BASIC CIVIL ENGINEERING & MECHANICS BT - 204

Department of Civil & Mechanical Engineering

Course Completion Unit Plan

Document	Revision	Effective Date	Page
BT-204		01-11-2022	1-2

CCUP- Basic Civil Engineering & Mechanics (BT-204)

LEC NO.	TOPIC	COURSE OUTCOMES	Reference
	Unit I Building Materials & Construction (CO:1)		
1.	Properties of Stones , bricks, cement, lime	CO1	A1, A2
2.	Laboratory test on concrete and mortar materials	CO1	A2
3.	Workability and strength properties of concrete	CO1	A1
4.	Nominal proportion of concrete, preparation of concrete	CO1	A3
5.	Compaction and curing of concrete	CO1	A2,A3
6.	Elements of building construction	CO1	A1,A3
7.	Different types of foundation	CO1	A3
	Unit II Surveying & Positioning (CO:2)		
8.	Introduction to surveying	CO2	A1,A2
9.	Surveying instruments- levels, theodolite, and related devices	CO2	A3,A1
10.	Measurement of distances by conventional and EDM methods	CO2	A3,A2
11.	Measurement of directions by different methods	CO2	A1
12.	Measurement of elevations by different methods	CO2	A2
13.	Reciprocal leveling	CO2	A1,A3
	Unit III Mapping & sensing (CO:3)		
14.	Mapping details and contouring	CO3	A4
15.	Profile cross sectioning and measurements of areas and volumes	CO3	A3,A4
16.	Applications of measurements in quantity computations	CO3	A4
17.	Survey stations	CO3	A1,A2,A3
18.	Introduction of remote sensing and its application	CO3	A3,A4

SANGE GROUP OF COLLEGES

Unit-4 Forces and Equilibrium (CO:4)			
1.	What is Engineering Mechanics	CO4	B2,B4
2.	Analytical method to solve coplanar concurrent forces	CO4	B1,B2,B3,B4
3.	Resolving the forces, coplanar non concurrent forces	CO4	B2,B4
4.	Free body diagram, Lami's theorem	CO4	B1,B2,B4
5.	Bow's Notation, Polygon law	CO4	B4
6.	Graphical treatment of concurrent and no concurrent forces	CO4	B4
7.	Varignon's theorem, Application of Equilibrium Concepts	CO4	B1,B2
8.	Method of joint ,Method of section	CO4	B1,B4
9.	Frictional forces in equilibrium problems	CO4	B1,B4
Unit- 5 CG and MI & Shear force and bending moments (CO:5)			
10.	Centroid of plane figure and CG of mass and forces	CO5	B2
11.	MI of area and mass, Radius of gyration	CO5	B2,B4
12.	MI of composite section	CO5	B2,B4
13.	Introduction to product of Inertia and Principle Axes	CO5	B1,B4
14.	Principle axes of section and principle of inertia	CO5	B4
15.	Support Reactions	CO5	B4
16.	Shear force and bending moment Diagram for Cantilever & simply supported beam with concentrated	CO5	B4
17.	Distributed load and Couple in beams	CO5	B4

ATINCT GROUP OF COLLEGES
UNIFORMLY TOWARDS BEING THE BEST

REFERENCES :

1) S. Ramamrutam & R.Narayanan; Basic Civil Engineering, Dhanpat Rai Pub.(A1)
2). Prasad I.B., Applied Mechanics, Khanna Publication.(A2)
3). Punmia, B.C., Surveying, Standard book depot.(A3)
4). Shesha Prakash and Mogaveer; Elements of Civil Engg & Engg. Mechanics; PHI(A4)
5) R.C. Hibbler – Engineering Mechanics: Statics & Dynamics (B1)
6) Engineering Mechanics: R.K. Rajput; S. Chand & CO.(B2)
7) A. Boresi & Schmidt- Engineering Mechines- statics dynamics, Thomson' Books (B3)
8) Engineering Mechanics: Dr. R.K Bansal; Laxmi Publication, New Delhi. (B4)

UNIT-2

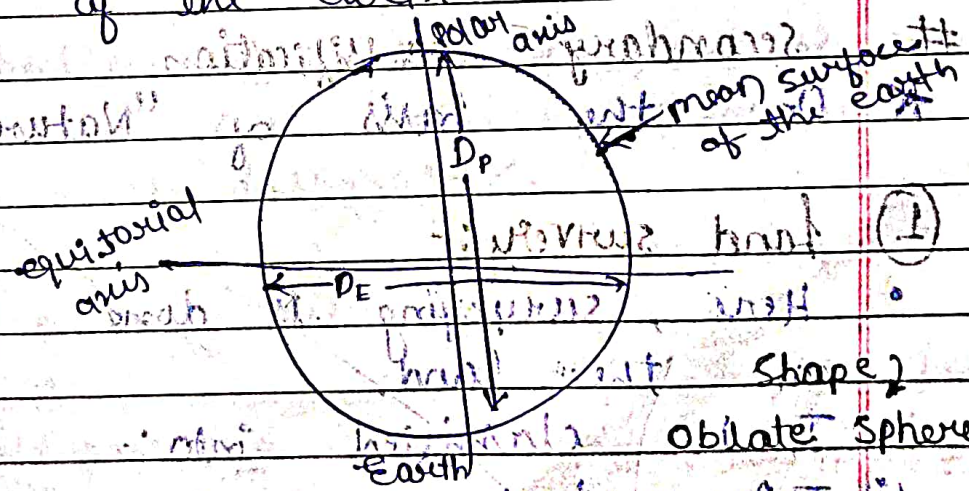
Chapter-1 → fundamental of surveying

Surveying and positioning

Introduction / definition

(Note-1) The process of determining the relative position of points on, above and below the surface of the earth by means of direct and indirect measurements of "distance", "direction" and "Elevation".

Note-2- Shape of the earth



(1)

Shape → oblate spheroidal

$D_P < D_E$

D_E is 43 KM greater than the D_P

Classification of surveying

► **Preliminary Classification:**

★ On the basis of the shape (curvature) of the earth the surveying is classified

max^m range 250 km

Date: / / Page no:

① Plane surveying :-

- In this type of surveying curvature of the earth is not taken into account.
- It is suitable to the used for small area of survey (< 25 km²)

② Geodetic surveying :-

- In this type of surveying the curvature of the earth is taken into account.
- It is suitable to the used for larger area of survey. (> 250 km²)

Secondary classification

* On the basis of "Nature of field"

① Land survey :-

- Here, surveying is done for features on the land.
- It is classified into :-

(i) Topographical survey :-

This is consist of horizontal & vertical locations of certain points by linear and angular measurements to determine physical features like - rivers, lakes, pond, forests, hills (natural features), roads, railways, canals, bridge, foundation, building, dam (artificial features)

पटवारी का सारा काम cadastral survey पर ही होता है
→ Legal properties को नापने के लिए

Date: / / Page no:

IMP * (ii) Cadastral survey :- This survey is made for fixing the property line and calculation of land area for transfer of land property.

(iii) City survey :- This survey are made in connection with construction of street water pipeline, fiber lines, cable lines etc.

(2) Marine / Hydrographical survey :- It deals with water bodies for the purpose of navigation, mean sea level, reservoir capacity, waste disposal etc.

(3) Astronomical survey :- It is carried for determining the absolute location of any point on the surface of the earth with the help of heavenly bodies / celestial bodies / spatial bodies.

Ex:- sun, any fixed star.

Secondary classification

★ On the basis of "object of surveying

Date: / / Page no:

① Engineering survey :- It is done to find sufficient data to be used for enggi. design works like roads, sewers (नालियाँ), reservoirs, etc.

② Millitary survey :- It is used for determining points of strategic importance for the country.

③ Geological survey :- It deals with determination of formation of earth strata.

④ Archaeological survey :- It is use to find existance of past civilization.

⑤ Mine survey :- It is carried out for exploration of new mines.

Secondary classification

★ On the basis of Instruments used into surveying.

Date: / / Page no:

① Chain survey :-

→ It is the simplest type of surveying in which linear measurements are taking with help of chain and tape

Note:- angular measurements are not taking in this type of survey.

② Compass survey :-

→ In this type of survey angular measurements (horizontal angles) are ~~taking~~ taken with the help of magnetic compass along with linear distances by the chain or tape.

③ Levelling survey :-

In this type of surveying levelling instruments are used to determine relative elevations of various point in the verticle plane.

④ Theodolite survey :-

In this type of survey horizontal and verticle angles are measured with help of theodolite.

least office work / least accurate

⑤ Plane Table survey :- → In this survey a map or plan is prepared in the field by observing the terrain after determining the directions of various lines and measuring the linear distances with the chain.

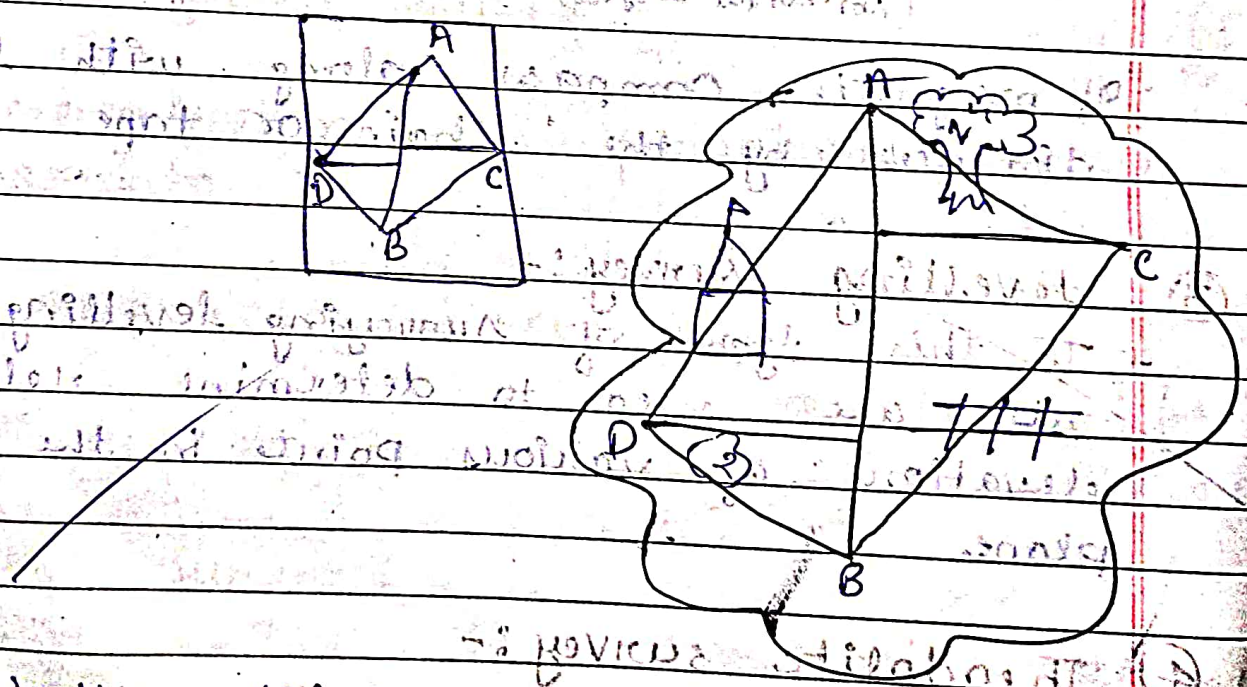
→ Accuracy of this survey is low but in this case plotting and measurement are done simultaneously.

⑥ EDM (Electronic Distance measurment) survey

→ In this type of survey linear measurment are taken with the help of EDM.

* Principle of survey:

1. To work from whole ~~two~~ to part :-



→ Weather plain or geodectic survey is done work to be cary out from whole to part.

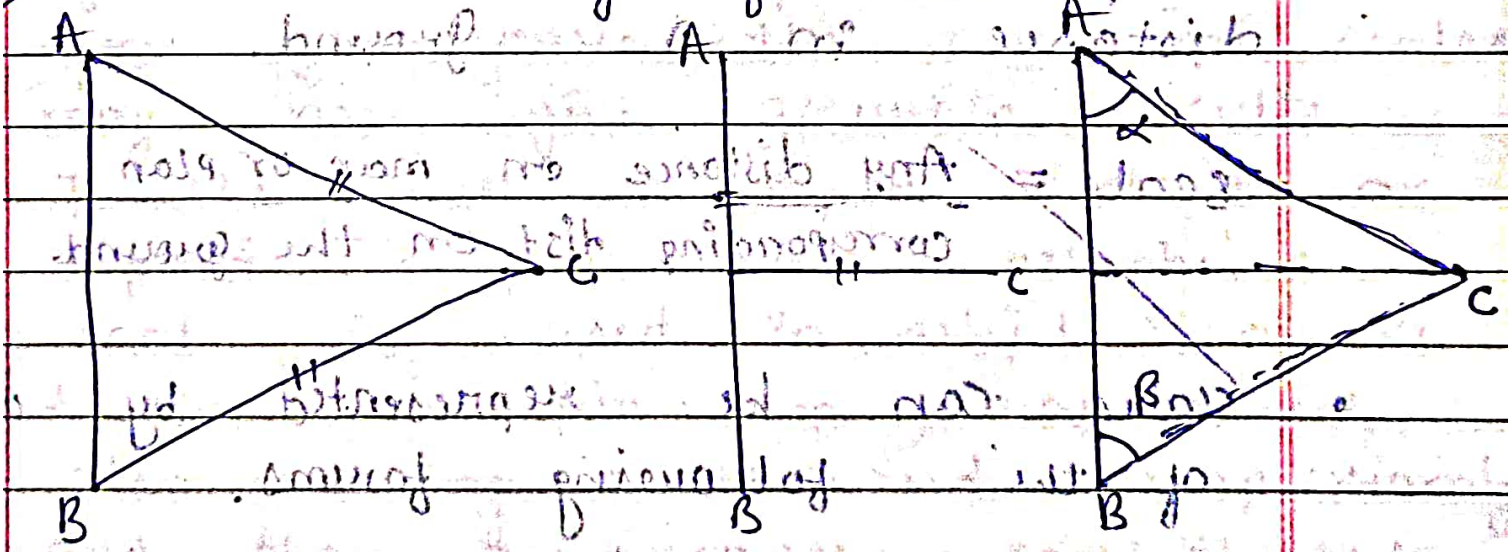
→ To which we establish first system of control point with high degree of accuracy.

minor control points are to be established by less precise method.

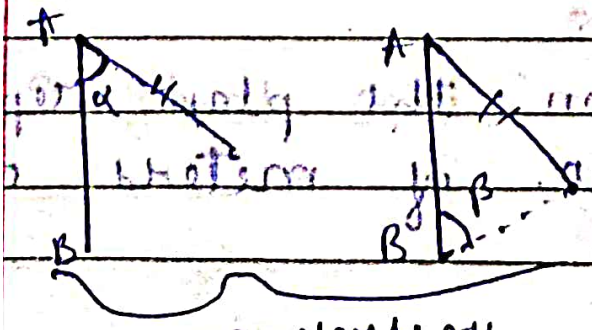
By doing so accumulation of errors is avoided and minor errors are localised

Establish a new station by taking atleast two measurements from a fixed reference point.

The relative position of the point to be survey should be located by measurements from atleast two point of reference the position of which already fixed



Chain survey | Offset | Traingulation



Traverse

Date: / / Page no:

Map and plan:

→ A map or plan is a graphical representation to some scale of the features on, near or below the surface of the earth.

→ The representation is called map when the scale is small and is called plan when the scale is large.

* Scales:-

→ It is the fix ratio that every distance on the plan or map bears with the corresponding distance in a ground.

$$\text{scale} = \frac{\text{Any distance on map or plan}}{\text{corresponding dist. on the ground}}$$

- scales can be represented by any of the following forms.

→ Numerical scale:

① Engg. Scale:

→ Here 1 cm of on the plan represents some whole no. of meters on ground.

Scale

▷ Numerical scale.

(1) Engg. scale

(2) Representative fraction (RF)

▷ Graphical scale.

Date: / / Page no:

$\boxed{1\,cm = 100\,m}$ → Engg. scale.

$1\,cm = 10000\,cm$

$\boxed{1 = 10000}$ R.F.

Representative fraction (RF):-

Here 1 unit of length on the plan represents some number of same units of length on the ground.

