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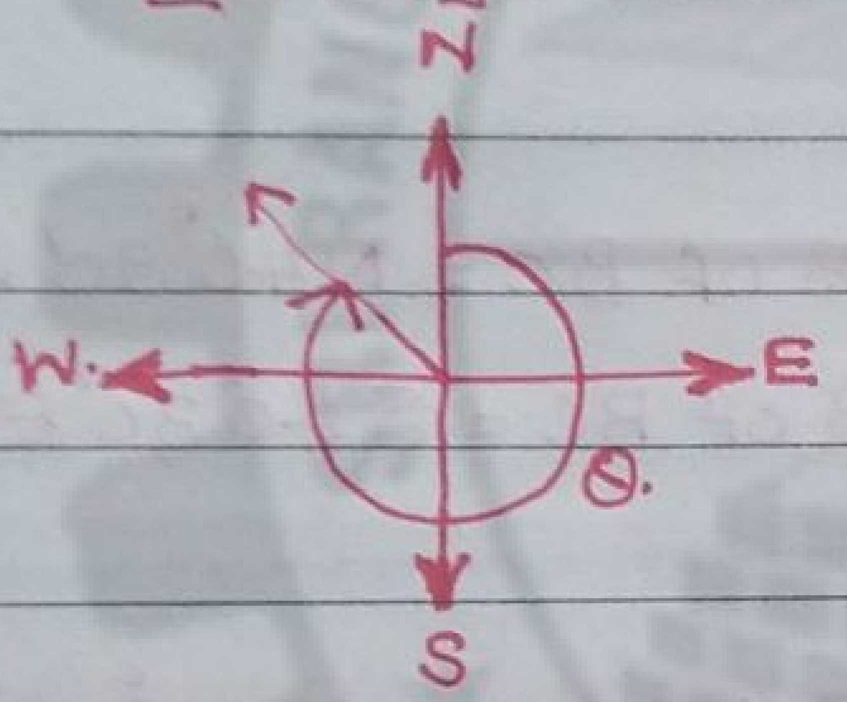
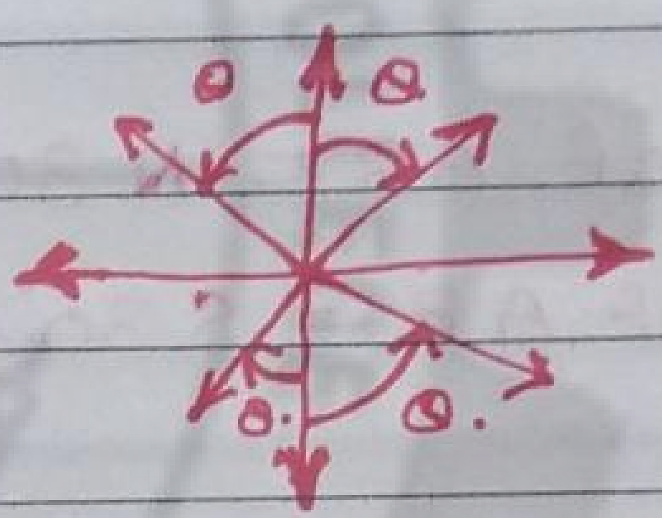
Compass Surveying

Bearing :-

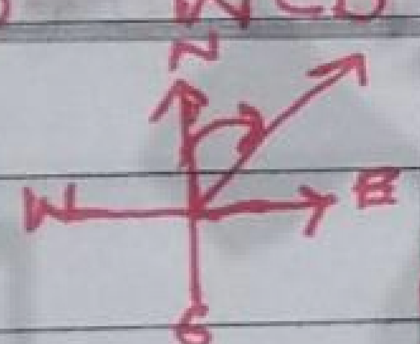
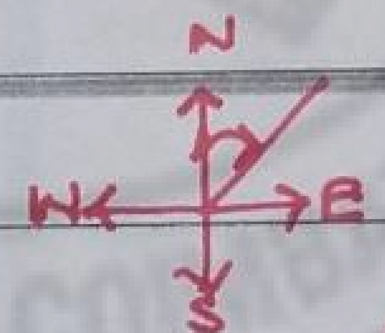
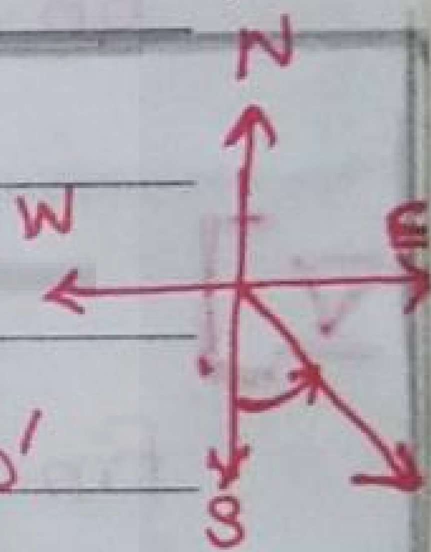
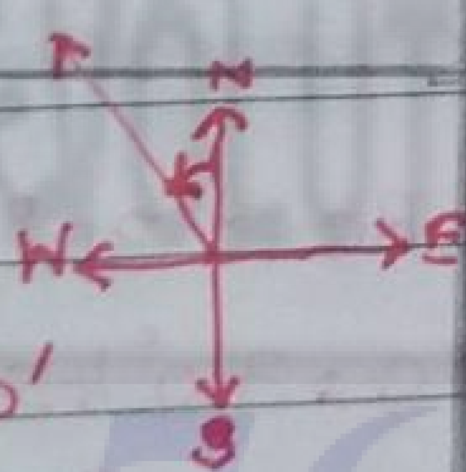
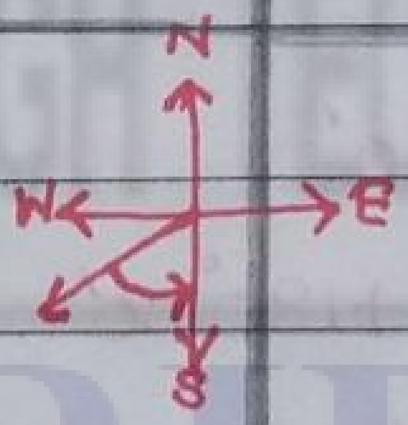
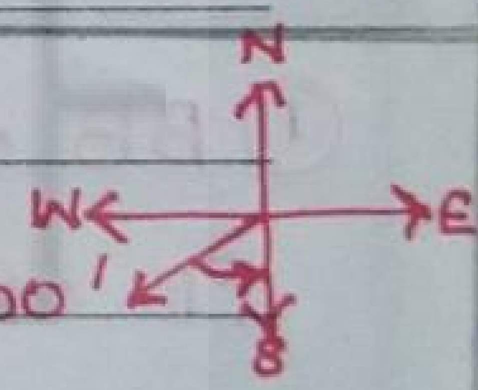
I] Fore bearing — Back bearing.

