to the centerline and on the either side of it for the purpose They are taken at each 10,m station on the centerline. The length of Cross section depends upon the nature of the work if cross sections are Short they are set square out by edge. If long they are set out by the Optical square, box sextant or theodolite.

They are serially numbered from the beginning of the Centerline and are taken simultaneously with the longitudinal section they may be taken at the hand level, level, abney level or theodolite

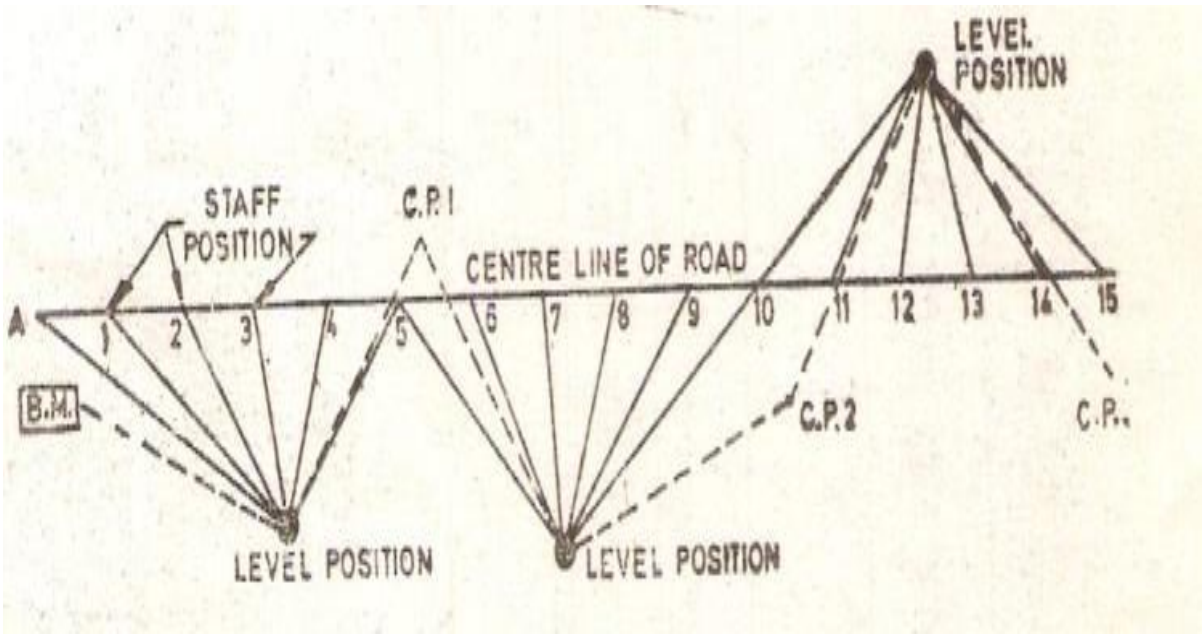
PROCEDURE:

Let ABC be the line of section set out on the ground and marked with pegs driven at equal interval (say 20m to 30m) as in the figure. The level is set up generally on one side of the profile to avoid too short sight on the points near the instrument and care is taken to set up the level approximately midway between two change points. The leveling is strated from the bench mark of known value. From each set up staff reading are taken on pegs already fixed at the desired interval and also at significant points where abrout changes of slope etc. occur. All these readings are recorded as intermediate slight against the respective chainages along the line in the level book. Other data of the level book is also filled up before starting the work. When the length of sight is beyond the power of the telescope (usually it is 100m) ,the foresight on the change point is taken. The level is then is then shifted and setup in an advanced position and a back sight is taken on the change point. The change point may or may not lie in the line of section. Chaining and reading are then continued as before,till the whole line of section is completed.