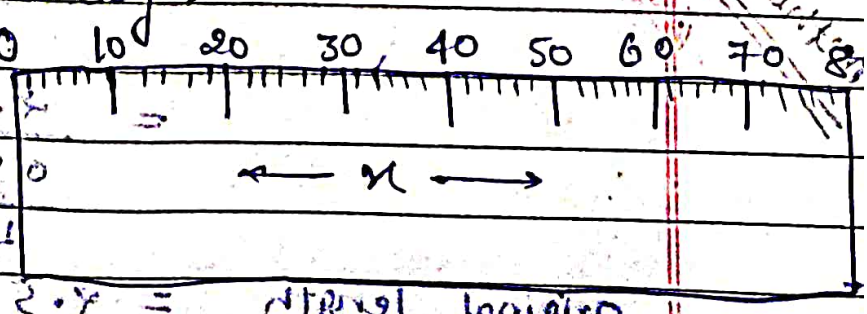
$1 : 1000$

$RF = \frac{1}{1000}$

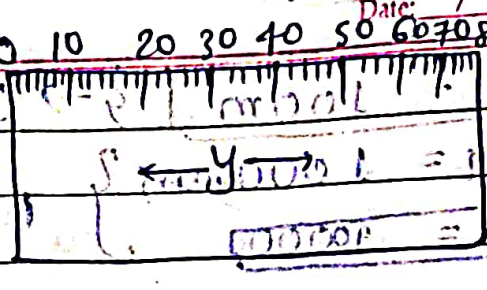
Graphical scale:-

If the plan or map is to be used after few years the numerical scales may not give accurate results. If the sheet or paper shrink or expand in such case graphical scale is used in which scale is drawn on plan or map which also shring or expand proportional and the distances and conditions to found accurately.

Original scale:-



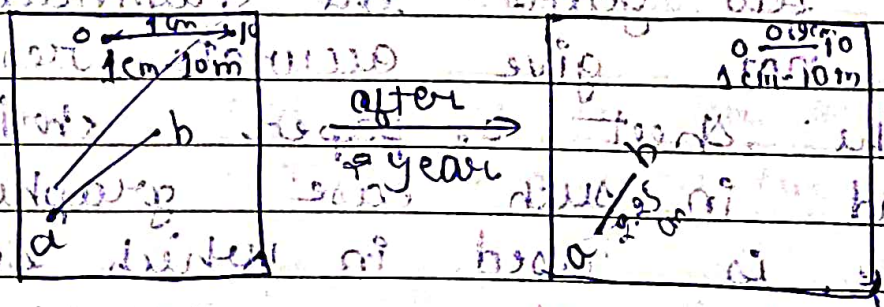
Shrunk scale :-



Shrunk factor = $\frac{\text{Shrunk length}}{\text{original length}} = \frac{y}{x}$

$= \frac{\frac{y}{1000}}{\frac{x}{1000}} = \frac{\text{shrunk scale}}{\text{original scale}}$

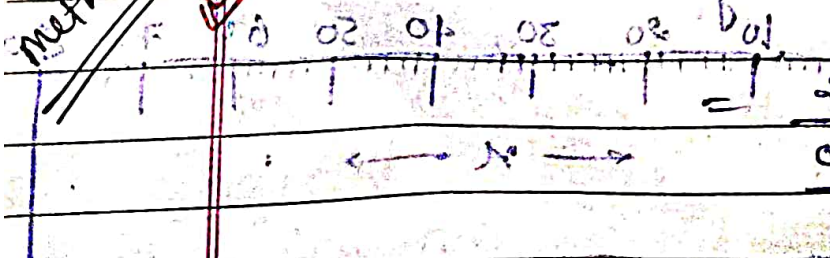
- correct distance at line in terms of original scale = $\frac{\text{Shrunk length}}{\text{Shrunk factor}}$
- Correct area in the term of original scale = $\frac{\text{shrunk area}}{(\text{shrunk factor})^2}$



original map shrunk map

Original length = $\frac{\text{Shrunk length}}{\text{Shrunk factor}}$

method :-



$= \frac{2.25}{\frac{9}{1}}$

original length = 2.5 cm

Correct dist. of line in the field = 25 m.

Method-2

shrunk = original × shrunk scale / original scale

shrunk = original × shrunk factor

$$\frac{\text{shrunk}}{1000} = \frac{\text{original}}{1000} \times \frac{\text{shrunk}}{\text{original}}$$

$$\frac{\text{shrunk}}{1000} = \frac{\text{original}}{1000} \times \frac{1000}{1}$$

$$\text{shrunk} = \text{original}$$

Correct dist. of line in the field = 25 × 1111.11

$$\frac{F.L}{1} = \frac{F.L}{1000}$$

$$F.L = 24.99\ m$$

$$\frac{F.L}{1} = \frac{F.L}{1000}$$

$$F.L = 25\ m$$

$$\text{shrunk length} = \text{original length} \times \frac{\text{shrunk scale}}{\text{original scale}}$$

$$\frac{F.L}{1} = \frac{F.L}{10\ m} \times \frac{1\ m}{1000}$$

$$\frac{F.L}{1} = \frac{F.L}{1000} \times \frac{1}{1}$$

NUMERICALS

1. The area of the plan of an old survey plating to a scale of 10m to 1cm. Measures now 100.2 cm^2 as found by planimeter. The plan is found to have shrunk show that a line original 10cm long Now measures 9.7cm only.

→ Compute the shrunk scale.

→ Compute the true area of survey.

Solve ⇒ Given,

Scale → 10m to 1cm

Shrunk ~~original~~ area → 100.2 cm^2

original length → 10 cm

shrunk length → 9.7 cm

1st case

Shrunk factor $= \frac{y}{x} = \frac{9.7}{10} = 0.97$

~~Original scale $= \frac{S.L}{S.F} = \frac{9.7}{0.97} = 10$ cm~~

~~original scale for area~~

$= \frac{9.7}{(0.97)^2} = \frac{9.7}{0.9409} = 10.3$

shrunk scale = original scale × S.F.

$= \frac{1cm}{10m} \times \frac{y}{x}$

$= \frac{1}{1000} \times \frac{9.7}{10}$

Shrunk scale $= \frac{1}{10000/9.7} = \frac{1}{1030.92}$

Correct area of field $= \frac{\text{Shrunk area}}{(\text{Shrunk factor})^2}$

(2) method

$= \frac{100.2}{(0.97)^2}$

Correct area on original map $= 106.49\ cm^2$

$1\ cm = 10\ m$

$1\ cm^2 = 100\ m^2$

correct area on the field $= \cancel{10.6} \times 100\ m^2$ (106.49)

$= 10649\ m^2$

method (2)

Correct area of field $= 100.2 \times (1030.92)^2$

$= \text{———} \times 10^{-4}\ m^2$

$= 10649.21\ m^2$

In 1950 plan of rectangular field was drawn with a scale of 1cm = 40 m. The present dimension of the field read as 30cm X 10cm. If the original reference line of 9.4 cm. Now reads 10cm. then what is the actual area of the field.

Chapter → 2nd

Date: / / Page no:

Introduction / Definition:

It is the process of determining the relative elevations of various points on below and above the surface of the earth.

Basic Definitions:

1. Level surface:

→ Any surface parallel to mean spheroidal surface of the earth is called Level surface.

Ex:- The water surface of still Lake is considered to be a level surface.

2. Level line

→ Any line lying on level surface is called level line.

3. Horizontal plane:

→ Any plane tengential to a level surface at any point.

4. Horizontal line

Date: / / Page no:

Any line lying on horizontal plane is called horizontal line.

Plumb line / Vertical line :

The direction indicated by plumb (direction of gravity).

Vertical plane :

Any plane passing through vertical line is called Vertical plane.

Datum / Datum surface :

A level surface which is taken as reference surface for the vertical distances of the different points of the earth surface.

Reduced level (RL) :

A reduced level of a point is its height relative to the datum.

Line of collimation / Line of sight :

Imaginary line passing through the intersection of cross hairs at the

Date: / / Page no:

diaphram.

10) Axis of telescope:

→ Imaginary line passing through the optical centre of the objective glass and optical centre of the eye piece and its continuation.

11) Bench mark (BM):

→ It is a fixed point of known elevation.

* Types:

(i) GTS (Great Trigonometrical survey) BM :-

→ This bench mark are stablished by survey of India department.

→ It is established at a large interval and with a high degree of accuracy.

→ There position and elevation are publish on GTS maps.

→ The standard adopted datum for GTS Bench mark is MSL (mean sea level) in Mumbai

(ii) Permanent Bench mark (PBM):

→ This bench mark are stablished by state PWD at closer interval b/w widely spaced GTS. BM

Date: / / Page no:

(iii) Temperary BM:

→ The BM stablished for short duration (only for a day).

(iv) Arbitrary BM:

→ The BM whose elevation are assumed arbitrary for lavelling of a small area.

(12) Backsight (BS) reading:

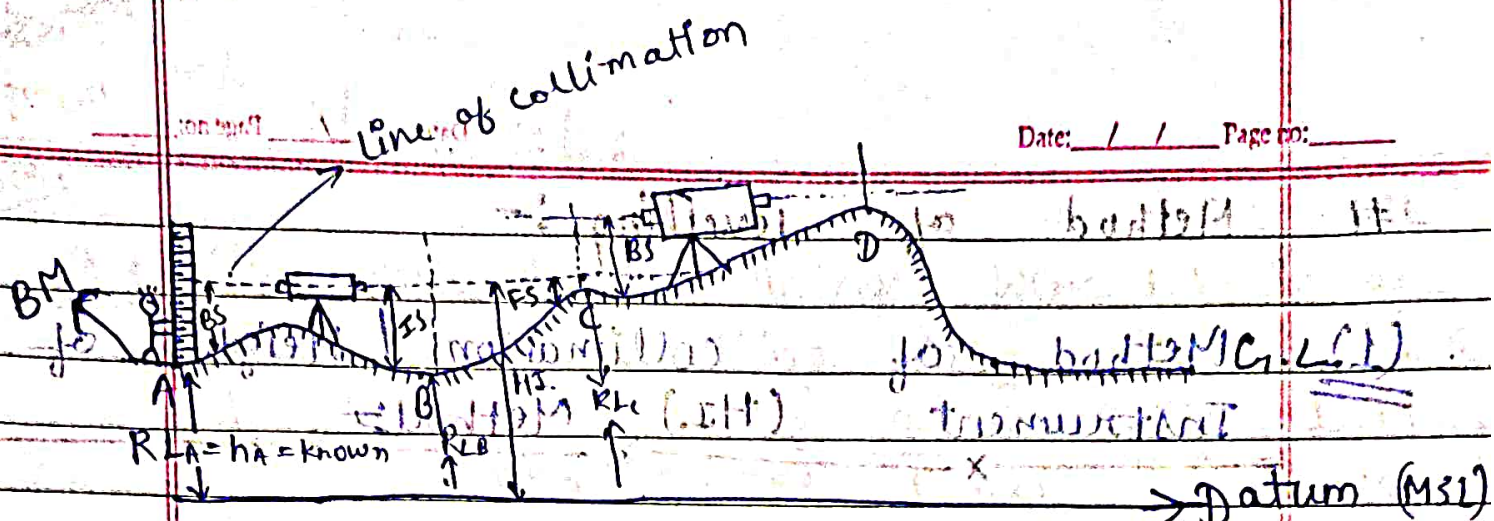
→ It is the first staff reading from any hand set up of the instrument at a point of BM.

(13) Fore sight (FS) reading:

→ It is the last staff reading from the same set up of the instrument at a point of unknown RL.

(14) Intermediate sight (IS) Reading:

→ It is the any other staff reading taken between BS and FS.



$$\boxed{HI = RL_A + BS}$$

$$\boxed{RL_B = HI - IS}$$

$$\boxed{RL_C = HI - FS}$$

Arithmatic check

$$RL_{first} + \Sigma BS = RL_{Last} + \Sigma FS$$

$$\boxed{RL_{Last} - RL_{first} = \Sigma BS - \Sigma FS.}$$

Date: / / Page no:

Method of levelling :-

(1). Method of collimation / Height of Instrument (H.I.) Method :-

Arithmetic check.

$$\boxed{\Sigma BS - \Sigma FS = \text{Last RL} - \text{First RL}}$$

(2) Rise and fall Method :-

Arithmetic Check

$$\boxed{\Sigma BS - \Sigma FS = \Sigma \text{Rise} - \Sigma \text{fall} = \text{Last RL} - \text{first RL}}$$

①

0.875, 1.225, 1.285, 1.425, 1.165, 0.785

②

0.925, 1.225, 2.825, 0.895, 1.255, 1.685

③

0.915 (m)

★★★★★★★

3112011 100%

IMP

Numericals :-

Date: / / Page no:

Q.1 The following readings were take in by a 4 m - levelling staff - 0.875, 1.225, 1.285, 1.425, 1.165, 0.785, 0.925, 1.225, 2.825, 0.895, 1.255, 1.685 and 0.915 (m). The Instrument was shifted after 5th and 9th readings. Enter the data in level book and calculate RL of the all the points if 1st reading was taken on BM (bench mark) 100.000 m apply check.

(June 2020)

Solution by H.I. method

Station	B.S(m)	I.S(m)	F.S(m)	H.I(m)	RL (m)	Remark
				~~100.875~~	~~100.000~~	
A	0.875			100.875	100.000	BM.
B		1.225			99.650	
C		1.285			99.590	
D		1.425			99.450	
E	0.785		1.165	100.495	99.710	CP-1
F		0.925			99.570	
G		1.225			99.270	
H	0.895		2.825	98.565	97.670	CP-2
I		1.255			97.310	
J		1.685			96.880	
K			0.915		97.650	
SUM	2.555		4.905			

CP = change Point

Arithmatic Check.

$\sum BS - \sum FS = \text{last RL} - \text{first RL}$

$2.555 - 4.905 = 97.650 - 100.00$

$-2.350 = -2.350$ Hence proved

Q. following readings were taken with 3m lavelling staff

Arithmatic Check

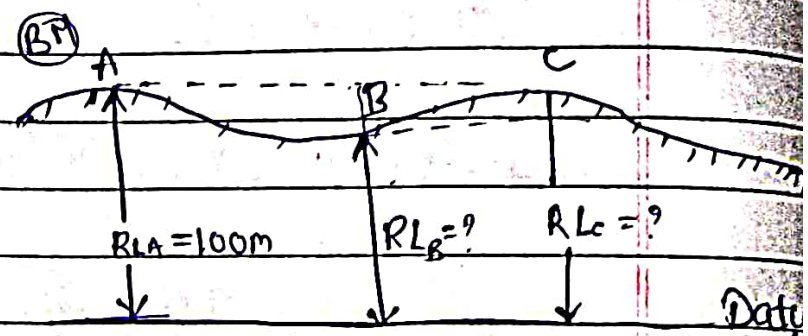
0.315, 0.855, 1.250, 1.880, 2.310, 1.850

2.550, 0.555, 2.350, 1.220, 0.350, 2.550

0.105, 1.550

the instrument was shifted after 4th and 7th reading. The last reading was taken on Bench mark (BM = 100.00 m) then determine the RL of all point by using and

Rise & fall method



Previous que. solⁿ.

solve - Q.1)

solve by Rice and fall method.

station	B.S.	I.S.	F.S.	Rise	Fall	R.L	Remark
A	0.875					100.00	BM
B		1.225			0.350	99.650	
C		1.285			0.060	99.590	
D		1.425			0.140	99.450	
E	0.785		1.165	0.260		99.710	CP-1
F		0.925			0.140	99.570	
G		1.225			0.300	99.270	
H	0.895		2.895		1.600	97.670	CP-1
I		1.255			0.360	97.310	
J		1.685			0.430	96.880	
K			0.915	0.770		97.650	
SUM	2.555		4.905	1.030	3.380		

Arithmatic check

$\sum BS - \sum FS = \sum Rise - \sum fall = last + RL - first + RL$

$1.030 - 3.380 = 97.650 - 100.00$

$2.350 = -2.350$

Hence proved

Q. Following readings were taken with levelling staff:

0.315, 0.855, 1.250, 1.880 (4th), 2.310,
1.850, 2.550, 0.555 (8th), 2.350, 1.220,
0.350 (11th), 2.550, 0.105, 2.315, 1.550 (m)

The instrument was shifted after 4th, 8th and 11th reading. If the last reading was taken on Bench mark (BM) = 100.00 (m) then determine the RL's of various points by using rise and fall method.

station	BS	IS	FS	Rise	fall	RL	Remarks
A	0.315					996.810	
B		0.855			0.540	996.270	
C		1.250			0.395	995.875	
D	2.310		1.880		0.630	995.245	CP-1
E		1.850		0.460		995.705	
F		2.550			0.700	995.005	
G	2.350		0.555	1.995		997.000	CP-2
H		1.220		1.130		998.130	
I	2.550		0.350	0.870		999.000	CP3
J		0.105		2.445		1001.445	
K		2.315			2.210	999.235	
L			1.550	0.765		1000.000	BM
SUM	7.525		4.335	7.665	4.475		

Arithmatic check

$\Sigma BS - \Sigma FS = \Sigma Rise - \Sigma fall = \text{last RL} - \text{first}$

$7.525 - 4.335 = 7.665 - 4.475 = 1000.000 - 99$

$3.190 = 3.190 = 3.190$

Date: / / Page no:

~~Draw the shear force diagram (SFD) and Bending moment diagram (BMD) for the given beam~~

The following readings were taken on continuous sloping ground.