a) Whole circle bearing (W.C.B)

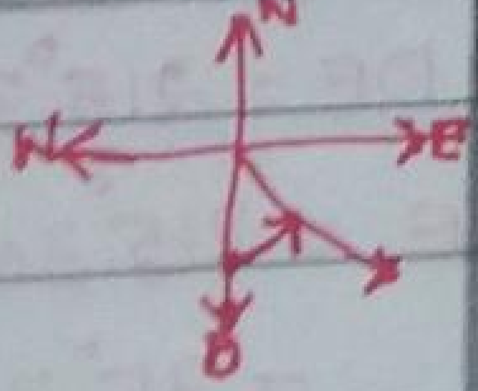
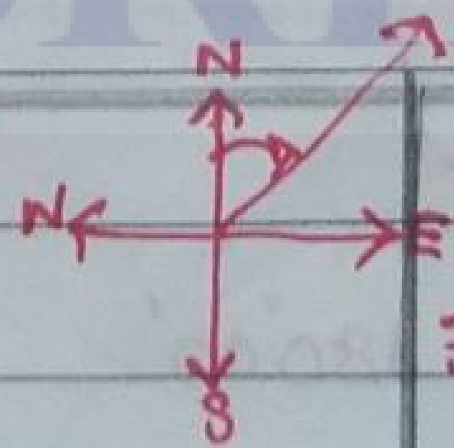
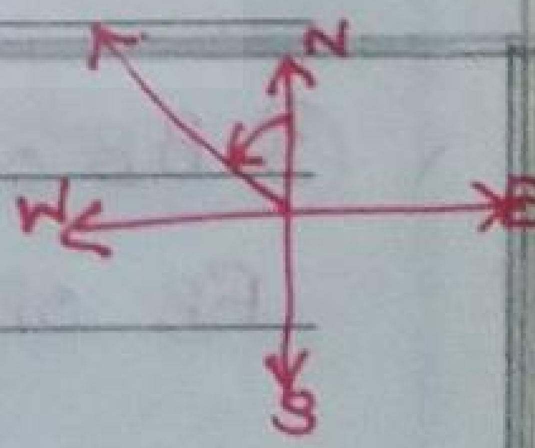
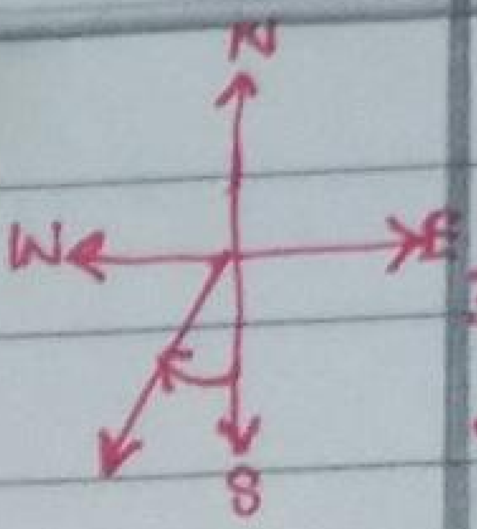
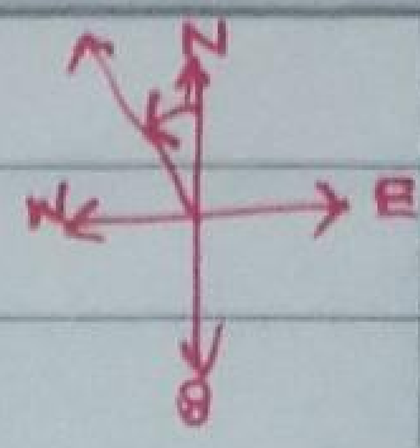
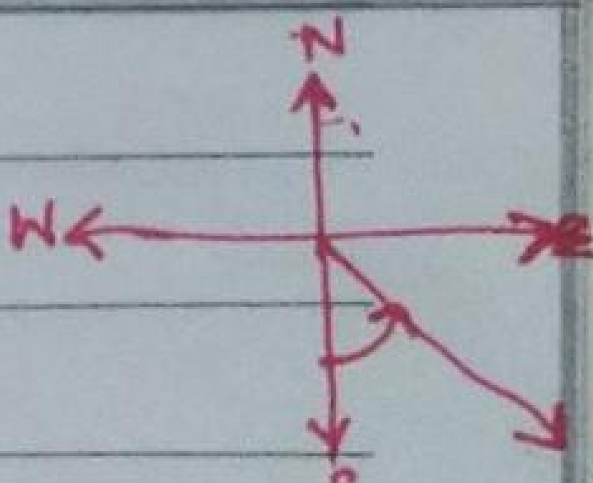
b) Reduced bearing (R.B) (or) Quadrantal bearing. (Q.B).