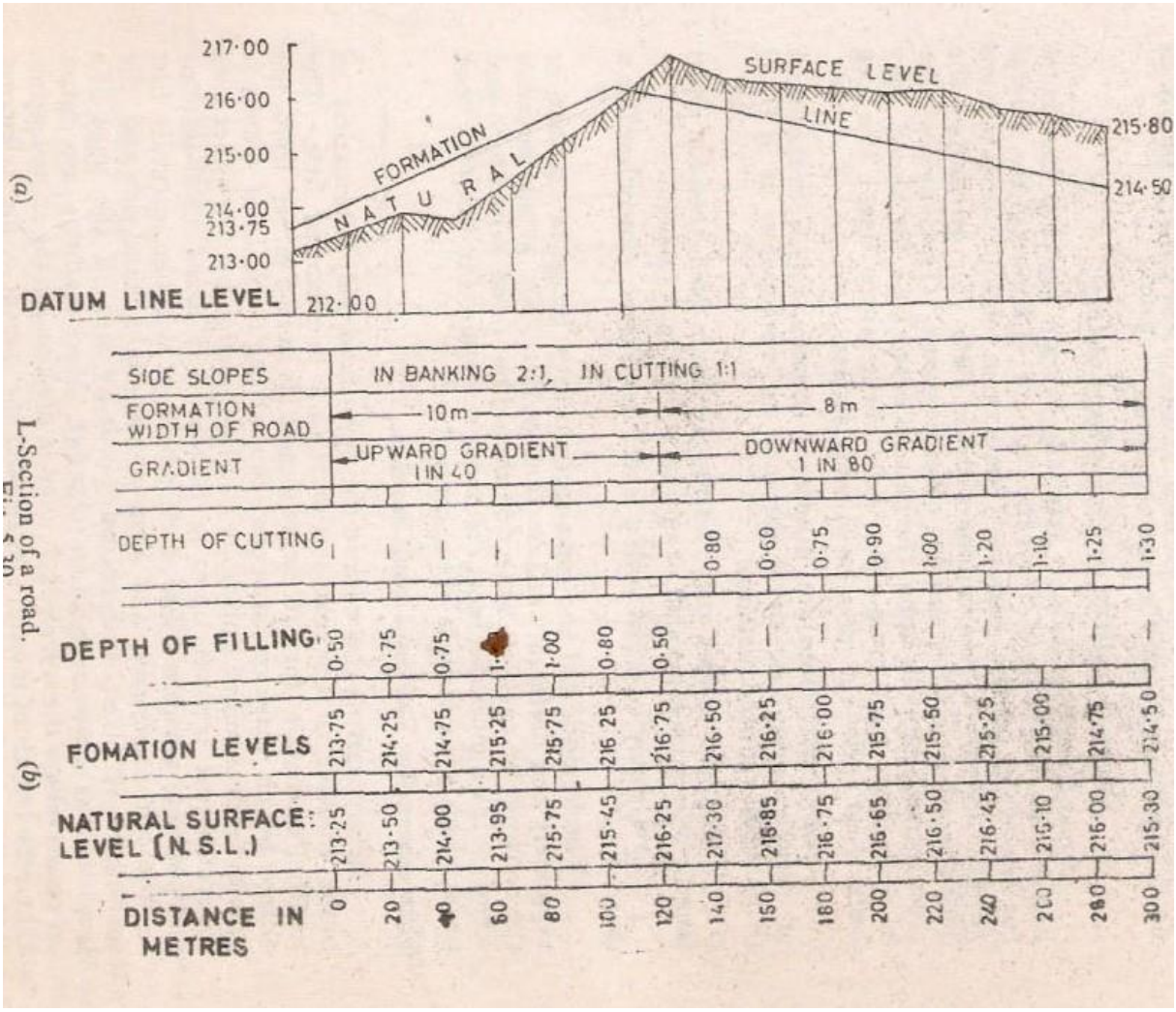
The work is to be checked in the progress of leveling by taking reading on other bench marks, on the way or on bench marks fixed by differential leveling.

The fore and back bearing of the section line should betaken and recorded. Next sketches of the bench mark, change points, and other feature such as nallah, a road, canal, etc. crossing the section line be drawn and fully described in the remarks column of the level-book.

The procedure and corresponding reading and values are represented on the page of a level-book for a part of road project.