0.305, 0.815, 1.335, 2.310 CP-1, 0.440.
0.875, 1.556, 2.050 CP-2, 0.210, 0.675,
1.425, 2.705

If the first reading was taken on BM=100. Determine the rise of all the points also apply check.

Date: / / Page no:

Chapter - 3
Theodolite

Introduction / Definition :- Theodolite is an complicated instrument used mainly for accurate measurement of horizontal and vertical angles upto 10" to 20" (second). Because of its various uses the theodolite is sometime known as universal instrument for surveying.

Uses of theodolite :-
It can be used for measuring horizontal angles, vertical angles, deflection angle, magnetic bearings, horizontal distance b/w two points, vertical height of an object, difference of elevation b/w various points, Ranging of line.

Basic terms :-

A classification of theodolite

(i) Transitiving theodolite :- The telescope can be revolved through complete revolution about its horizontal axis in a vertical plane

(ii) Non - Transiting Theodolite :- The telescope can be revolved through incomplete revolution about

(iii) Face left :- when the vertical circle of the theodolite is on the left of the observer at the time of taking readings

(iii) Face right :- — " — Right — " —

Date: / / Page no:

④ → Telescope normal:-
The face left position known as telescope normal, telescope direct bubbol up.

⑤ → Telescope inverted:-
The face Right position known as telescope inverted, telescope reversed bubbol down.

⑥ → changing face:-
The operation of bringing of vertical circle from one side of the observer to the other.

★ ⑦ → swinging of telescope:-
Turning of telescope in a horizontal plane.

(i) Right swinging:-
when the telescope is turn clockwise

(ii) Left swinging:-
turn anticlockwise

★★★ ⑧ Trunnion Axis:-
It is the axis of rotation of telescope in vertical plane.

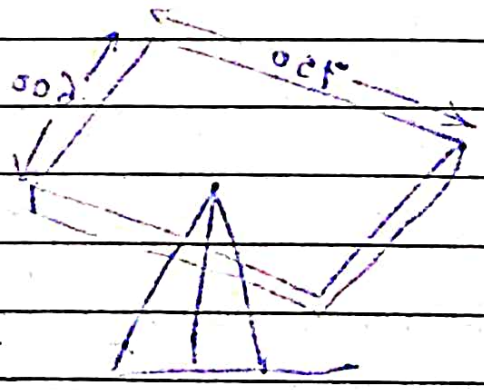
Date: / / Page no:

⑨ Sensitivity of bubble tube:-
The ability of a bubble tube to show a very small deviation of bubble from its horizontal position.

⑩ Size of theodolites:-
The size of theodolite is defined a/c to the diameter of the lower plate.

IMP Diagram of Theodolite along with its component parts.

- → Tribrach
- → Leveling foot screws
- → Trivet
- → lower & upper plate
- → lower & upper tengent screws
- → Clamping screw
- → Horizontal & verticle graduated circle
- → spindle
- → Plate Bubble
- → Altitude Bubble
- → Telescope
- → A - frame
- → Compass.



Date: / / Page no:

Chapter - 4

plane table surveying

(P)

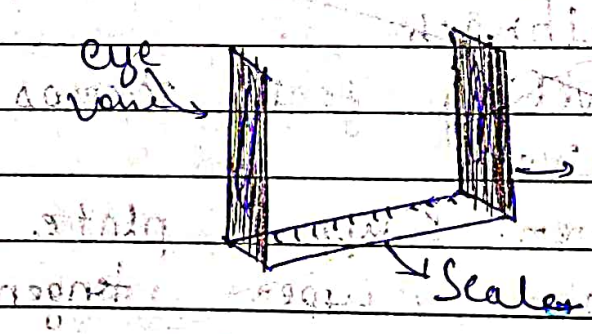
Principle of plane table surveying :-

Rays are drawn from station to object on paper are parallel to the lines ——"——"—— ~~field~~ from the stations to the object on the ground

Instruments :-

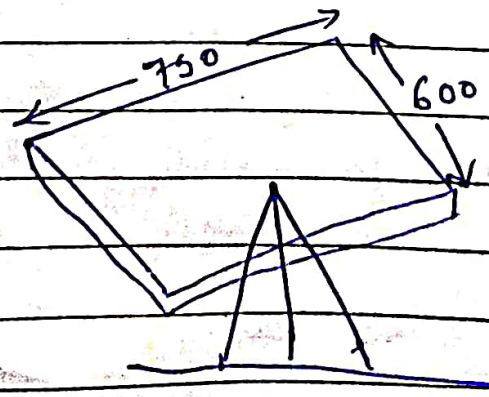
(1) Plane Table :- Size 750mm × 600mm

wooden drawing board



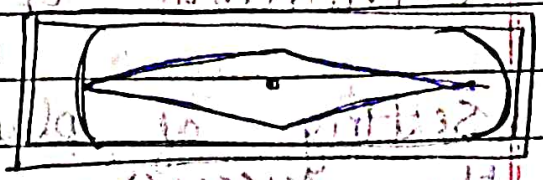
(2) Alidade :-

Plain Alidade Telescope Alidade

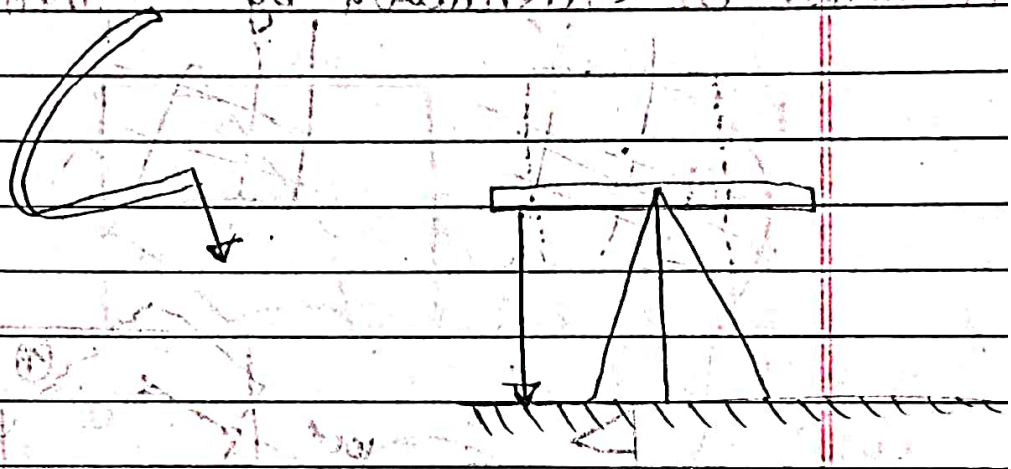


Date: / / Page no:

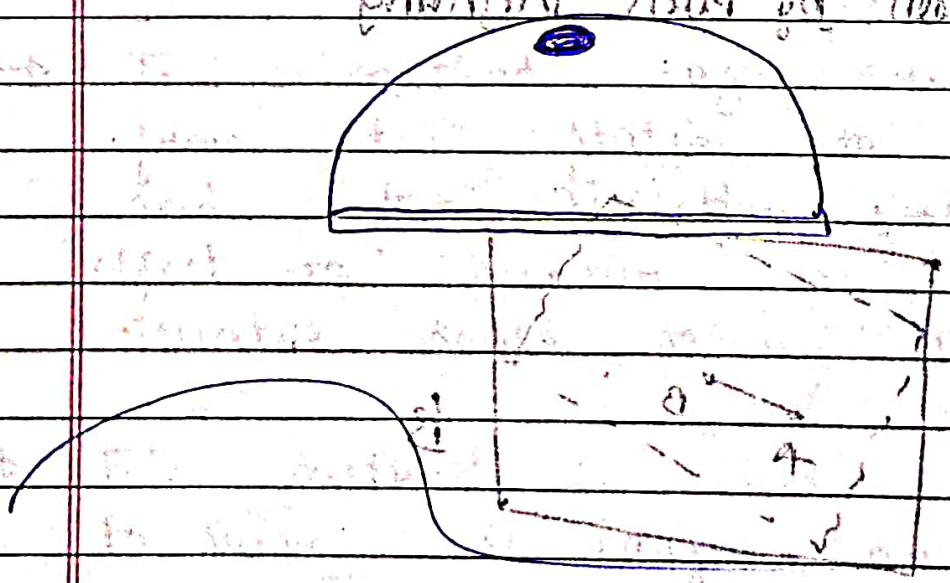
(3) Trough compass



(4) U-fork / Plumbing fork attached with plumb bob.



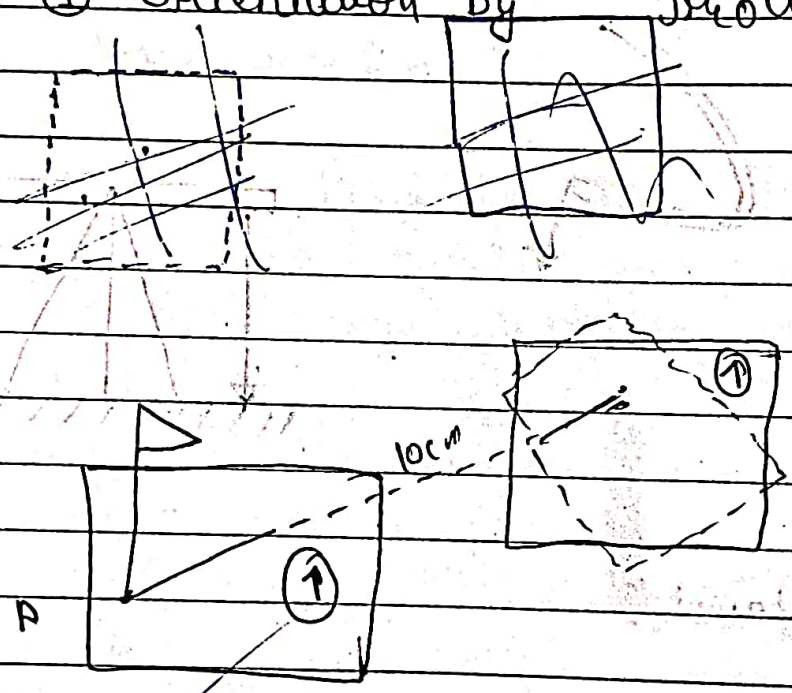
(5) Spirit level



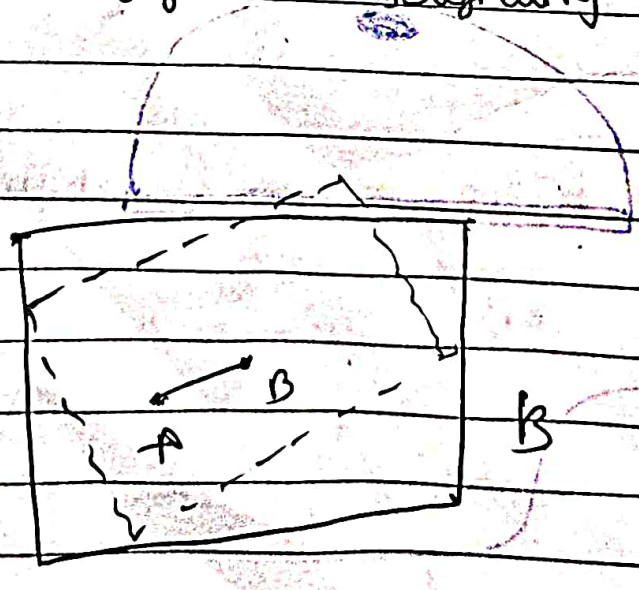
Orientation of plane table:-

Setting of plane table at each of the successive station parallel to the position it occupied at the starting station.

Methods:- ① Orientation by Trough compass.

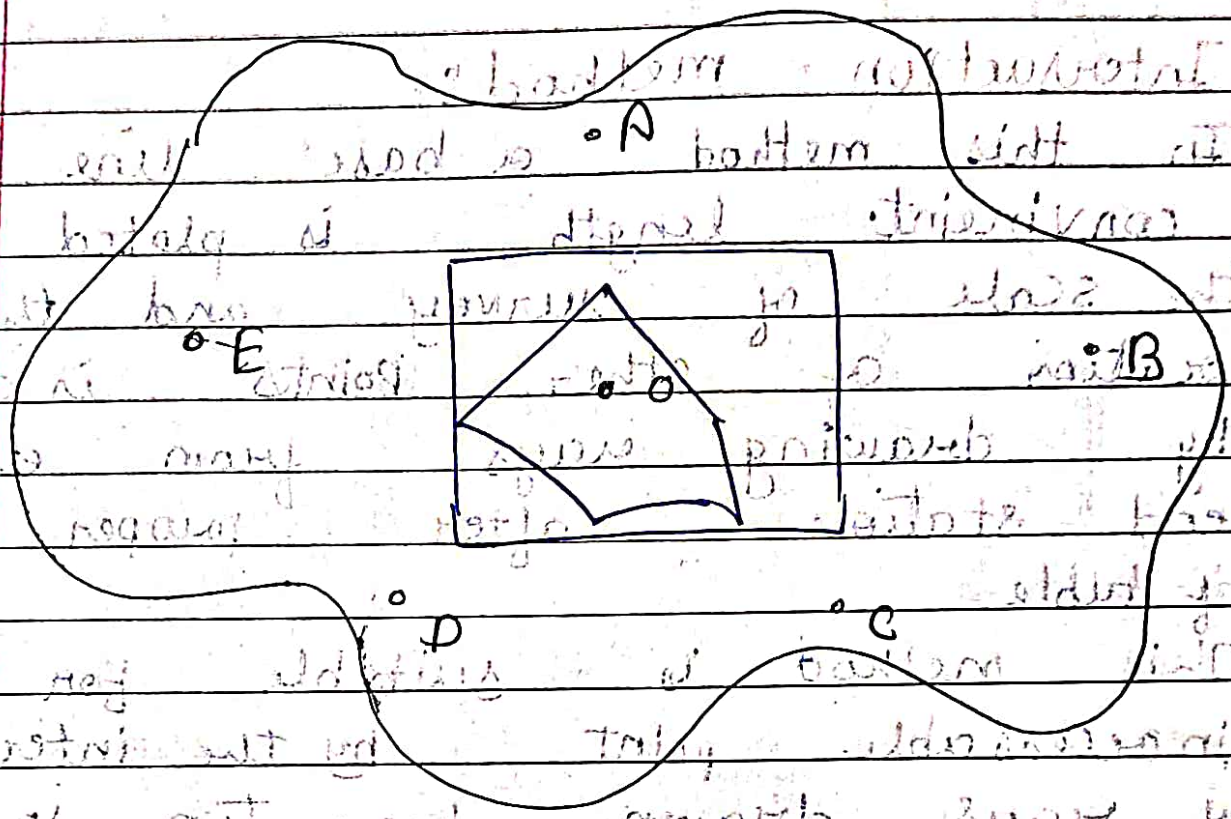


Orientation by Back sighting



Methods of plane table survey

) Radiation methods



This method is suitable for locating the object from a single station

In method rays are drawn from the station to the object, and the direction from to of object to measure an plated to an situable scale along the refected ra

This method is not convinient to survey a large area.