Example:- [WCB]	[R.B (or) Q.B]
	

II] Convert From WCB to RB :-

① 76°24′  RB = N 76°24′E.	② 45°20′  RB = N45°20′E	③ 125°30′  RB = 180°00′ − 125°30′ = S 54°40′E.
④ 320°30′  360°00′ − 320°30′ = N39°30′W.	⑤ 222°15′  222°15′ − 180°00′ = S 42°15′W.	⑥ 225°30′  225°30′ − 180°00′ = S 45°30′W.

III] Convert from RB to W.C.B :-

① S 43°30′ E.  180°00′ − 43°30′ = 136°30′	② N 26°45′E  = 26°45′	③ N 11°W  360°00′ − 11°00′ = 349°00′
④ S 36°30′W  180°00′ + 36°30′ = 216°30′	⑤ N40°15′W  360°00′ − 40°15′ = 319°45′	⑥ S 14°30′ E  180°00′ − 14°30′ = 165°30′

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IV] Finding :- BB for the given FB :-

If it is greater than 180°, minus (−) the value, less means (+) plus.

① FB of AB = 310°30′ BB of AB = 130°30′ (310°30′ − 180°00′)	② FB of BC = 145°15′ BB of BC = 145°15′ + 180°00′ = 325°15′
③ FB of CD = 181°30′ BB of CD = 181°30′ − 180°00′ = 1°30′.	④ FB of DE = 60°45′. BB of DE = 60°45′ + 180°00′ = 240°45′.
⑤ FB of AB = N 30°30′ W BB of AB = S 30°30′ E.	⑥ FB of BC = N 40°30′ W. BB of BC = S 40°30′ E.
⑦ FB of CD = S 60°15′ W BB of CD = N 60°15′ E.	⑧ FB of DE = N 45°30′ E. BB of DE = S 45°30′ W.

V]

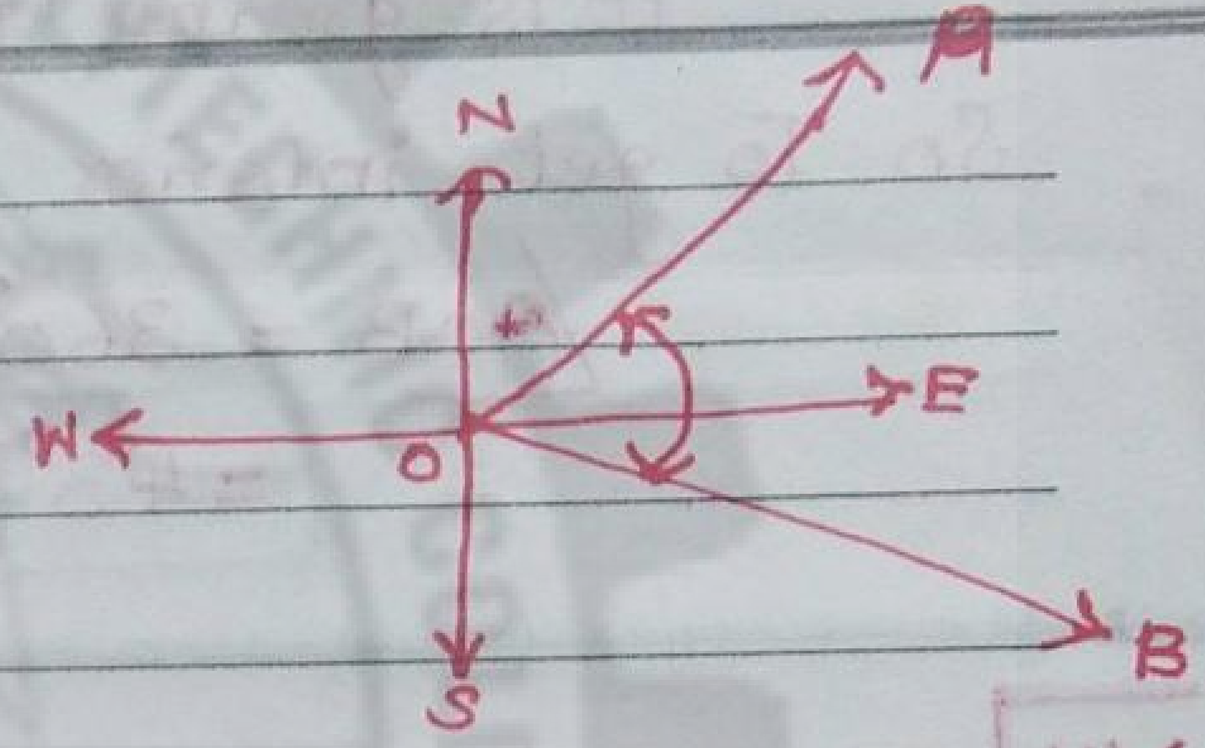
Finding :- FB for the given BB :-

① BB of AB = 40°30′ FB of AB = 40°30′ + 180°00′ = 220°30′.	② BB of BC = 310°45′ FB of BC = 310°45′ − 180°00′ = 130°45′
③ BB of CD = 145°45′ FB of CD = 145°45′ + 180°00′ = 325°45′	④ BB of DE = 215°30′ FB of DE = 215°30′ − 180°00′ = 35°30′