Plotting the Longitudinalsection



LEVEL BOOK

Whenever leveling operation is carried out the staff reading taken in the field are entered in the note book called a Level-Book. Each page of it has the following columns which help in booking of reading and reduction of levels.

Page of Level-Book

Page of Level-Book										
Name of work survey for:-									Page No:-	
Levelling from--------------------------------To--------------------------										
Instrument No--						Conducted by:-				
Station	Distance In meters	Bearings		Staff Reading			Height of Instrument or		Reduced Level	Remarks
		FORE	BACK	Back (B.S)	Inter (I.S)	Fore (F.S)	Rise	Fall		

EXPERIMENT NO – 4

OBJECTIVE:- To study the various electronic surveying instruments like EDM, Total Station etc

Electronic Distance Measuring Instruments (EDMI)

Direct measurements of distances and their directions can be obtained by using electronic instruments that rely on propagation, reflection and reception of either light waves or radio waves. They may be broadly classified in to three types:- a. Infra red wave instruments b. Light wave instruments c. Microwave instruments Infrared wave instruments:- The instruments measure distances by using amplitude modulated infrared waves. At the end of the line, prisms mounted on targets are used to reflect the waves. These instruments are light and economical and can be mounted on the theodolites for angular measurements. The range of such an instrument will be 3km and the accuracy achieved is +10mm. Eg: Distomat D1 1000 and Distomat D1 5 It is a very small , compact EDM, particularly useful in building construction and other civil engineering works where distance measurements are less than 500m . Linear measurements can be taken without the use of conventional tapes and chains thus reducing the number of instruments. To measure distances ,one has to simply point the instrument to the reflector , and the touch of a key the measurements are displayed.

Light wave instruments

These are instruments which measures distances based on propagation of modulated lightwaves based on propagation of modulated light waves. The accuracy of such an instrument varies from 0.5 to 5 mm / km distance and has a range of nearly 3 km. Eg : Geodimeter This instrument which works base on the propagation of modulated light waves, was developed by E Bergstand of the Swedish geographical Survey in collaboration with the manufacturer M/s AGA of Sweden. The instrument is more suitable for night time observations and requires a prism system at the end of the line for reflecting the waves.

Microwave instruments

These instruments make use of high frequency radio waves .these instruments were invented as early as 1980 in South Africa by Dr.T L Wadley. The range of these instruments is up to 100 km and can be used during both day and night. Eg : Tellurometer It was the first successful microwave electronic distance measurement equipment. The name derives from the Greek tellus, meaning Earth. The Tellurometer emits an electronic wave: the remote station reradiates the incoming wave in a similar wave of more complex modulation, and the resulting phase shift was a measure of the distance travelled. The results appear on a cathode ray tube with circular sweep. This instrument penetrates haze and mist in daylight or darkness and has a normal range of 30–50 km but can extend up to 70 km. For measuring distance using a Tellurometer, two such instruments are required ,one to be stationed at each end of the line, with two highly skilled persons, to take observations. One instrumetn is used as a master unit and the other as

a remote unit.Just by pressing a button a master can be converted to a remote unit and vice versa. A speech facility(communication facility) is provided to each operator to interact during measuremnt.

Total Station

A total station is an electronic/optical instrument used in modern surveying. The total station is an electronic theodolite (transit) integrated with an electronic distance meter (EDM) to read slope distances from the instrument to a particular point. It can perform the following functions:-• Distance measurement• Angular measurement• Data processing• Digital display of point details• Sorting of data in an electronic field book• the important features of total station are Key board Control:- Digital panel:- The panel displays the values of distance, angle ,height and the coordinates of the observed point where the reflector is kept. Remote height object: - The heights of some inaccessible objects such as towers can be read directly he microprocessor provided in the instrument applies the correction for curvature and mean refraction automatically. Traversing program:- The co-ordinates of the reflector and the angle of bearing of the reflector can be stored and can be recalled for next set up of the instrument Setting out for distance ,direction and height:- Where ever a particular direction and a horizontal distance is to be entered for the purpose of locating the point on the ground, using a retarget, then the instrument displays the angle through which the theodolite has to be turned and the distance by which the reflector should move.