→ It is suitable surveying area where the various station are all visible from central station

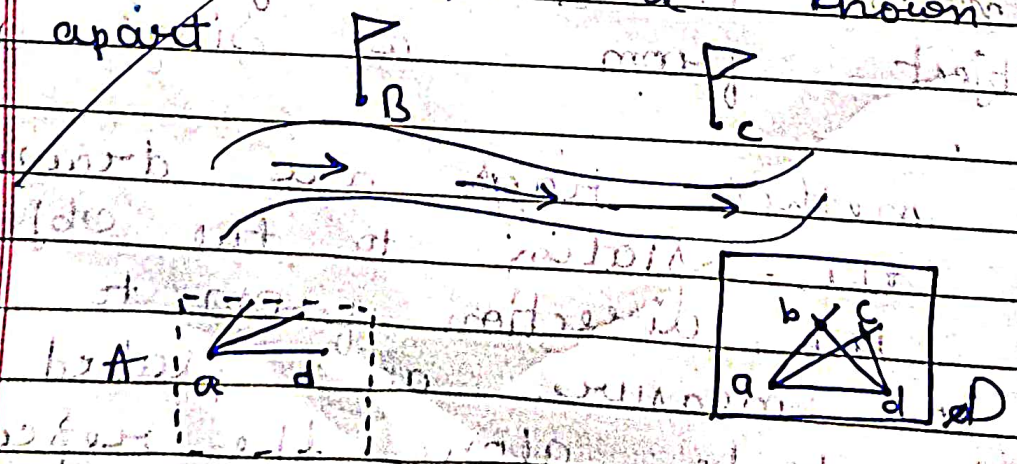
Method of plane table surveying:-

Imp

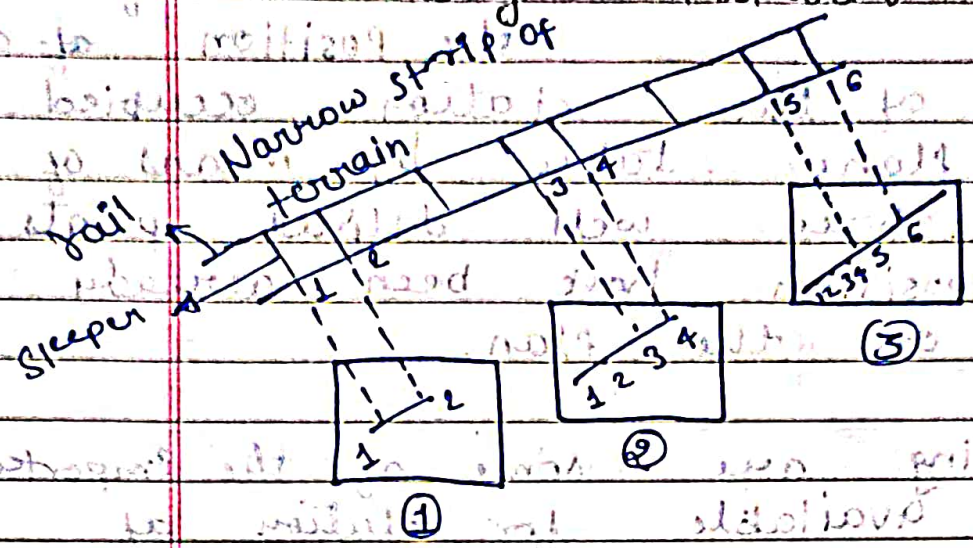
② Intersection method:-

In this method a base line of convinient length is plotted on the scale of survey and the location of other points is determin by drawing rays from each on end station after proper orienta of table.

→ This method is suitable for locatin inaccessable point by the intersection of rays drawn from two instrumen station at a known ~~station~~ dist apart



(3) Traversing Method :-



Open trearers.

→ It is used when narraw strip of terrain is to be survey.

ex:- survey of ~~routes~~ rods, railway tracks.

VIMP

(4) Resection method :-

(i) This method is very useful when one of the plotted station is accessable from the station to be plotted.

(ii) Resection is the process of determini the plotted position of the station occupied by the plan table by means of sight taken towards known points, location of which have been plotted.

Date: / / Page no:

→ Three point Problem :- Location of the position of the plan of the station occupied by the plane table by means of observations three well defined points whose position have been already ploted on the plan.

The following are some of the importa method available for solution of these problems.

(i) Mechanical method (Tracing paper method)
(ii) Graphical method (Bessel's method)
(iii) Trial & Error Method (Lehman's method

→ Two point Problem :-

→ Same statement of three
→ only replace three from two

Date: / / Page no:

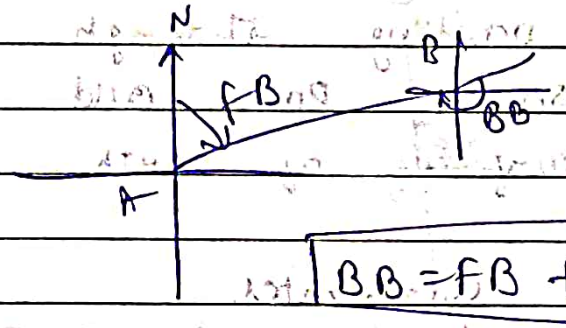
(5) Fore Bearing & Back Bearing :-

(1) Fore bearing :-

(2) Back bearing :- It is the bearing of any survey line in the backward path in the survey

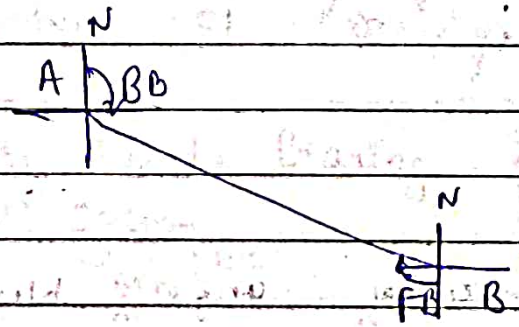
Relationship b/w FB & BB

Case I ⇒ when FB < 180



$$\boxed{BB = FB + BD}$$

Case II when FB > BD.



$$\boxed{BB = FB - 180}$$

Proof :- Convert the following FB into BB

① 200° 50' ② 40° 17'

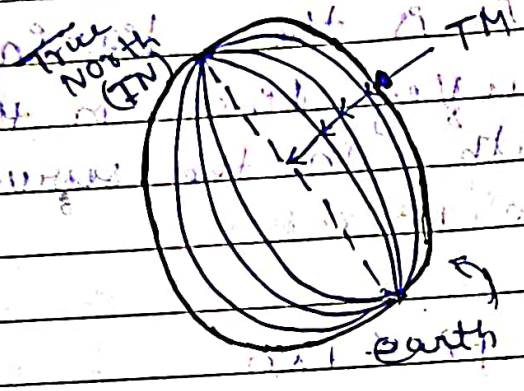
③ 535° E ④ N 23° 48' W

Chapter-5
Compass-surveying

Date: / / Page no:

Basic Terms:

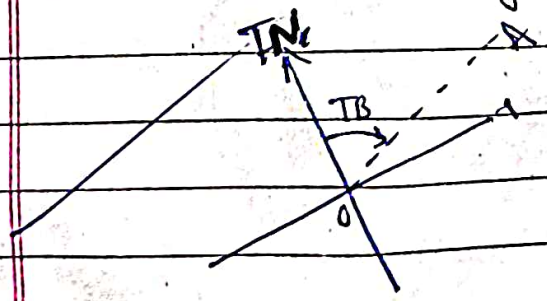
(1) True Meridian (TM):



→ Imaginary line passing through geograph North and South pole and any of point at surface of earth.

→ It is a universal coordinates.

(2) True Bearing (TB):

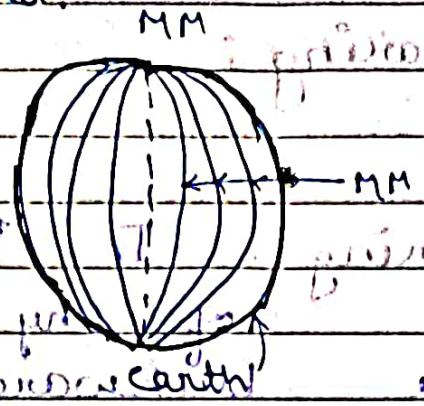


It is the horizontal angle b/w the tru meridian and a survey line

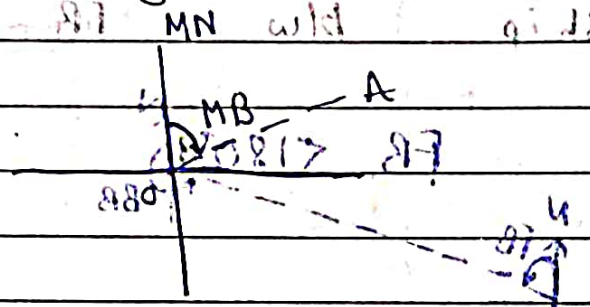
(3) Magnetic meridian (MM):

→ Imaginary line passing through magnetic North and South pole and any of point at surface of earth

→ It is the coordinates which are affected by magnetic field.

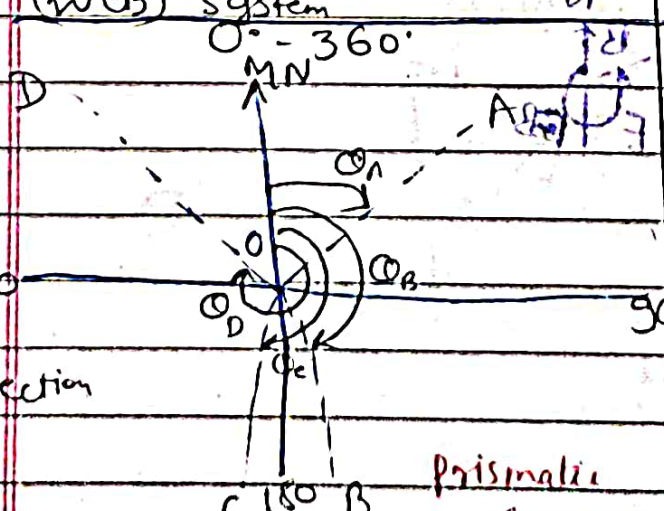
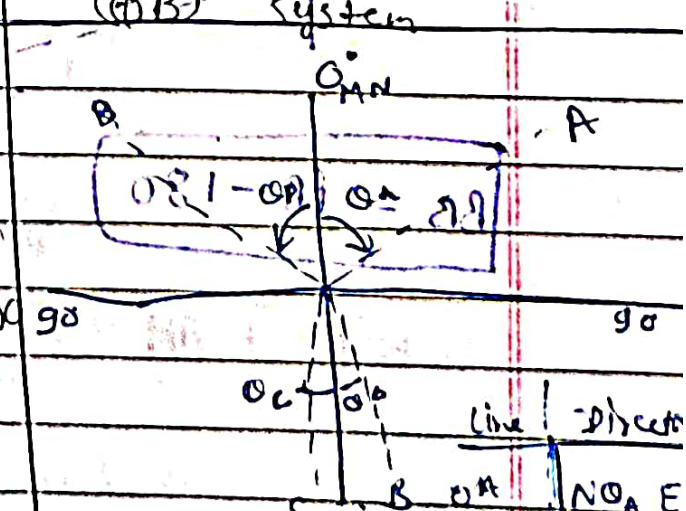


(4) Magnetic Bearing (MB)



It is the horizontal angle b/w the magnetic meridian and a survey line.

(5) System of Bearing

Whole Circle Bearing (WCB) System	Quadrant Bearing (QB) System
	
Prismatic Compass	Surveyor Compass

Line	Direction
OA	Q_A
OB	Q_B
OC	Q_C
OD	Q_D

Line	Direction
OA	$NQ_A E$
OB	$SQ_B E$
OC	$SQ_C W$
OD	

Date: / / Page no:

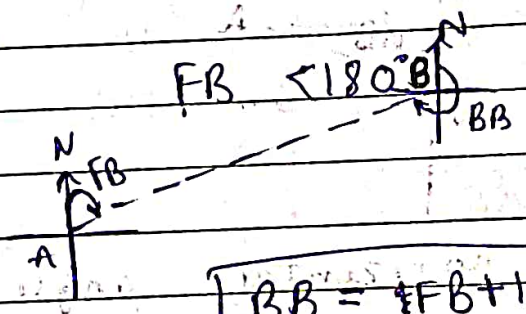
(5) Fore Bearing & Back Bearing:

(i) fore bearing :-

(ii) Back bearing :- It is the bearing of any survey line in the backward of the surv

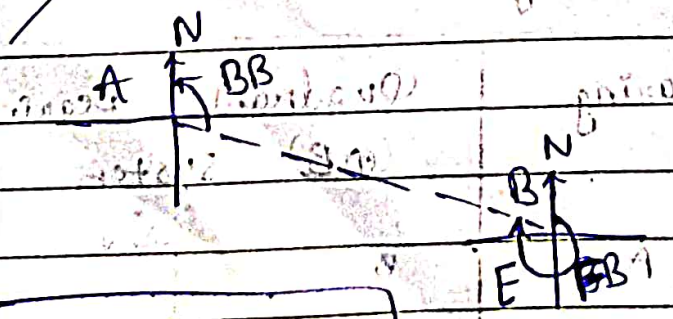
→ Relationship b/w FB & BB

case-I- When FB < 180°



$$BB = FB + 180$$

Case II- when FB > 180°



$$BB = FB - 180$$

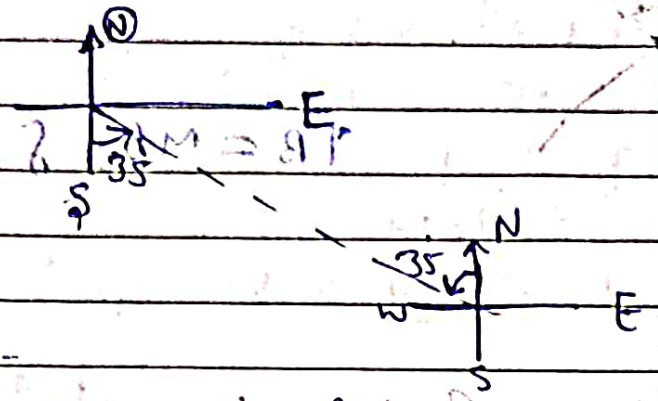
Date: / / Page no:

★ Problem:- Convert the following FB into BB

(i) 200° 50' (ii) 40° 11'

(iii) S35°E (iv) N23° 18' W

Solve ⇒ (iii)

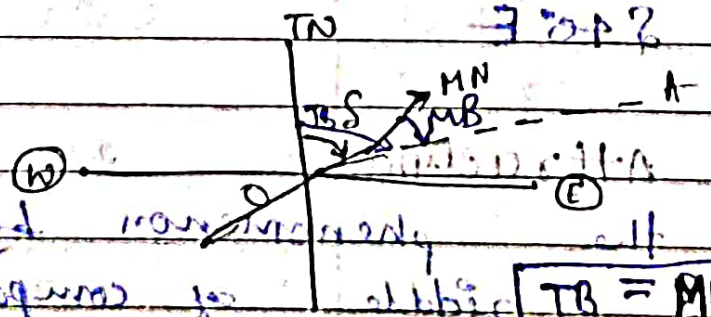


Ans ⇒ N 35°W

(6) Magnetic Declination (δ)

It is the horizontal angle b/w the true meridian and magnetic meridian

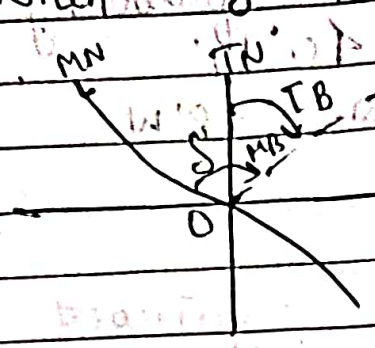
Case I when δ towards (E)



$$\boxed{TB = MB + \delta}$$

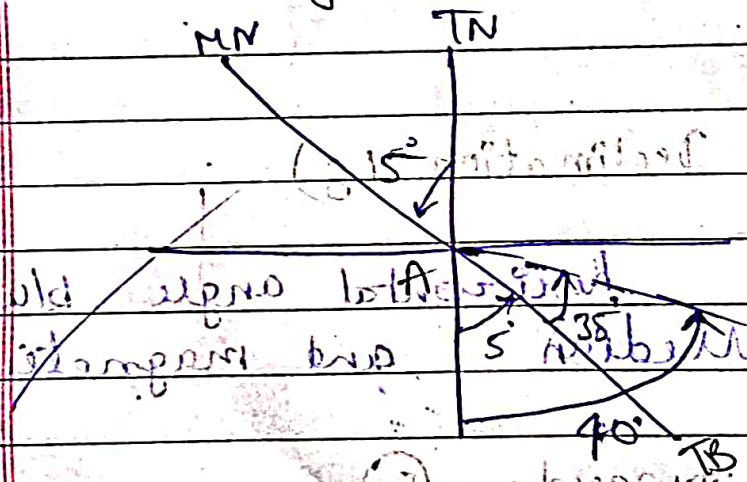
Date: / / Page no:

Case (2) When δ towards (W)



$TB = MB - \delta$

Q Determine the True bearing of survey line AB. If the magnetic bearing is South 35° east & declination is 5° west.



Ans ⇒ δ 40° E

(7) Local Attraction:-

It is the phenomenon by which the magnetic = BT Needle of compass is deviated from the true magn north direction due to the pre of local magnetic field.

How to detect?

It can be find out by taking diff b/w FB & BB of any survey line. If it comes out 180° then go the forming station are not affected local station other wise it is affected by local station

Numerical

Q1 The following Bearings were taken in running up closed travers while surveying in Bhopal.