VI Computation of included angles from bearings :-

① $OA = 30°30'$, $OB = 140°15'$,
$OC = 220°45'$, $OD = 310°30'$

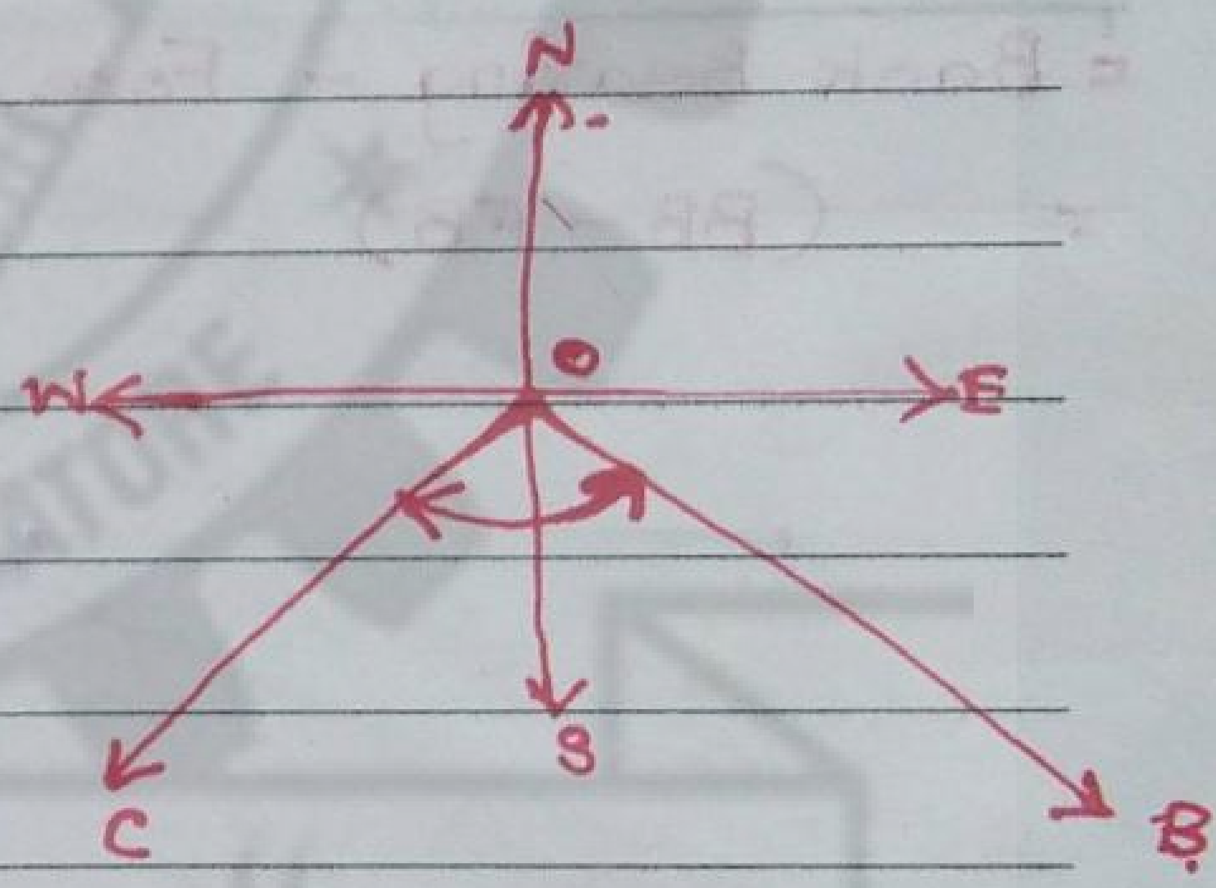
Find:- $\angle AOB$, $\angle BOC$ & $\angle COD$.