EXPERIMENT NO. 5 (A)

OBJECTIVE: To determine the pH of a given sample of water

Introduction: The term pH refers to the measure of hydrogen ion concentration in a solution and defined as the negative log of H^+ ions concentration in water and wastewater. The values of pH 0 to a little less than 7 are termed as acidic and the values of pH a little above 7 to 14 are termed as basic. When the concentration of H^+ and OH^- ions are equal then it is termed as neutral pH.

Principle: The pH electrode used in the pH measurement is a combined glass electrode. It consists of sensing half cell and reference half cell, together form an electrode system. The sensing half cell is a thin pH sensitive semi permeable membrane, separating two solutions, viz., the outer solution, the sample to be analyzed and the internal solution, enclosed inside the glass membrane and has a known pH value. An electrical potential is developed inside and another electrical potential is developed outside, the difference in the potential is measured and is given as the pH of the sample.

Pure water is slightly ionized and at equilibrium the ion product is –

$[H^+]\,[OH^-] = kw$

$= 1.01 \times 10^{-14}$ at 25^0C …….(1)

and $[H^+] = [OH^-]$

$= 1.005 \times 10^{-7}$

where $[H^+]$= activity of hydrogen ions, moles/L

$[OH^-]$ = activity of hydroxyl ions, moles/L and,

kw = ion product of power.

A logarithmic scale is convenient for expressing a wide range of ionic activities. Equation 1 in logarithmic form is

$-\log10\,[H+] + (-)\log10\,[OH-] = 14$

or $pH + pOH = pkw$……(2)

where,

$pH = -\log [H^+]$

$pOH = -\log [OH^-]$

(here p designates of –log of a number)

Equation 2 states that as pH increases, pOH decreases correspondingly and vice-versa because pkw is constant for a given temperature. At 25^0C, pH 7.0 is neutral, the activity of the hydrogen and

hydroxyl ions are equal.

Apparatus:

pH meter, Standard flask, Magnetic Stirrer, Funnel, Beaker, Wash Bottle,Tissue Paper, Forceps

Reagents:

1. Buffers Solutions of pH 4.01, 7.0 and 9.2
2. Potassium Chloride
3. Distilled Water

Calibration of Instrument:

Using the buffer solutions, calibrate the instrument.

Step 1: In a 100 mL beaker take pH 9.2 buffer solution and place it in a magnetic stirrer, insert the teflon coated stirring bar Fig: Glass Electrode and stir well.

Now place the electrode in the beaker containing the stirred buffer and check for the reading in the pH meter. If the instrument is not showing pH value of 9.2, using the calibration knob adjust the reading to 9.2. Take the electrode from the buffer, wash it with distilled water and then wipe gently with soft tissue.

Step 2: In a 100 mL beaker take pH 7.0 buffer solution and place it in a magnetic stirrer, insert the teflon coated stirring bar and stir well. Now place the electrode in the beaker containing the stirred buffer and check for the reading in the pH meter. If the instrument is not showing pH value of 7.0, using the calibration knob adjust the reading to 7.0. Take the electrode from the buffer, wash it with distilled water and then wipe gently with soft tissue.

Step 3: In a 100 mL beaker take pH 4.0 buffer solution and place it in a magnetic stirrer, insert the teflon coated stirring bar and stir well. Now place the electrode in the beaker containing the stirred buffer and check for the reading in the pH meter. If the instrument is not showing pH value of 4.0, using the calibration knob adjust the reading to 4.0. Take the electrode from the buffer, wash it with distilled water and then wipe gently with soft tissue. Now the instrument is calibrated.

Procedure:

- In a clean dry 100 mL beaker take the water sample. Now place the electrode in the beaker containing the water sample and check for the reading in the pH meter.
- Wait until you get a stable reading. Note down the reading of the pH meter.
- Take the electrode from the water sample, wash it with distilled water and then wipe gently with soft tissue.

Observations:

Sample No	Name of Sample	pH
1.		