Sol

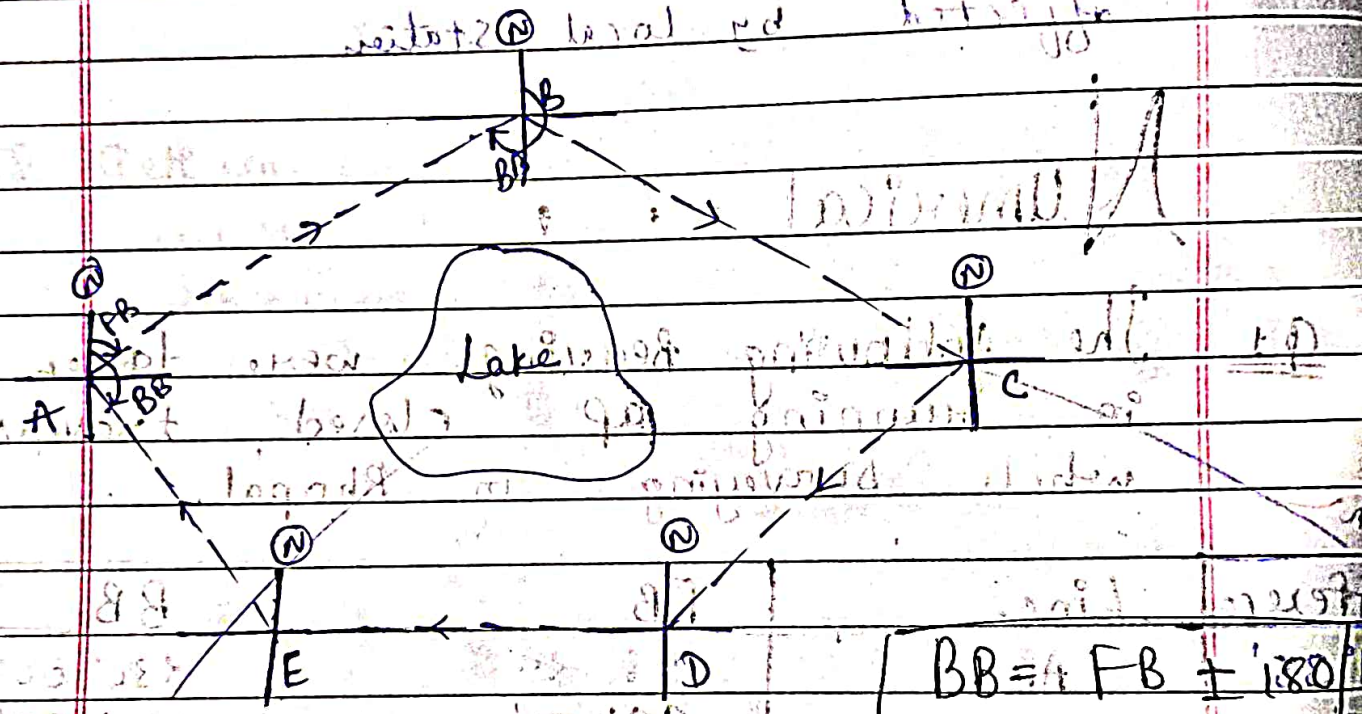
Difference	Line	FB	BB
181° 35'	AB	048° 25'	230° 00'
180°		48° 55'	228° 55'
178° 5'	BC	177° 45'	356° 00'
180°		176° 40'	356° 40'
180° 40'	CD	104° 15'	284° 55'
180°		104° 55'	
180° 00'	DE	165° 15'	345° 15'
180°			
180° 30'	EA	259° 30'	79° 00'
180°			79° 30'

Date: / / Page no:

→ State the stations which are affected by local attraction and how much

→ Determine the ~~true~~ corrected bearing

→ Determine the true bearing if the declination is 3°30' W



$$BB = FB \pm 180$$

+ve FB < 180

−ve FB > 180°

Station	L-A
A	−300
B	+1.05
C	−40

★ Remote sensing:-

It is a technique to get information about an object without making any physical contact with the object.

It uses sensors to detect the object on earth surface over atmosphere or over water body.

e.g:- Camera, scanner, human beings etc.

These sensors are classified into two

(a) Passive sensor:- It uses an existing source of energy

(b) Active sensor:- It uses man made or artificial source of energy for data collection

★ Resolution in remote sensing:-

In a remote sensing the term resolution is used represent resolving power which helps in identifying the presence of two objects and about their properties.

Here, sensors are analyse in term of following resolution.

(a) Spectral resolution:- It represents color bands which

Date: / / Page no:

visible in the image.

(b) Special resolution: It discribes how much in detail in a image is visible.

(c) temporor resolution: It discribes the no of times an object assembled and how often data obtained about it.

(d) radiometric resolution: It is significe the sensitivity of sensor.

UNIT-3

Mapping & Sensing

Date: / / Page no:

Introduction:-

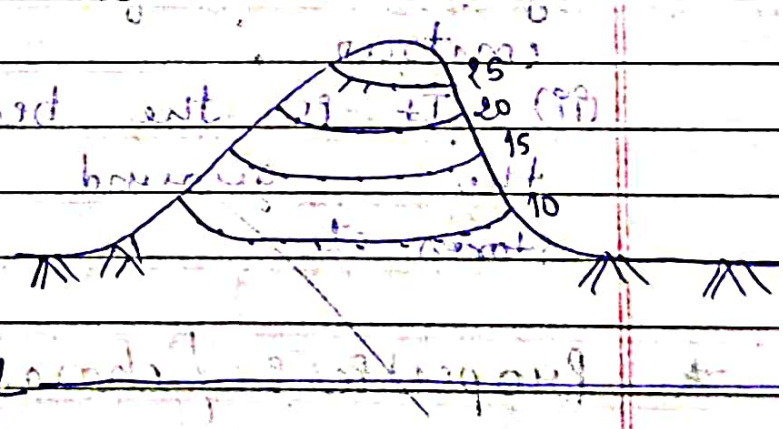
→ If the relative height are shown in the map are called ~~mapping~~ Topographical map.

→ Topographical maps are nothing but the contour maps in which relative heights are shown with the help of contour.

→ It is the best representation of the ground

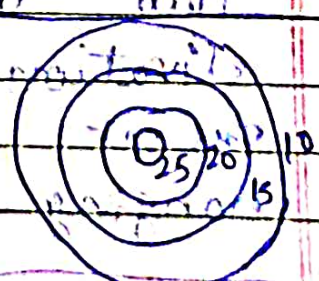
Basic terms:-

1) Contour / contour line :-



It is the imaginary line which join the same elevated point.

Contour map →



Date: / / Page no:

(2) Contour Interval (C.I.):- It is the vertical difference between any two consecutive contours. It is the fixed value for the contour map.

(3) Horizontal equivalent (HE) It is the horizontal diff. between any two consecutive contour to contour at any point.

(ii) It is not fixed value and varies point to point.

(4) Contour map:- It is the horizontal vertical representation of ground feature with the help of contour.

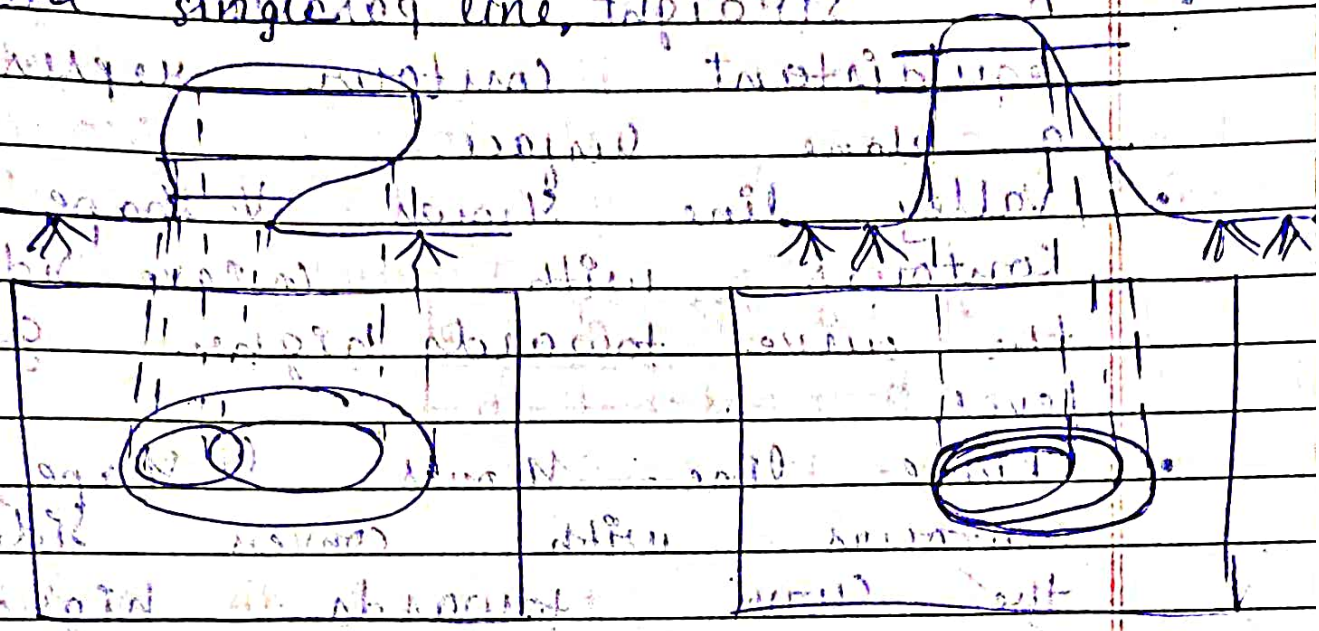
(ii) It is the best method to represent the ground features like mountains, stores etc.

★ Properties:- / characteristics of contours:-

- A contour line cannot split into two lines.
- Two contour lines of different elevations cannot cross each other except in the case of overhanging diff.

Date: / / Page no:

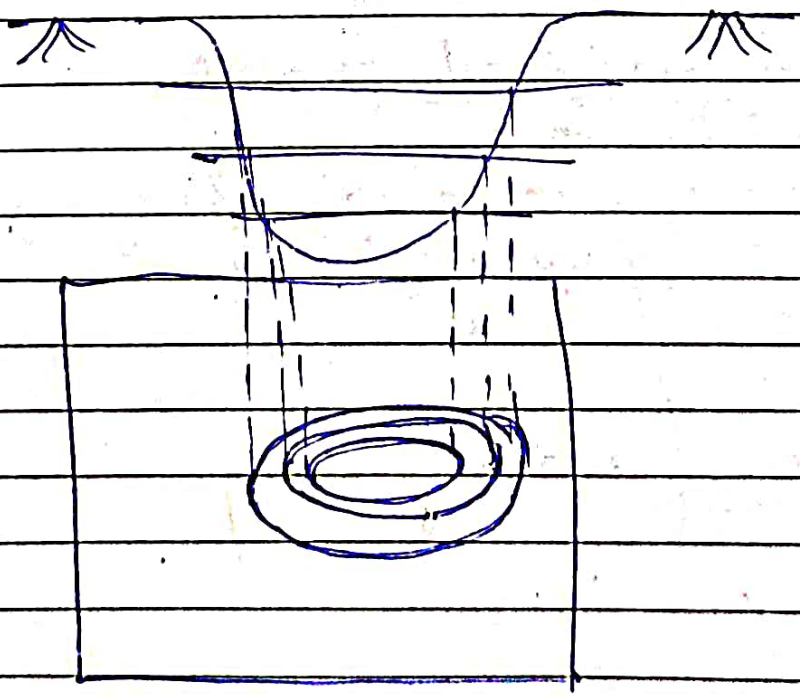
- In the case of vertical cliff the contour are united to from a singlong line.



contour plan

- Close contour inside higher one represent a hill and inside lower one represents depression.

- Parallel contour indicates inclined plane.



Date: / / Page no:

2. Average ordinate Rule

$$A = \frac{\text{sum of ordinate} \times \text{length of Base line}}{\text{No. of ordinate}}$$

$$= \frac{O_1 + O_2 + O_3 + \dots}{n+1}$$

$$\boxed{A = \frac{\Sigma O}{n+1} \times L}$$

3. Trapezoidal Rule:

$$A = \frac{\text{Common Interval}}{2}\left[\text{first ordinate} + \text{last ordinates} + 2 \times \text{sum of remaining ordinates}\right]$$

$$\boxed{A = \frac{d}{2}\left[O_{first} + O_{last} + 2\sum O_{rest}\right]}$$

4. Simpson's Rule:

It is applicable only for "odd No. of ordinates".

$$\boxed{A = \frac{d}{3}\left[O_{first} + O_{last} + 4\sum O_{even} + 2\sum\right.}$$

Date: / / Page no:

Engi. Mechanics (Mechanics of Rigid

UNIT- 4

i. Introduction of engineering mechanic
ii. composition & resolution of forces
iii. Equilibrium of forces
iv. Trasses
v. Friction.

UNIT - 5

i. Centroid
Centre of gravity
moment of Inertia
IMP ii. Shear force and bending momen

Theoretical
computational
experimental

* Engg. Mechanics :-
The subject of engg. mechanics is the branch of applied sources which deals with the laws and principles alongs with their application to it. Knowledge of engg. mechanics is very essencial for a engg. in planning, designing and construction of various structure and machines.

* Division of Engg. mechanics.

1. Statics :-
It is the branch of engg. mechanics which deals with the rigid body at rest.

2. Dynamics :-
It is the branch of engg mechanics which deal with the rigid body at motion.

(a) Kinetics :- force को निकालते हैं।
It is the branch of dynamics which deals with body is in motion due to application of forces.

(b) Kinematics :- force नहीं निकालते हैं। बस वो किस dimension मे है पता करते हैं one dim, 2dim etc.
It is that branch of dynamics which deals with body is in motions without any reference of force which are responsible for the motion.

Date: / / Page no:

* Force:-

The force is an imp factor in the of biomechanics which may be broadly defined as an agent which produces or tends to produce, destroys or tends to destroys motion.

* Effects of force:-

It may change the motion of a body i.e. If a body is at rest the force may set it in motion.

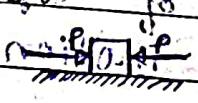
And If the body is already in motion the force may accelerate it.

The body may retard the motion of a body.

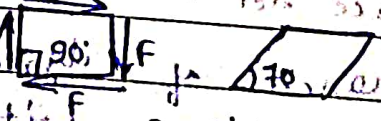
* Types of forces:-

1) Tensile force:-

2) Compressive force:-



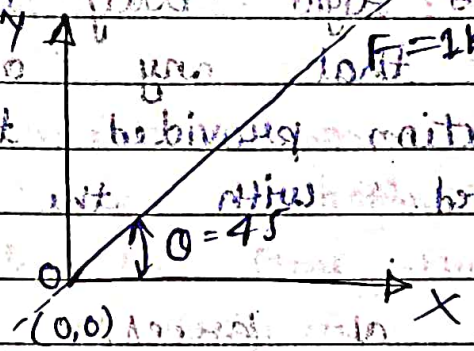
3) Shear force:-



Date: / / Page no:

★ Characteristics of Forces

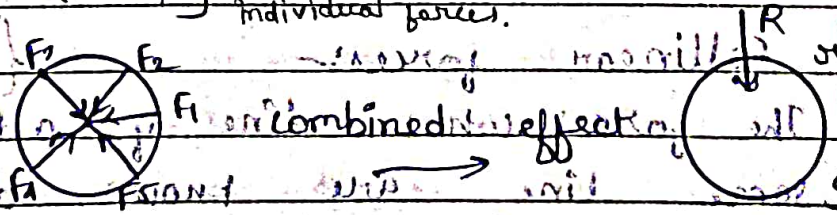
1) Magnitude of force (KN, N ...)
2) Direction of force / Line of action of force.
3) Nature of force (tensile, compressive, shear)
4) Point of application of forces

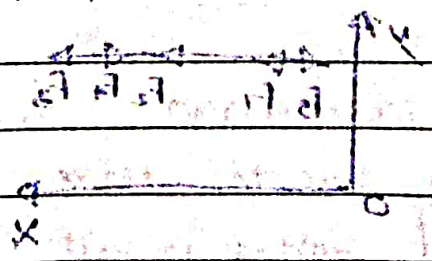


★ Principle of physical Indipendence of forces:-

It states "If a number of forces are simultaneously acting on a particle then the resultant of this forces will have the same effect as produced by all the forces".

Note { एक एक किलो के पाँच पत्थरों को पाँच किलो के एक पत्थर से replace कर सकते है। } means resultant forces has equal effect as individual forces.