1) $\angle AOB$ = Bearing of OB − Bearing of OA

$= 140°15' - 30°30'$

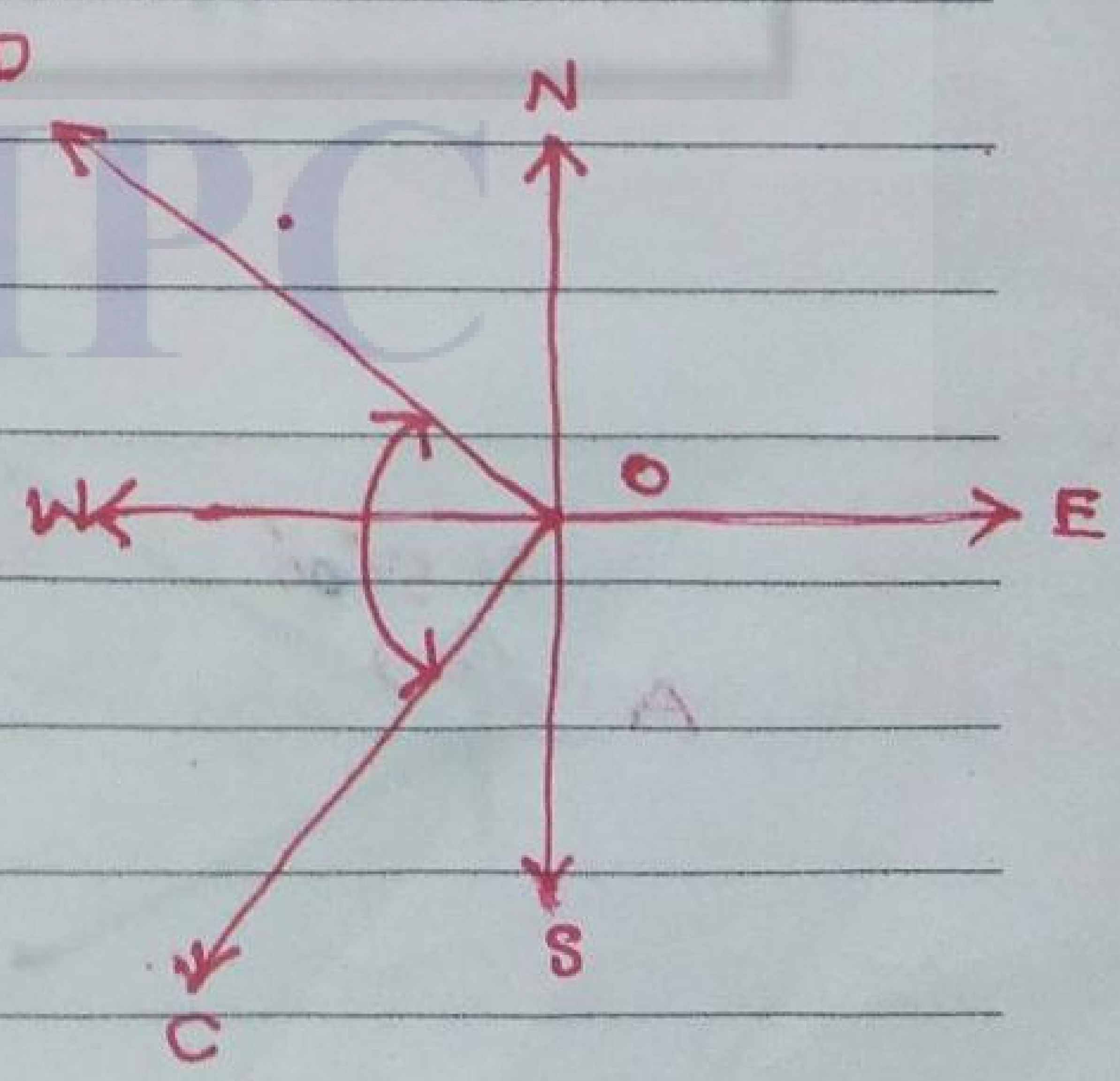
$\boxed{= 109°45'}$



2) $\angle BOC$ = Bearing of OC − Bearing of OB.