2.		
3.		

Result: The pH of the given water sample is……..

Significance of pH determination in Wastewater:

(i) Determination of pH is one of the important objective in biological treatment of the wastewater. In anaerobic treatment if the pH goes below 5.0 due to excess accumulation of acids, the process is severely effected. Shifting of pH beyond 5 to 10 upsets the aerobic treatment of wastewaters. In these circumstances the pH can be adjusted by addition of suitable acids or alkali to optimize the treatment of the wastewater.

(ii) Dewatering of sludges, oxidation of cyanides and reduction of hexavalent chromium into trivalent chromium also need a favourable pH range.

(iii) pH value or range is of immense value for any chemical reaction. A chemical shall be highly effective at a particular pH. Chemical coagulation, disinfection, water softening and corrosion control are governed by pH adjustment.

Precautions:

- We should take reading when the pH meter stops oscillating.
- pH meter should be checked for any error.
- We should take reading very carefully.

EXPERIMENT NO. 5 (B)

Objective: To determine the hardness value of a given sample of water.

Aim

To determine the total hardness of the given samples by EDTA titrimetric method.]

Principle

Originally, the hardness of water was understood to be a measure of the capacity of water for precipitating soap. Soap is precipitated chiefly by the calcium and magnesium ions commonly present in water, but may also be precipitated by ions of other polyvalent metals, such as aluminium, iron, manganese, strontium and zinc, and by hydrogen ions. Because, all but the first two are usually present in insignificant concentrations in natural waters, hardness is defined as a characteristic of water, which represents the total concentration of just the calcium and the magnesium ions expressed as calcium carbonate. However, if present in significant amounts, other hardness producing metallic ions should be included.

When the hardness is numerically greater than the sum of the carbonate alkalinity and the bicarbonate alkalinity, the amount of hardness, which is equivalent to the total alkalinity, is called carbonate hardness; the amount of hardness in excess of this is called non-carbonate hardness. When the hardness is numerically equal to or less than the sum of carbonate and bicarbonate alkalinity all of the hardness is carbonate hardness and there is no noncarbonate hardness. The hardness may range from zero to hundreds of milligrams per litre in terms of calcium carbonate, depending on the source and treatment to which the water has been subjected.

Ethylenediamine tetra-acetic acid and its sodium salts (EDTA) form a chelated soluble complex when a solution of certain metal cations. If a small amount of a dye such as Eriochrome black T is added to an solution containing calcium and magnesium ions at a pH of 10 ± 0.1, the solution will become wine red is then added as a titrant, the calcium and magnesium will be complexed. After sufficient EDTA has be to complex all the magnesium and calcium, the solution will turn from wine red to blue. This is the end the titration.

Apparatus

1. Burette
2. Pipette
3. Erlenmeyer flask
4. Bottle etc.

Reagents

1. Standard EDTA titrant (0.01 M)
2. Eriochrome black T indicator
3. Ammonia buffer solution

Procedure

1. Dilute 25 mL of sample (V) to about 50 mL with distilled water in an Erlenmeyer flask.
2. Add 1 mL of buffer solution.
3. Add two drops of indicator solution. The solution turns wine red in colour.
4. Add the standard EDTA titrant slowly with continuous stirring until the last reddish tinge disappears from the solution. The colour of the solution at the end point is blue under normal

conditions.
5. Note down the volume of EDTA added (V_1).

Observation

Calculation

$$\text{Hardness as } CaCO_3 = \frac{V_1 \times S \times 1000}{V} \text{ mg / L}$$

where,
S = mg $CaCO_3$ equivalent to 1 mL of EDTA titrant
= 1 mg $CaCO_3$

$$\text{Hardness as } CaCO_3 = \frac{1000\ V_1}{V} = \text{.....mg / L}$$

Results

EXPERIMENT NO. 5 (C)

Objective: To determine the turbidity value of a given sample of water.

Determination of turbidity in water sample using nephelo turbidity meter

AIM:- To determine the turbidity of the given sample water by Nephelometric method.