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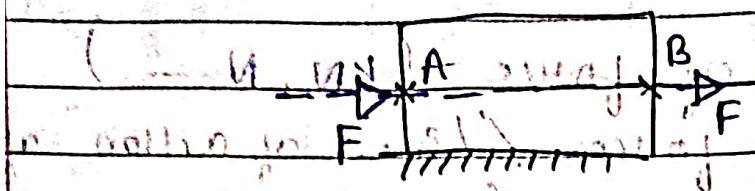
Principle of transmissibility of forces:



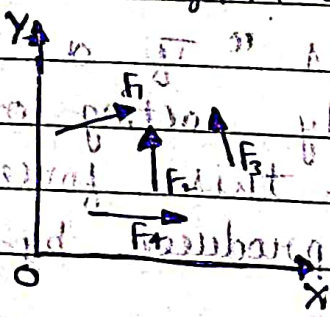
A और B Point एक line में पड़े हो तो एक ही force का effect दोनों पर होगा।

It states "If a ~~no force~~ force had that any point on a rigid body it may also be considered to act that any other point on its line of action provided this point is rigidly connected with the body

System of forces:-

When two or more forces act on a body to form a system of forces, they are called

Coplanar forces:-



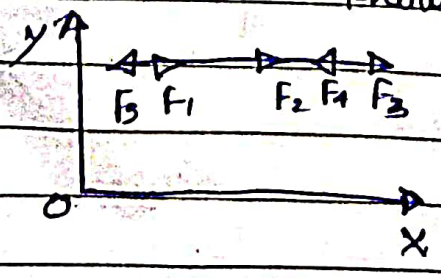
{same plane}

The forces whose line of action lie on a same plane are known as coplanar forces.

Collinear forces:-

{same line}

The forces whose line of action lie on a same line are known as collinear forces



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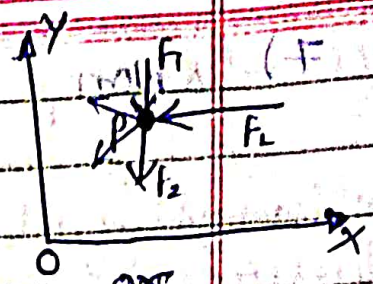
3) Concurrent forces:- {same point}

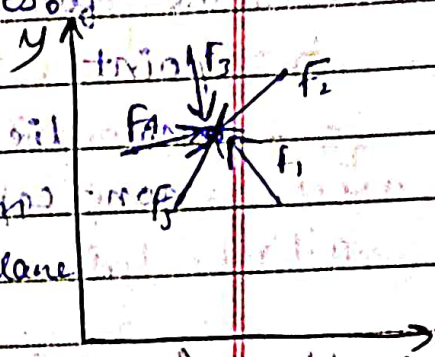
The forces which meet at one point are known as concurrent forces. The concurrent force may or may not be collinear.



4) Coplanar Concurrent forces:-

The forces which meet at one point then the line of actions also lie in the same plane are known as coplanar concurrent force.

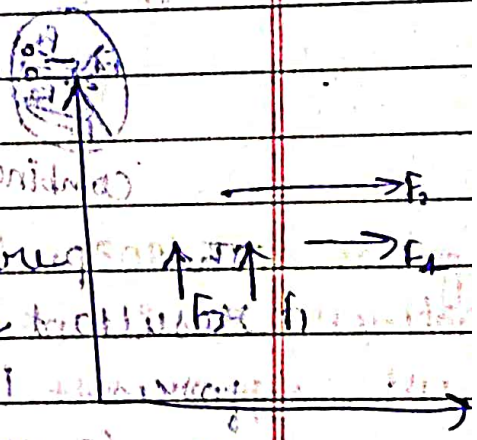
(i) $\Sigma H = 0$
(ii) $\Sigma V = 0$



5) Co-Planer Non-concurrent forces

The forces which do not meet at one point but there line of actions lie on the same plane are known as co planer Non-concurrent forces.

(i) $\Sigma H = 0$ sum of Horizontal forces
(ii) $\Sigma V = 0$ sum vertically
(iii) $\Sigma M_e = 0$ sum moment of force

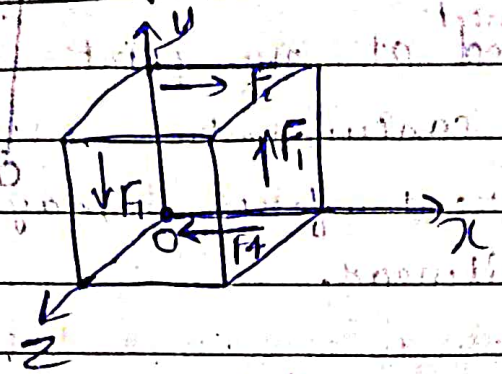


6) Non-Coplanar Concurrent forces:-

The forces which meet at one point but there line of action do not lie on the same plane.

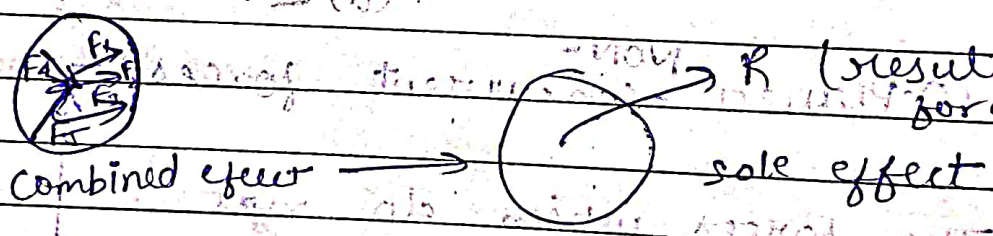
Date: / / Page no:

7) Non coplanar Non concurrent



The forces which do not meet at one point and their lines of action do not lie on same plane are called non-coplanar non-concurrent forces.

Composition of forces:-



The process of finding out the resultant force of a no. of given forces is called composition of force or compounding of forces.

* Method for resultant forces:-

(1) Analytical method.

(2) Method of resolution.

(1) Analytical method:- (i) law of ||gram of forces

(ii) method of resolution.

Date: / / Page no:

(i) Law of parallelogram of forces:-

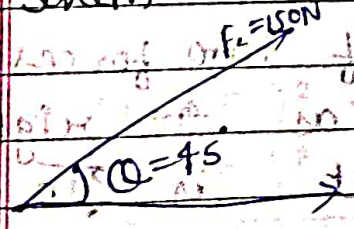
It states:- "If two forces acting simultaneously on a particle be represents in magnitude and direction by the two adjecent sides of parallelogram. Their resultant may be represented in magnitude and direction by the diagonal of the parallelogram which passes through their point of intersection.

$$R = \sqrt{P^2 + Q^2 + 2PQ\cos\theta} \quad \text{— (1)}$$

magnitude of resultant that force (R)

$$\tan\alpha = \frac{Q\sin\theta}{P + Q\cos\theta} \quad \text{— (2)}$$

Q. two forces of 100 N and 150 N are acting simultaneously at a point is a resultant of this two forces. If the angle b/w them is 45°



$F_1 = 100 N$

$F_2 = 150 N$

$$R = \sqrt{F_1^2 + F_2^2 + 2F_1F_2\cos\theta}$$

$$R = \sqrt{(100)^2 + (150)^2 + 2(100)(150)\cdot\cos 45}$$

$$R = 232 N$$

Date: / / Page no:

Q.2 Two forces may angle of 120° The bigger force is a 40 N and the resultant is perpendicular to smaller one. Find the smaller force.

F_1 = Bigger force = 40 N

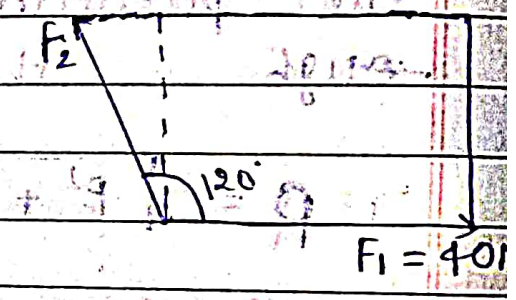
F_2 = Smaller force = ?

$\theta = 120°$ $(F_1 \wedge F_2)$

$90°$ $(F_2 \wedge R)$

$\theta, \alpha_1 = 120° - 90°$

$= 30°$



$$\tan\alpha = \frac{F_2 \sin\theta}{F_1 + F_2 \cos\theta}$$

$$\tan 30° = \frac{f_2 \sin(120)}{40 + f_2 \cos(120)}$$

$f_2 = 20$ N

Q 3 Find the magnitude of two forces such that if they act as 90 right angle their resultant is $\sqrt{10}$ N. but if they act as 60° their resultant is $\sqrt{13}$ N.

Date: / / Page no

Solve ⇒ 3

Case - I

$F_1 \wedge F_2 = \theta = 90^\circ$, $R = \sqrt{10}$ N

Case - II

$F_1 \wedge F_2 = \theta = 60^\circ$, $R = \sqrt{13}$ N

To determine :-

(i) $F_1 = ?$

(ii) $F_2 = ?$

$R = \sqrt{F_1^2 + F_2^2 + 2F_1F_2}$

$10 = F_1^2 + F_2^2 + 2F$

$10 = F_1^2 + F_2^2$

$13 = F_1^2 + F_2^2 + 2F_1F_2 \times 1$

$13 = F_1^2 + F_2^2 + F_1F_2$

by eq. (1)

$13 = 10 + F_1F_2$

$\boxed{F_1F_2 = 3}$ — (2)

Mathematical Calculations

$(F_1 + F_2)^2 = F_1^2 + F_2^2 + 2F_1F_2$

$(F_1 + F_2)^2 = 10 + 2 \times 3$ by eq. (1)

$(F_1 + F_2)^2 = 16$

$\boxed{F_1 + F_2 = 4}$ — (3)

$(F_1 - F_2)^2 = F_1^2 + F_2^2 - 2F_1F_2$

$= 10 - 2 \times 3$

$F_1 - F_2 = \sqrt{4}$

$\boxed{F_1 - F_2 = 2}$ — (4)

Date: / / Page no:

Now solving eq. ③ and eq. ④

$F_1 = 3N$ $F_2 = 1N$ Ans

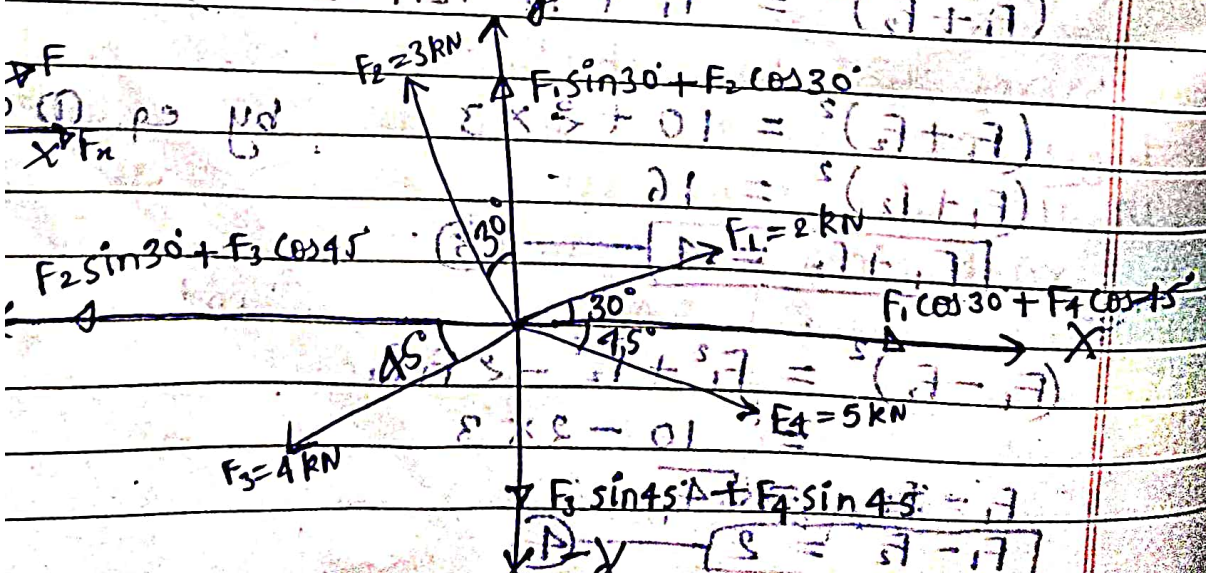
Resolution of a force:-

Principle of resolution :-

~~Write~~ The process of spliting of the given force into no. of components without changing its effect on the body is called resolution of a force.

Principle of resolution :-

It states The algebric sum of the resolved parts of a no. of forces in a given direction is equal to the resolved part of the resultant in the same direct



Date: / / Page no:

$\Sigma F_x = \Sigma H \rightarrow (+, -)$

$\Sigma F_y = \Sigma V \rightarrow (+, -)$

$+ \Sigma F_x = \Sigma H = \boxed{F_1 \cos 30^\circ + F_4 \cos 45^\circ - F_3 \cos 45^\circ - F_2 \sin 30^\circ}$

$+ \Sigma F_y = \Sigma V = \boxed{F_1 \sin 30^\circ + F_2 \cos 30^\circ - F_3 \sin 45^\circ - F_4 \sin 45^\circ}$

$$R = \sqrt{(\Sigma F_x)^2 + (\Sigma F_y)^2} \quad \text{—— (1)}$$

$$\tan\alpha = \frac{\Sigma F_y}{\Sigma F_x} \quad \text{—— (2)}$$

* Location of resultant force :-

→ When ΣV is positive then resultant makes angle between 0° to 180°

→ When ΣV is negative the resultant make angle between 180° to 360°

→ When ΣH is positive the resultant make angle between 0° to 90° or 270° to 360°

→ When ΣH is negative the resultant makes angle between 90° to 270°

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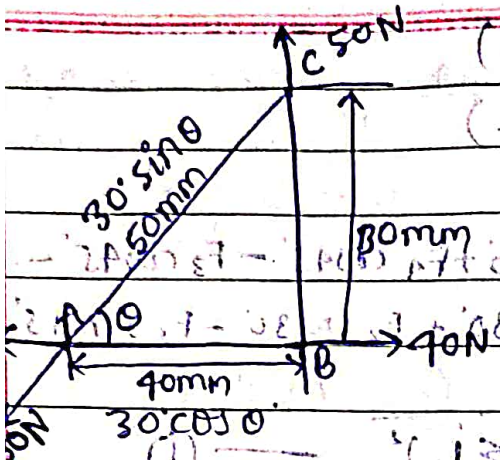
Date: / / Page no:



$R = ?$

$\alpha = ?$

$(B/H)\cos\theta = \frac{AB}{AC} = \frac{40}{50} =$

$(P/H)\sin\theta = BC/AC = 30/50$

$\Sigma H = 40 - 30\cos\theta = 40 - 30 \times 0.8 = 16\,N$

$\Sigma V = 50 - 30\sin\theta = 50 - 30 \times 0.6 = 32\,N$

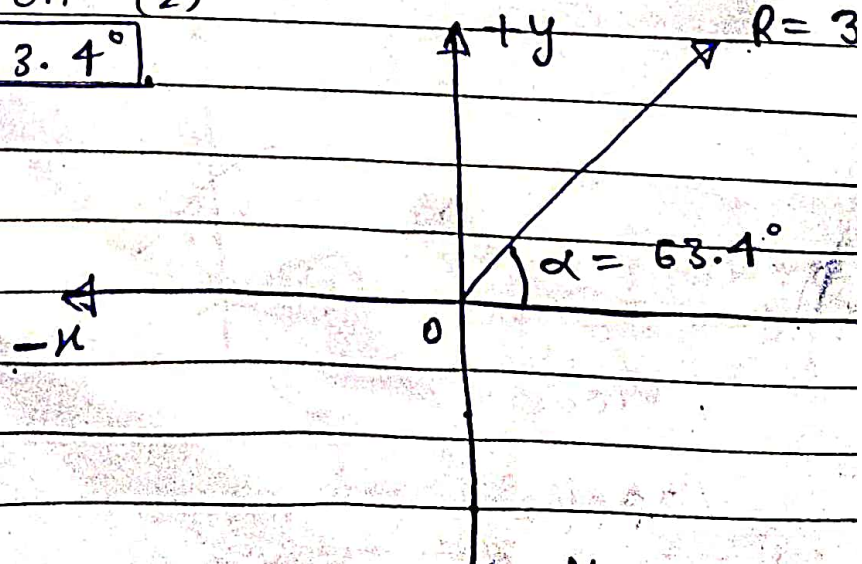
$R = \sqrt{(\Sigma H)^2 + (\Sigma V)^2} = \sqrt{(16)^2 + (32)^2}$

$\boxed{R = 35.8\,N}$

$\tan\alpha = \frac{\Sigma V}{\Sigma H} = \frac{32}{16}$

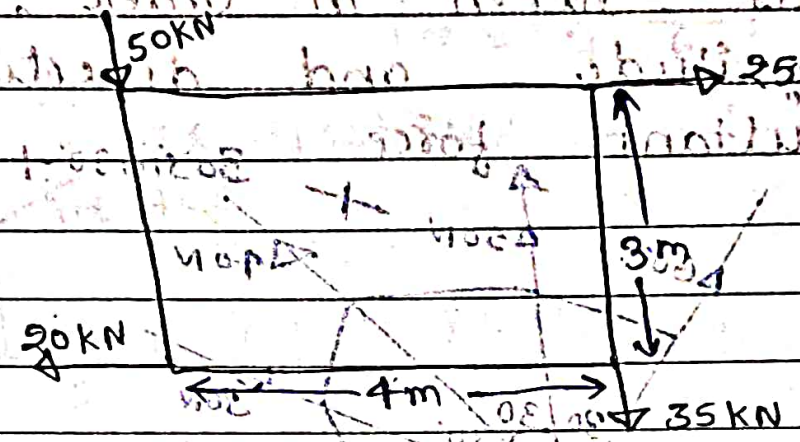
$\alpha = \tan^{-1}(2)$

$\boxed{\alpha = 63.4^\circ}$



Date: / / Page no:

ystem of forces are acting at the
ers of the rectangular block.
rmine the magnitude and direction
the resultant force.