$= 220°45' - 140°15'$

$\boxed{= 80°30'}$

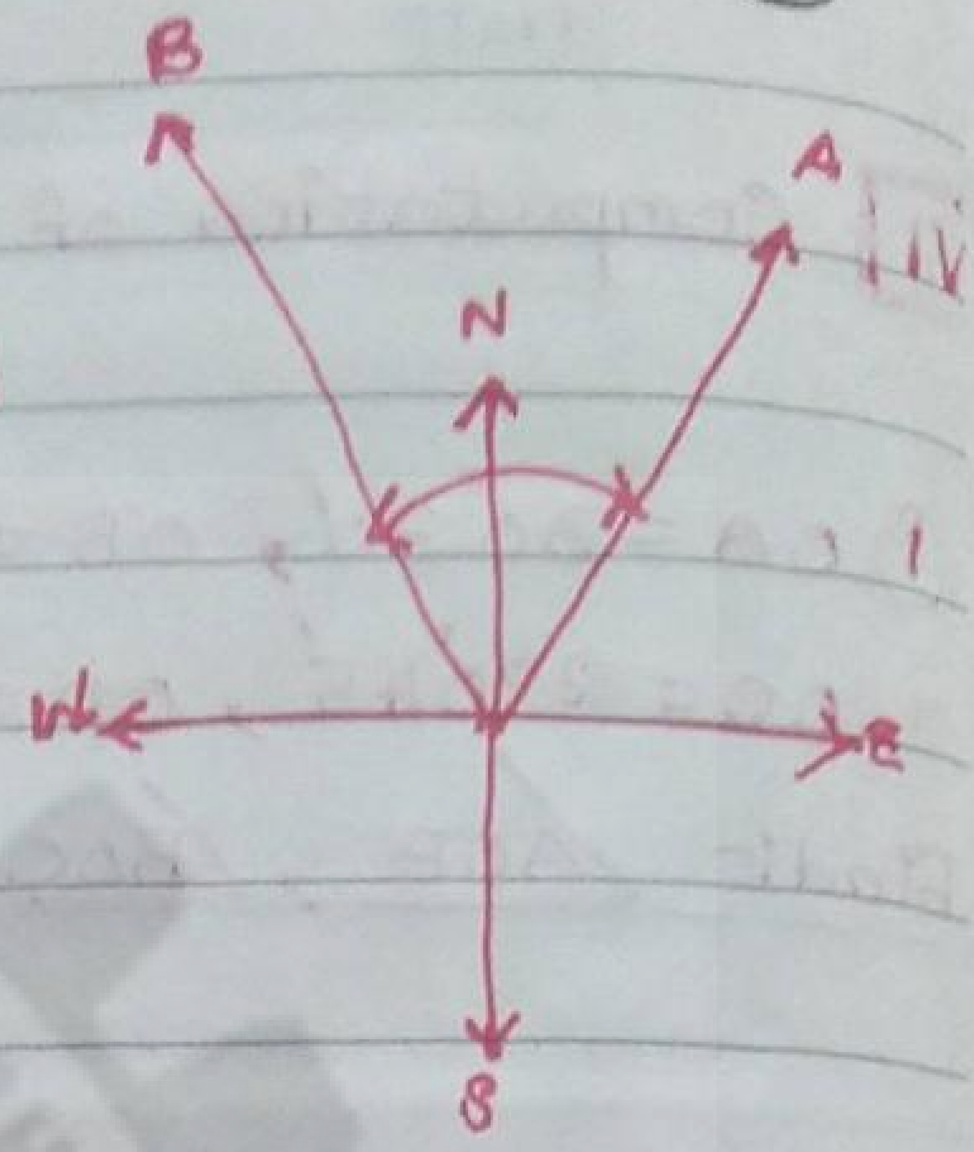


3) $\angle COD$ = Bearing of OD − Bearing of OC

$= 310°30' - 220°45'$

$\boxed{= 89°45'}$

(2) $OA = 16°12'$, $OB = 332°18'$



Find $\angle AOB$ = Bearing of OB − Bearing of OA

$= 332°18' - 16°12'$

$= 316°6'$ (Exterior angle)

It is greater than 180°,

So To get interior angle $\angle AOB$

$\angle AOB = 360° - 316°6'$

$\boxed{= 43°54'}$.

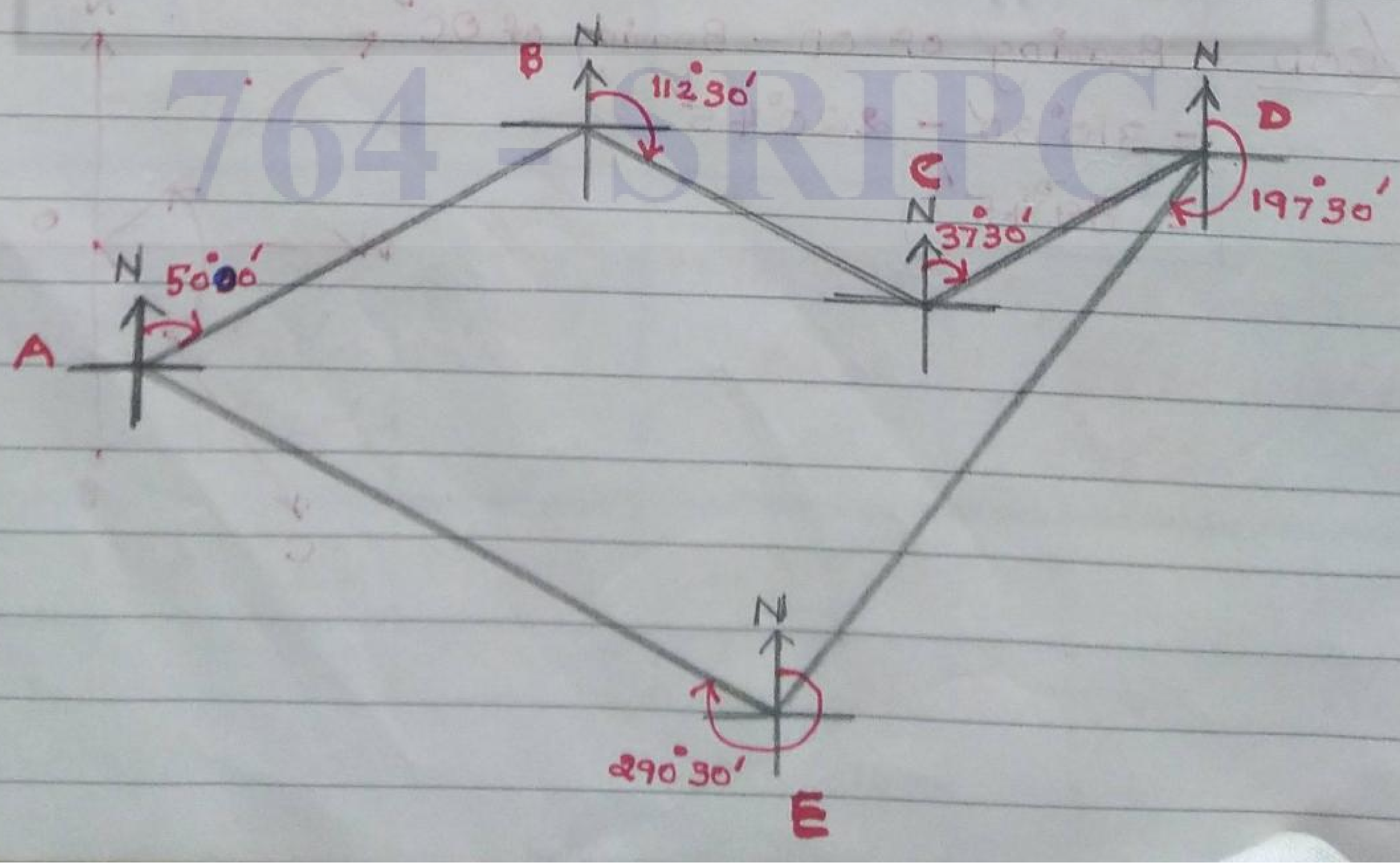
VII Included angles:-

For clockwise direction:- [closing Traverse] :- [clockwise]:-

= Back Bearing − Fore Bearing

= (BB − FB)

LINE	FB	BB
AB	50°00'	230°00'
BC	112°30'	292°30'
CD	37°30'	217°30'
DE	197°00'	17°00'
EA	290°30'	110°30'



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$\angle A$ = BB of AE − FB of AB
$= 110^\circ 30' - 50^\circ 00'$
$= 60^\circ 30'$.