APPARATUS:- Nephelo turbidity meter.

THEORY:- Turbidity is a measure of the extent to which light is either absorbed or scattered by suspended material present in the water. Turbidity is surface waters results from the erosion of colloidal material such as clay, slit, rock fragments and metal oxides from soil, vegetable fibers and micro-organisms may also contribute to turbidity. Drinking water supplies requires special treatment by chemical coagulation and filtration before it may be used for public water supply.

This turbidity can be brought down to required level by adding coagulants. Coagulants when added to water it will form a geletaneous substance known as floc and this will arrest the fine suspended and colloidal particles. These arrested particles will settle down rapidly because of increase in their size.

RELEVANCE:- Turbidity waters are aesthetically displeasant and are not accepted for domestic use. The colloidal matter associated with turbidity provides adsorption sites for chemicals and biological organisms that may be harmful or cause undesirable tastes and odour. Disinfection of the turbid waters is difficult and unsatisfactory, since the colloids partially shield organisms from the disinfectant. This IS values for drinking water is 10 to 25 NTU.

REAGENTS:-

Turbidity free water:- Pass distilled water through a lower turbidity than distilled water, discard the first 200ml, collected. If filtration does not reduce turbidity use distilled water.

Stock turbidity solutions:-

i) Solution 1:- Dissolve 1.0 grams hydrazine suplate $(NH2)2.H2So4$ in distilled water and dilute it to 100 ml in a make up flask.

ii) Solution 2:- Dissolve 10.0 grams hexamethylene tetramine $(CH2)6N4$ in distilled water and dilute it to 100ml.

iii) Solution 3:- In a 100ml flask, mix 5ml. each of solution 1 and 2. Allow it to stand 24 hours, then dilute it to 100ml and mix thoroughly. The turbidity of this solution is 400 NTU.

iv) Standard Turbidity Solution:- Take 10.0ml of solution 3 in a 100ml make up flask and dilute it to 100ml. with turbid free water. The turbidity of this suspension is 40 NTU.

PROCEDURE:-

a) Calibration of Nephelometer:-

i) Select proper range of NTU on Nephelometer.

ii) By placing distilled water in Nephelometer test tube, set the Nephelometer reading to zero by using the knobs provided for zero setting.

iii) Using the standard turbid solution (i.e. 40 NTU), calibrate the Nephelemeter (i.e. adjust the Nephelemeter reading to 40 NTU using calibration knob)

b) Determination of turbidity of sample water:

i) For samples having turbidities less than 40 NTU: Thoroughly shake the sample so as to remove any air bubbles and pour it into meter cell. Read out the turbidity of the sample from the digital display.

ii) For samples having turbidities above 40 NTU:- Dilute sample with 1,2 or 3 volumes of turbidity free water and convert the value obtained as below.

If five volumes of turbidity free water were added to one volume of sample and the diluted sample showed a turbidity of 30 NTU, then the actual value is equal to 180 units. i.e.

RESULTS:-

EXPERIMENT-7

OBJECTIVE: To determine the Total solids of the given sample

PRINCIPAL: Total solids are determined as the residue left after evaporation and drying of the unfiltered sample.

APPARATUS:

1. Evaporating Dishes (pyrex, porcelain or platinum)
2. Oven
3. Desiccator
4. Water bath

PROCEDURE:

= A clean porcelain dish is ignited in a muffle furnace and after partial cooling in the air, it is cooled in a desiccator and weighed.

= A 100 ml of well-mixed sample (graduated cylinder is rinsed to ensure transfer of all suspend matter) is placed in the dish and evaporated at 100 ^{0}C on water bath, followed by drying in oven at 103 ^{0}C for 1 hour.

= Dry to a constant weight at 103 ^{0}C, cool in a desiccator and weigh.

CALCULATION:

$$\text{Total solids (mg/l)} = \frac{(A - B) \times 10^6}{V}$$

A = Final weight of the dish in gm. B = Initial weight of the dish in gm. V = Volume of sample taken in gm.