$\Sigma H = 25 - 20 = 5\ KN \longrightarrow$ (0-90 / 270°-360)

$\Sigma V = -50 - 35 = -85\ KN \longrightarrow$ (180° - 360°)

$R = \sqrt{(\Sigma H)^2 + (\Sigma V)^2} \Rightarrow \sqrt{(5)^2 + (-85)^2}$

$\boxed{R = 85.15\ KN}$

Direction of resultant force $= \tan\alpha = \frac{\Sigma V}{\Sigma H} = \frac{-85}{5}$

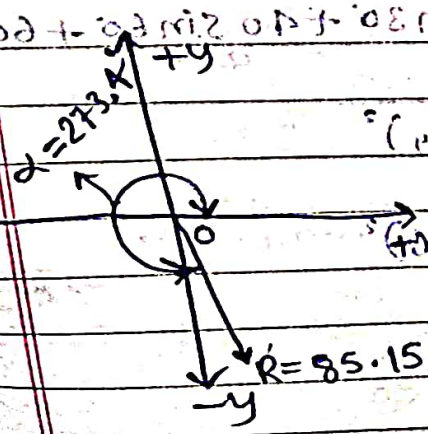
$\tan\alpha = -17$

$\alpha = \tan^{-1}(-17)$

$\alpha = -86.6°$

$\alpha = 360° - 86.6° = 273.4$

$\boxed{\alpha = 273.4°}$

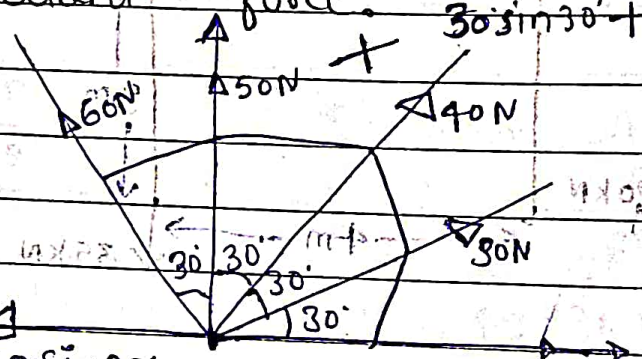


3

Date: / / Page no:

The forces 20N, 30N, 40N, 50N and 60N are acting at one of the angular point of a regular Hexagon towards the other 5 angular points, taken in order. Find the magnitude and direction of the resultant force.

$\Rightarrow$ $30\sin 30° + 40\sin 60° + 60$

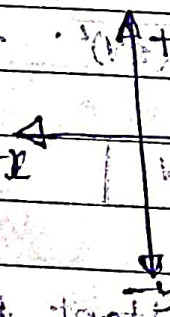


$60\sin 30°$

To find:

(i) $R = ?$

(ii) $\alpha = ?$



$\Sigma F_x = \Sigma H = 20 + 30\cos 30 + 40\cos 60 - 60\sin$

$\Sigma F_y = \Sigma V = 50 + 30\sin 30° + 40\sin 60° + 60$

$R = \sqrt{(\Sigma F_x)^2 + (\Sigma F_y)^2}$

$R = \sqrt{(36)^2 + (151.6)^2}$

$\boxed{R = 155.8\ N}$

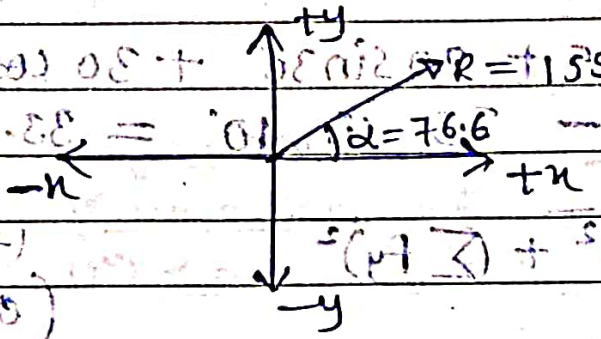
Date: / / Page no:

② Direction of resultant force

$$\tan\alpha = \frac{\Sigma F_y}{\Sigma F_x} = \frac{15.6}{3.6}$$

$$\alpha = \tan^{-1}(x)$$

$$\boxed{\alpha = 76.6^\circ}$$



Q. The following forces act at a point

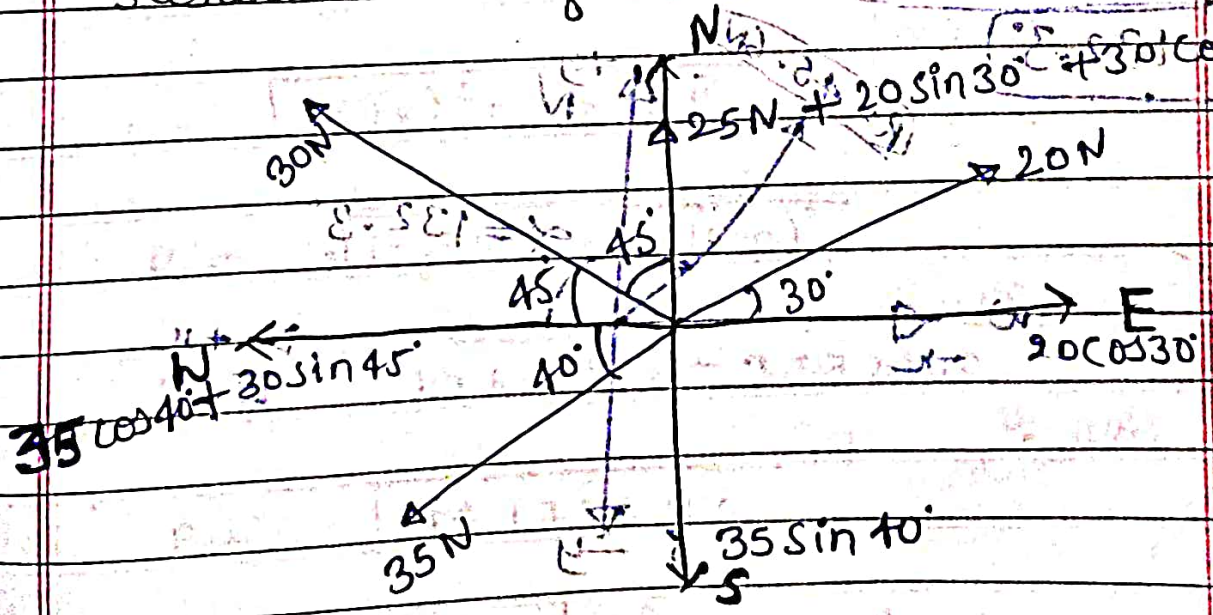
① 20 N, inclined 30° towards North of east.

② 25 N towards North.

③ 30 N towards North West

④ 35 N inclined at 40° towards South of West.

Find magnitude & direction of resultant force



Force diagram

Date: / / Page no:

Find

$R = ?$

$\alpha = ?$

$\sum F_x = \sum H = 20\cos 30^\circ - 35\cos 40 - 30\sin$

$= -30$

$\sum F_y = \sum V = 25 + 20\sin 30^\circ + 30\cos 45^\circ$

$- 35\sin 40^\circ = 33.7\,N$

$R = \sqrt{(\sum F_x)^2 + (\sum F_y)^2}$

$R = \sqrt{(-30.7)^2 + (33.7)^2}$

$\boxed{R = 45.6\,N}$

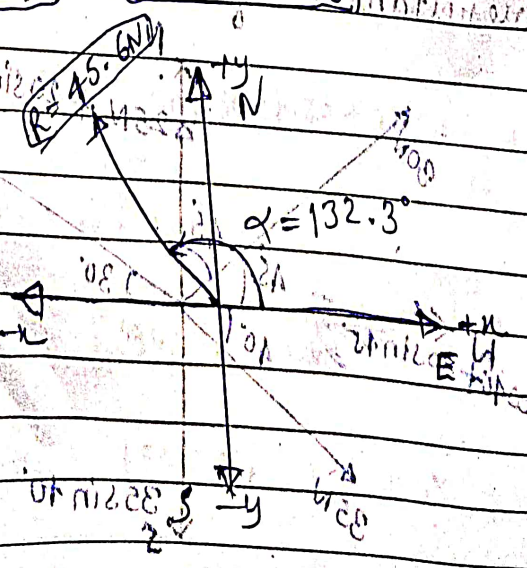
Direction of resultant force =

$\tan\alpha = \frac{\sum F_y}{\sum F_x} = \frac{33.7}{-30.7}$

$180^\circ - 47.70$

$\boxed{\alpha = -47.70}$

132.3°



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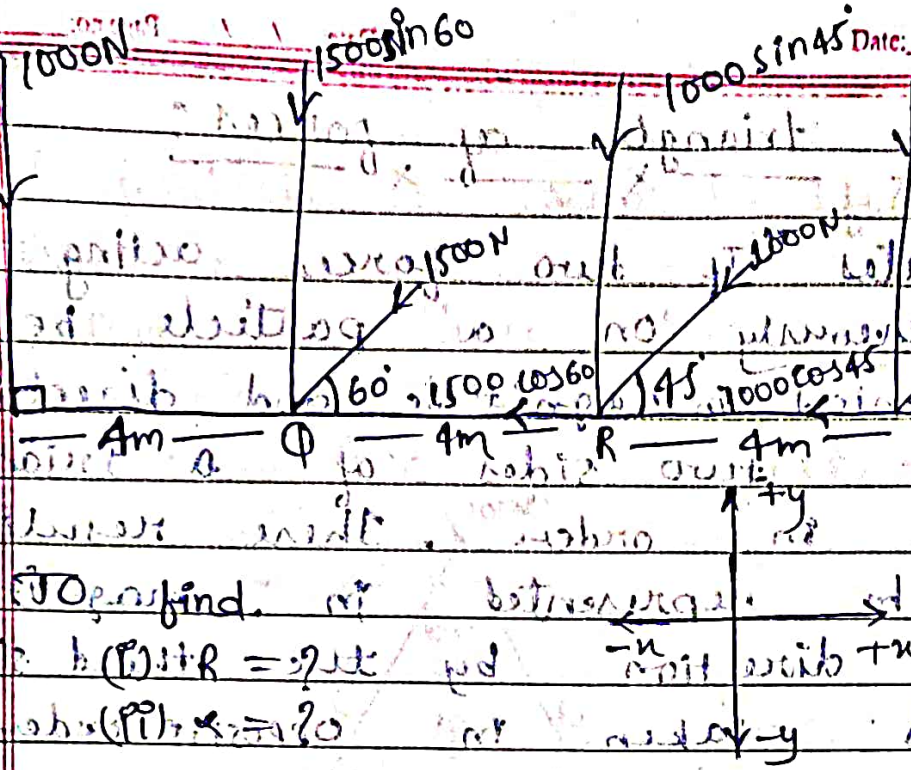


$\sum F_x = \sum H = -1500\cos 60 - 1000\cos 45 + 500\cos 30 = -1890N$

$\sum F_y = \sum V = -1000 - 1500\sin 60 - 1000\sin 45 - 500\sin 30 = -3256N.$

Direction of resultant force $= \tan\alpha = \frac{\sum F_y}{\sum F_x}$

$\tan\alpha = \frac{-3256}{-1890}$

$\alpha = 59.8°$

$R = \sqrt{(\sum F_x)^2 + (\sum F_y)^2}$

$R = \sqrt{(-3256)^2 + (-1890)^2}$

$R = \sqrt{10601536 + 3572100}$

$R = \sqrt{14173636}$

$R = 3764.788$

① Law of triangle of forces.
② Law of polygon of forces.

Date: / / Page no:

Law of triangle of forces:

It states "If two forces acting simultaneously on a particle be represented in magnitude and direction by the two sides of a triangle taken in order. These resultant may be represented in magnitude and direction by the third side of Δ taken in opposite order.

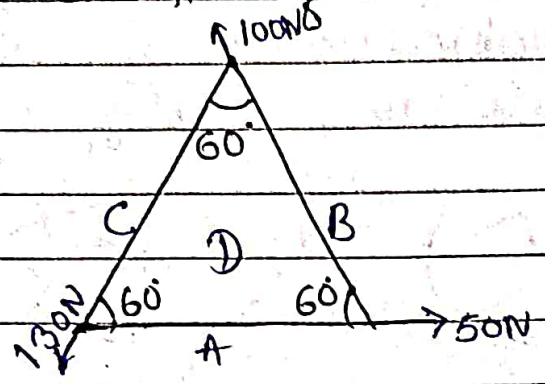
Law of polygon of forces:

It is an extension of law of Δ of forces. For more then two forces, Which states

"If a no. of forces acting simultaneously on a particle be represented in magnitude & direction by the sides of a polygon taken in order then the resultant of all these forces may be represented in magnitude & direction by the closing side of the polygon taken in opposite order.

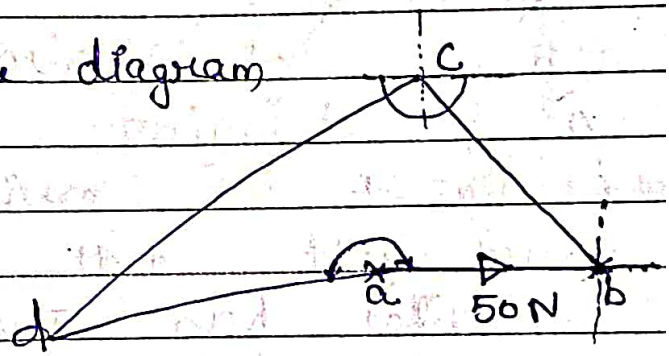
Date: / / Page no:

A particle is acted by 3 forces 50N, 100N...
along the three sides of an equi
Δ. Find geraphically the m
& direction of resultant force



Scale:-
20N

Space diagram



Unit-4

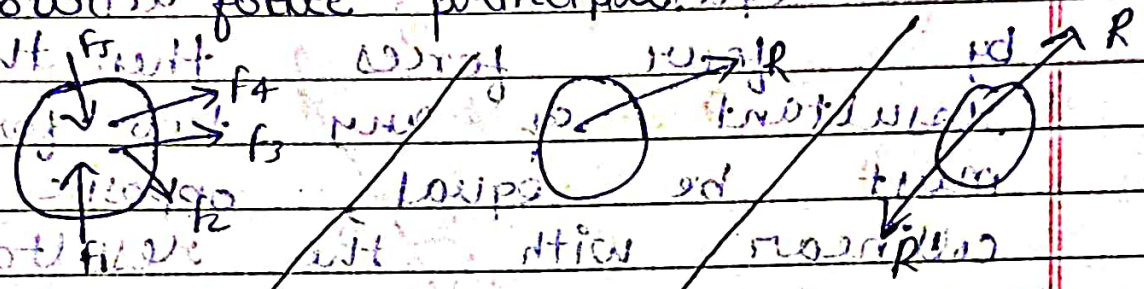
Chapter-3

Date: / / Page no:

Equilibrium of forces:

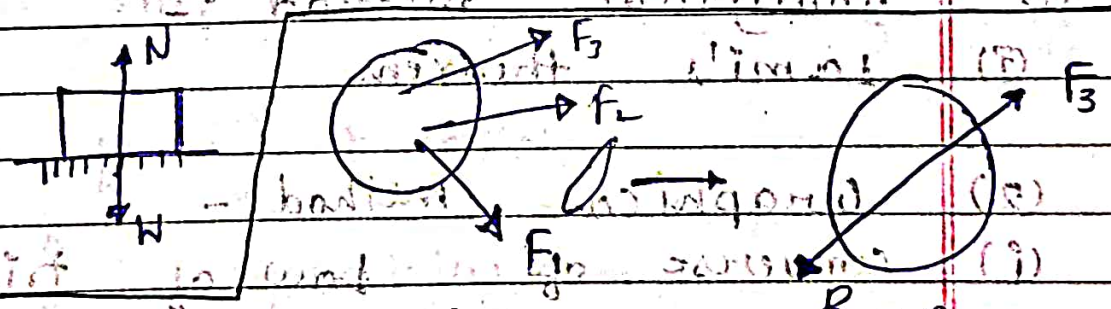
- Principle of equilibrium:

- Two force principle
- Three force principle
- Fourth force principle



Two force Principle:-

As per this principle if a body in equilibrium is acted upon by two forces then they must be equal opposite and collinear.