$\angle B$ = BB of BA − FB of BC
$= 230^\circ 00' - 112^\circ 30'$
$= 117^\circ 30'$

$\angle C$ = BB of CB − FB of CD
$= 292^\circ 30' - 37^\circ 30'$
$= 255^\circ 30'$

$\angle D$ = BB of DC − FB of DE
$= 217^\circ 30' - 197^\circ 00'$
$= 20^\circ 30'$

$\angle E$ = BB of ED − FB of EA
$= 17^\circ 00' - 290^\circ 30'$
$= -273^\circ 30'$
Now Add with 360° to get (+ve)
So, $-273^\circ 30' + 360^\circ$
$= 86^\circ 30'$

Sum of Included angles $= \angle A + \angle B + \angle C + \angle D + \angle E = 540^\circ 00'$
$= 60^\circ 30' + 117^\circ 30' + 255^\circ 30' + 20^\circ 30' + 86^\circ 30' = 540^\circ 00'$
check:-
$(2n-4)90^\circ = (2\times5-4)90^\circ = 540^\circ 00'$

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VIII) Included angles:- clockwise closed Traverse :-

LINE	FB
AB	30°30'
BC	140°15'
CD	220°00'
DA	310°30'

→

LINE	FB	BB
AB	30°30'	210°30'
BC	140°15'	320°15'
CD	220°00'	40°00'
DA	310°30'	130°30'

Back Bearing:-

AB = 30°30' + 180°00' = 210°30'

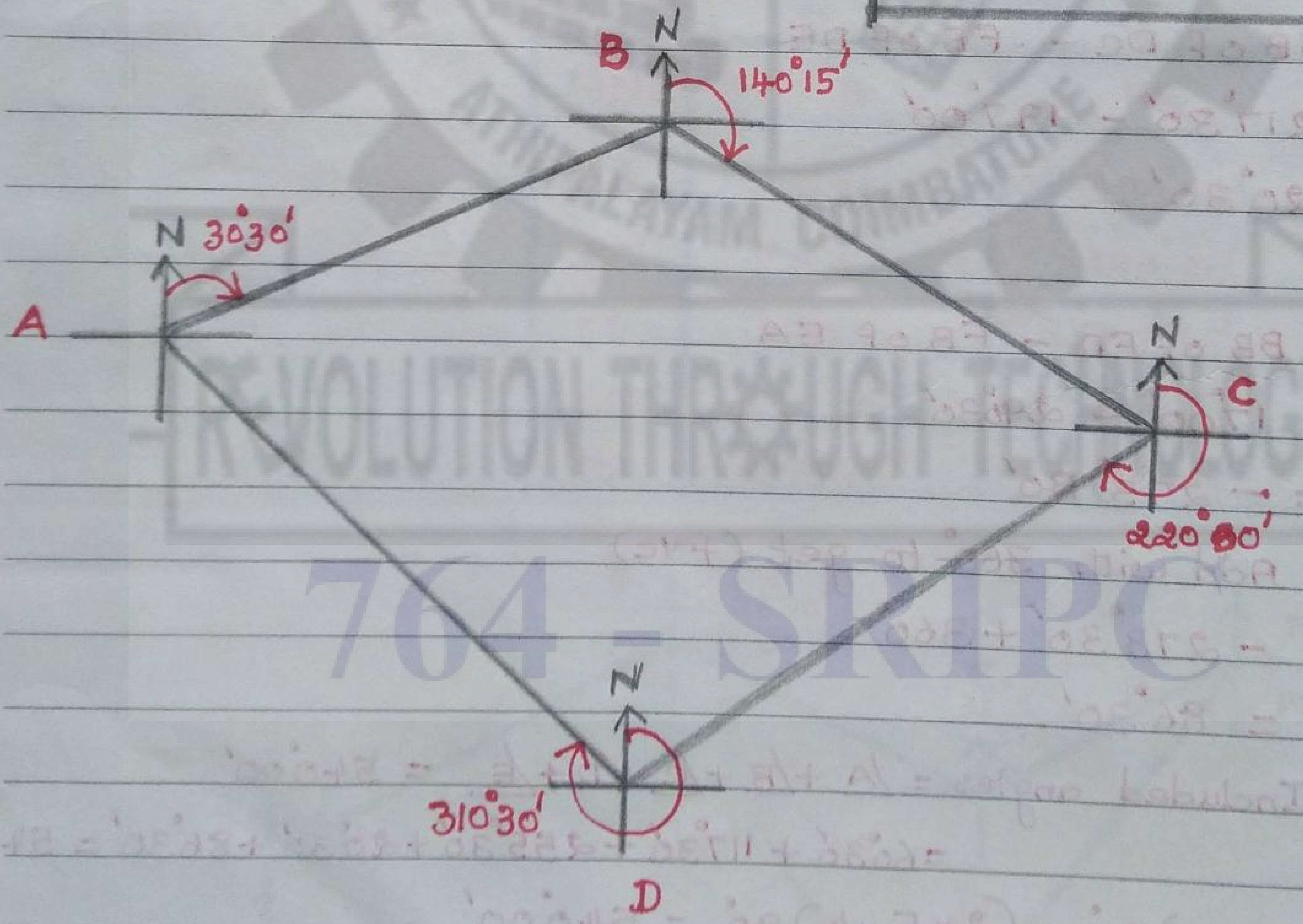
BC = 140°15' + 180°00' = 320°15'

CD = 220°00' − 180°00' = 40°00'

DA = 310°30' − 180°00' = 130°30'

NOTE:-

1) FB is less than 180°, add 180° with FB
2) If FB is greater than 180°, Minus with 180°.



Formula:-

BB − FB.