OBSERVATION AND RESULTS:

Sample details	Volume of sample (ml)	Initial weight of the dish (mg)	Final weight of the dish (mg)	Total Solids (mg/l)

APPLICATION OF TOTAL SOLIDS DATA IN ENVIRONMENTAL ENGINEERING:

1. The estimation of total solids in wastewater is useful to determine its suitability for sewage farming etc.
2. Total Solids determination is used to access the suitability of potential supply of water for various uses. In cases, in which water softening is needed, the type of softening procedure used nay be dictated by the total solids content.
3. Corrosion control is frequently accomplished by the production of stabilized water through pH adjustment. The pH at stabilization depends to some extend upon the total solids present as well as the alkalinity and temperature.

EXPERIMENT-6 & 8

OBJECTIVE: To study different types of water supply and Sanitary Fittings.

1. TRAP :

Trap may be defined as a fitting placed at the ends of the soil pipes or the sullage pipe to prevent the passes of foul gases from the pipes to the outside.

Depending upon their shapes, the traps may be:

(i) P-trap

(ii) Q-trap (iii)

S-trap

(iv) Intercepting trap

(v) Nahani trap

Out of the above three types of traps are shown here. A trap essentially consists of a U-tube, which retains water, acting as a seal between foul gases inside the pipes and the outside atmosphere. They are largely used for bathrooms, sinks and lavatories. In all such needs, they are made with enlarged mouth, so that the waste pipe may be thoroughly flushed out.

2. NIPPLE:

This is used for connecting the piece of pipe. The nipple is a smaller piece than the full length. Nipple are used to connect the sockets, elbows, enlarger and reducers, end plugs and union socket etc. They are designated as 20mm, 25mm or so G.I. (galvanized iron) nipple.

3. REDUCER:

It is used to join the pipes of different diameter. When a large size pipe is to be joined to small size pipe, reducers are used. They are designated as 25mm X 20mm G.I. reducer.

4. TEE:

Tees are used to bifurcate the flow. The bifurcation may be to the same size pipe or different size. The tee is used in the main line for the connection of the branch line. The tee is always perpendicular the main line. They are designated as 25mm X 25mm X 25mm or 25mm X 25mm X 20mm or so.

5. END PLUG:

It is used at the end of pipelines to stop the flow. It may be internal or external threaded depending upon the use.

6. ELBOW:

This is used to change the direction of pipe line at right angle. The size of the elbow is small. Whenever a sharp turn is required for example besides the corners of a building elbows are used though, there is larger head loss compared to the bends.

7. BEND:

The bend is used to change the direction of the line in any direction generally to the right angle. The size of the bend is larger than the elbow and there is a smooth transaction of flow so the head loss is lesser. It requires more space to be accommodated and is costlier than the elbow.

8. SOCKET:

The socket is a small piece of G.I. pipe to connect the two similar diameter pipe lengths. It is generally internally threaded. A special type of socket is known as union socket which had two detachable collars by which it can be unthreaded without disturbing the whole assembly.

9. SOCKET & SPIGOT JOINT:

This type of joint is used to join the same diameter pipe lines for the proper joining of two pipes cement mortar or the lead is used and it is also used to prevent the leakage.

10. C.I. DETACHABLE JOINTS:

These types of joints are very much useful in connecting A. C. or mild steel etc pipes. They can be easily repaired or replaced.

11. STONE WARE or SALT GLAZED PIPES:

These pipes are widely used for carrying sewage in the house connection as well as lateral sewers. They are available in various sizes of 5cm increments from 10 to 30 cm and 7.5cm increments from 30 to 90cm. Their length is generally 75cm only.

These pipes are manufactured from clay and shales of special quality, which are first pulverised and mixed with water and salt glazing is done during baking at high temperature.

ADVANTAGES OF PIPES:

i. These pipes are highly resistant to sulphide corrosion.

ii. They are hydraulically very efficient.

iii. They are quite strong in compression.

iv. These pipes are highly impervious and do not allow any sewage to seep out of them.

v. These pipes are quite cheap, durable, easily available and can be easily laid and jointed.