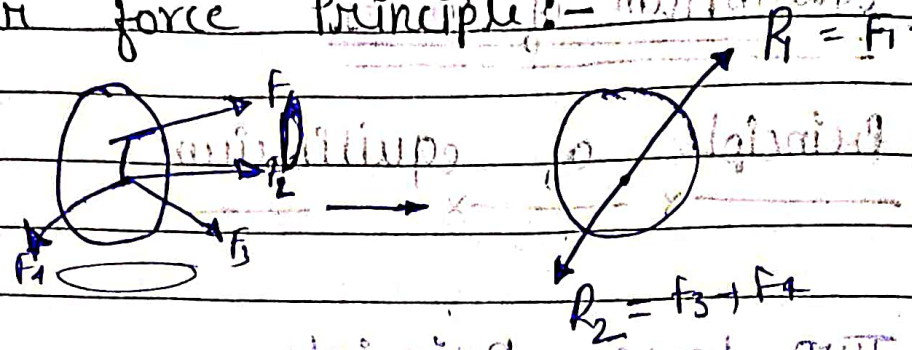


Three force principle:-

As per this principle, if a body in equilibrium is acted upon by three forces then the resultant of any two forces must be equal opposite and collinear with the third force.

Date: / / Page no:

Four force Principle:-



As per this principle if a body in equilibrium is acted upon by four forces then the resultant of any two forces must be equal, opposite and collinear with the resultant of other two forces.

Methods for equilibrium of coplanar forces:-

Analytical method :-

Lami's theorem

Graphical method :-

Converse of law of triangle of forces

Converse of law of polygon of forces

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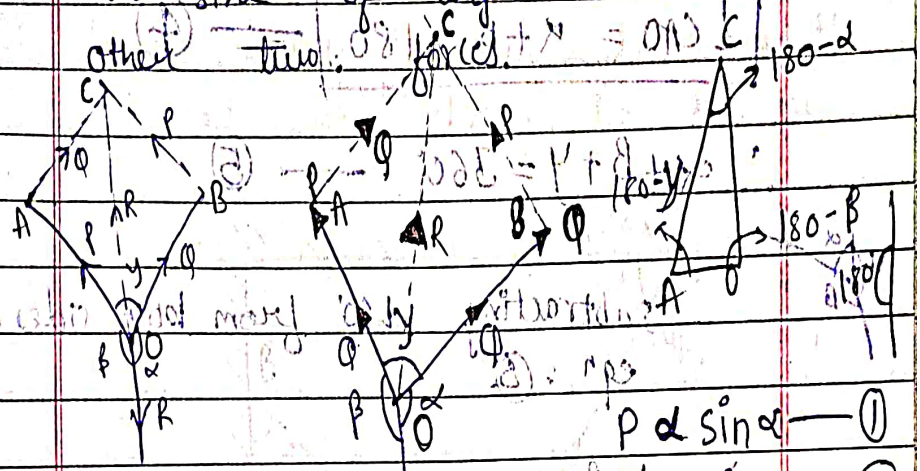
Date: / / Page no:

(1) Lami's theorem :-

- Statement →

If three coplanar forces acted at a point be in equilibrium then each force is proportional to the sine of angle between the other two forces.



$P \propto \sin\alpha$ — (1)

$Q \propto \sin\beta$ — (2)

$R \propto \sin\gamma$ — (3)

$$\frac{P}{\sin\alpha} = \frac{Q}{\sin\beta} = \frac{R}{\sin\gamma}$$

* Three forces principle
* Two forces principle
* Law of parallelogram of forces
* Sine rule (Principle of Triangle)

$OB = AC = Q$

$\angle AOC = 180 - \beta$

$\angle ACO = \angle BOC = 180 - \alpha$

Date: / / Page no:

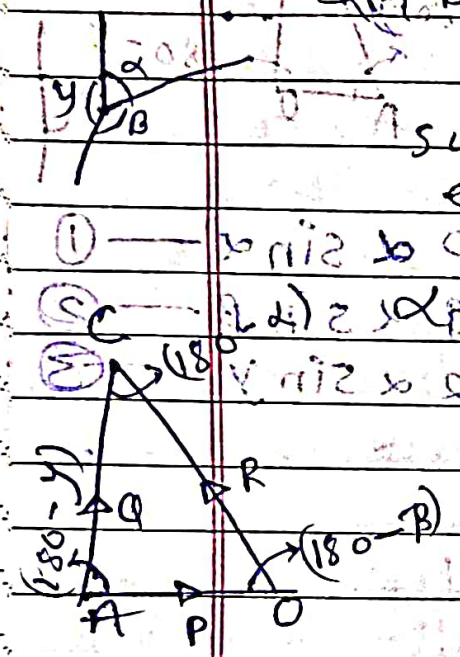
$\therefore \angle CAO = 180^\circ - [\angle AOC + \angle ACO]$ (1)

$\angle CAO = 180^\circ - [180 - \beta + 180 - \alpha]$

$\angle CAO = 180 - 180 + \beta - 180 + \alpha$

$\boxed{\angle CAO = \alpha + \beta - 180^\circ}$ — (4)

$\alpha + \beta + y = 360^\circ$ — (5)



subtracting 180° from both side of eqn. (5)

$\alpha + \beta - 180^\circ + y = 360^\circ - 180^\circ$

$\angle CAO + y = 180^\circ$

$\boxed{\angle CAO = 180^\circ - y}$ — (6)

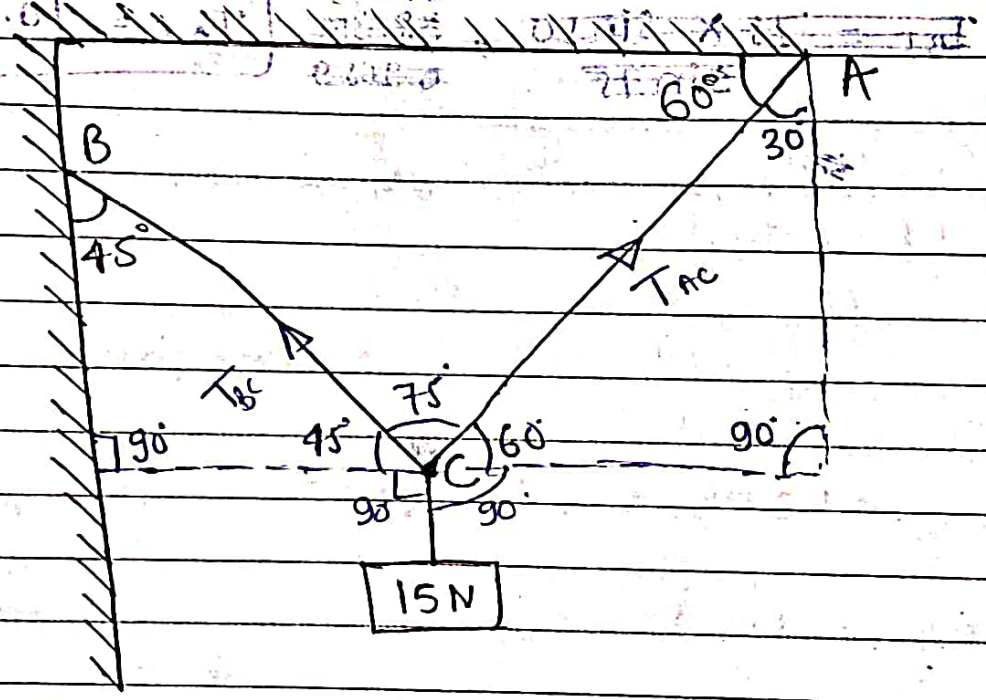
NOW applying Sine Rule from proportion of triangle, on ΔAOC

$$\frac{OA}{\sin(180-\alpha)} = \frac{AC}{\sin(180-\beta)} = \frac{OC}{\sin(180-y)}$$

$$\frac{P}{\sin\alpha} = \frac{Q}{\sin\beta} = \frac{R}{\sin y}$$

Date: / / Page no:

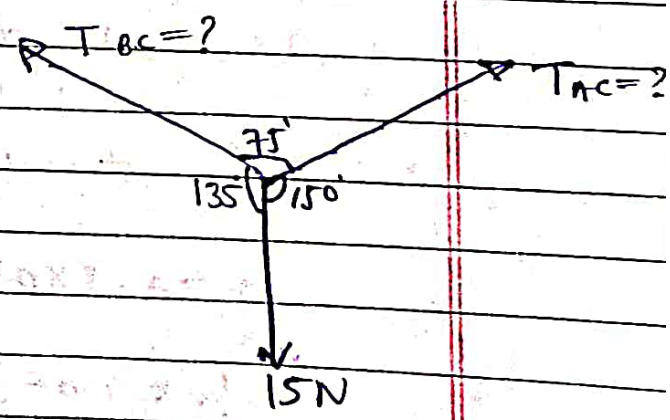
en ~~an~~ electric light ~~fixture~~ weighing
N. Hence from a point C by
strings ~~on~~ ~~electri~~ AC and BC
e string AC is inclined at 60°
o horizontal and BC at 45° to
he horizontal, as per diagram.
Using lami's theorem determine the
forces ~~of~~ in the string AC and BC.



To find:-

i) Tension T_{BC} = ?

(ii) Tension T_{AC} = ?



Date: / / Page no:

Now applying Lami's theorem Poin

$$\frac{T_{BC}}{\sin 50^\circ} = \frac{T_{AC}}{\sin 135} = \frac{15}{\sin 75^\circ}$$

$\boxed{T_{BC} = 7.76\ N}$ $\boxed{T_{AC} = 10.98\ N}$

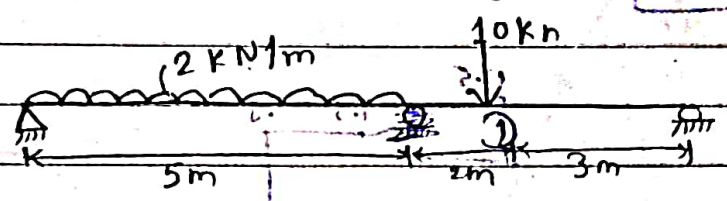
$$T_{AC} = \frac{15 \times \sin 135}{\sin 75}$$

$$\cancel{T_{BC} = \frac{15 \times \sin 50}{\sin 75}} = \cancel{\frac{11.49}{38.30}} \cancel{0.3659}$$

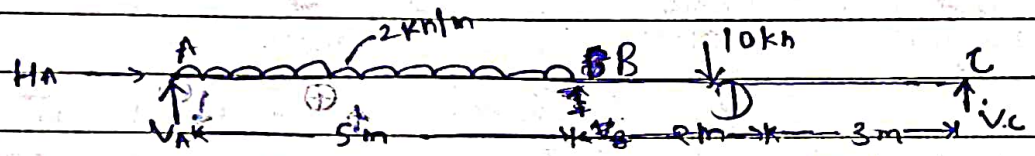
$\boxed{T_{AC} = 10.98}$

Date: / / Page no:

Prob: Draw the shear force diagram (SFD) and Bending moment Diagram (BMD) for the given beam.



solve⇒ Free body Diagram



SFD:

At support A

$SF_{A_L} = 0$ $SF_{A_R} = V_A = 10.5$ kN

Reaction

$\boxed{\Sigma V = 0}$ ↑ = ↓

$V_A + V_C = 2 \times 5 + 10.$

$V_A + C = 20$ ——— (1)

taking moment about 'A' = 0.

$-V_C \times 10 + 10 \times 7 + 10 \times 2.5 = 0$

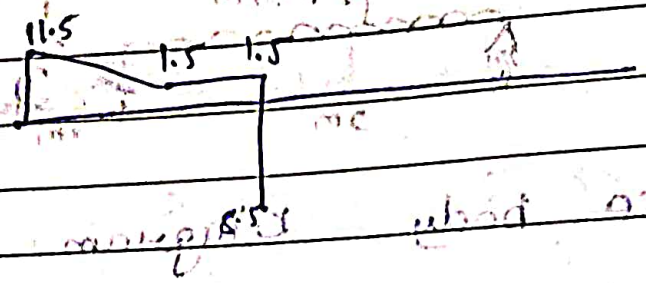
$V_C = \frac{(70 + 25)}{10}$

$\boxed{V_C = 9.5 \text{ kN}}$ $\boxed{V_A = 10.5 \text{ kN}}$

$\boxed{\Sigma H = 0}$

$\rightarrow = \leftarrow$

$\boxed{H_A = 0}$



SFD

At point B

$SFB_L = V_A - 2 \times 5$

$= 10.5 - 10$

$= 0.5$ kN

$SFB_R = 0.5$ kN

At Point D.

$SFD_L = 0.5$ kN

$SFD_R = 0.5 - 10$

$= -9.5$ kN.

At Point C.

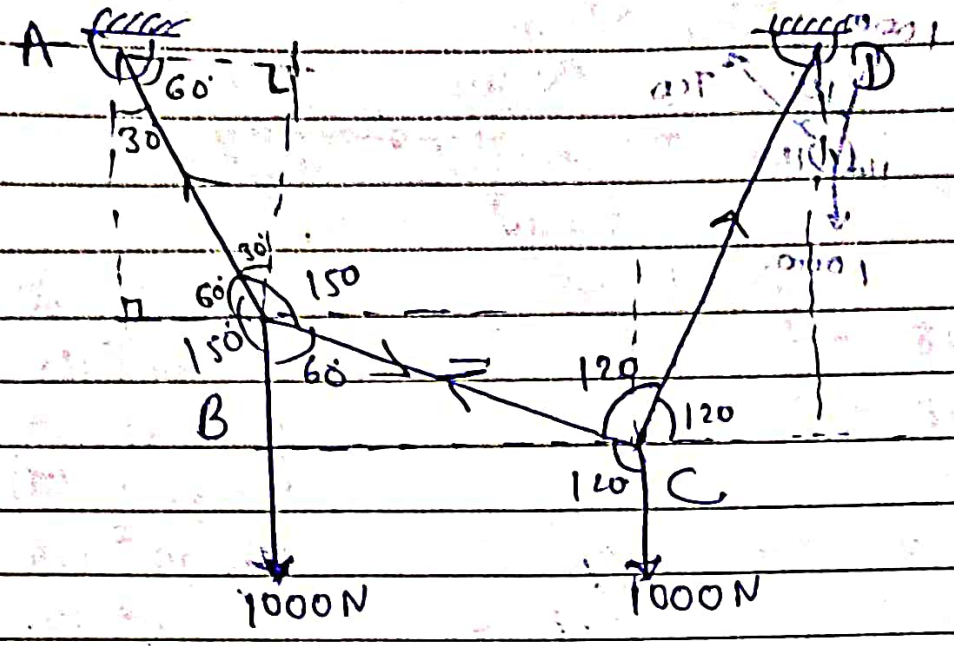
$SFC_L = 0.5 - 2 \times 5 = -9.5$

$SFC_R = -9.5 + 9.5$ kN

$= 0$

Date: / / Page no:

Numerical problem on Lami's theorem.



To find :

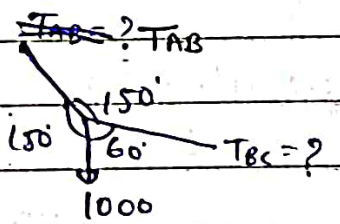
(i) $T_{AB} = ?$

(ii) $T_{BC} = ?$

(iii) $T_{CD} = ?$

Point "B"

$T_{AB} = ?$



Now applying Lami's theorem at point 'B'

$$\frac{T_{AB}}{\sin 60^\circ} = \frac{T_{BC}}{\sin 150} = \frac{1000}{\sin 150}$$

$$\boxed{\begin{aligned} T_{AB} &= 1732\ N \\ T_{BC} &= 1000\ N \\ T_{CD} &= 1000\ N. \end{aligned}}$$

Ans