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$\angle A$ = BB of AD − FB of AB
$= 130°30' - 30°30'$
$= 100°00'$

$\angle B$ = BB of BA − FB of BC
$= 210°30' - 140°15'$
$= 70°15'$

$\angle C$ = BB of CB − FB of CD
$= 320°15' - 220°00'$
$= 100°15'$

$\angle D$ = BB of DC − FB of DA
$= 40°00' - 310°30'$
$= -270°30'$ (−)ve, Greater than 180°, so (+) with 360°
$= -270°30' + 360°00'$
$= 89°30'$

Now, check:-
$(2n-4)90°$
$= (2\times4-4)90°$
$= (8-4)90°$
$= (4)90°$
$= 360°$

Sum of Included angles = 360°
$\angle A + \angle B + \angle C + \angle D = 360°$
$100°00' + 70°15' + 100°15' + 89°30' = 360°$
$360° = 360°$

CHECK OK ✓

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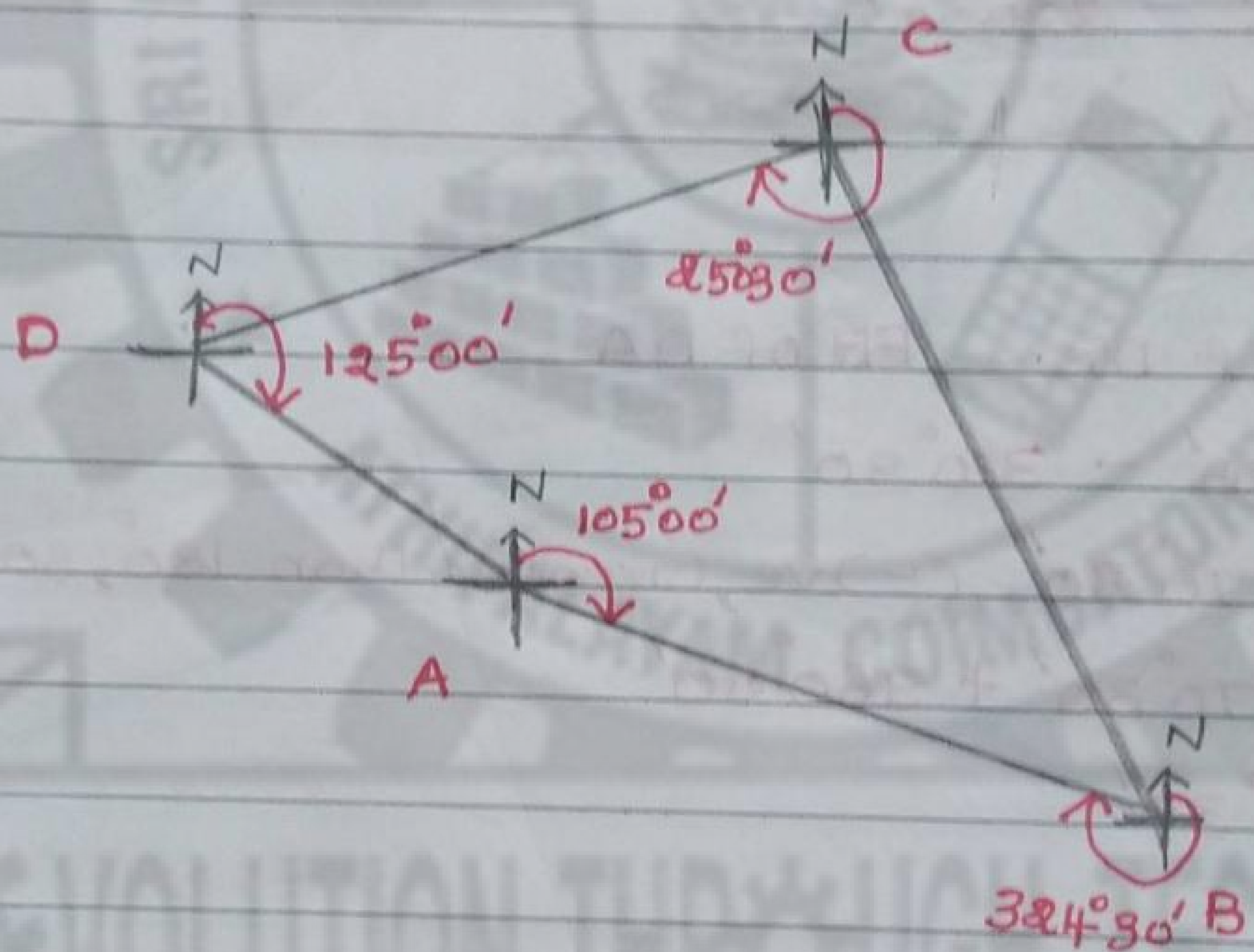
IX Included angles, Anti-clockwise (or) Counter clockwise, closed traverse :-

LINE	FB	BB
AB	105°00'	285°00'
BC	324°30'	144°30'
CD	250°30'	70°30'
DA	125°00'	305°00'



For Anti-clockwise direction:-

Formula :- Fore bearing − Back bearing.

FB − BB.

$\angle A$ = Fore bearing − Back bearing

= FB of AB − BB of AD.

= 105°00' − 305°00'

= −200°00', Now Add with 360° to get (+) ve

= −200°00' + 360°

= 160°00'

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$\angle B$ = FB of BC − BB of BA

$= 324°30' - 285°00'$

$= 39°30'$

$\angle C$ = FB of CD − BB of CB

$= 250°30' - 144°30'$

$= 106°00'$

$\angle D$ = FB of DA − BB of DC

$= 125°00' - 70°30'$

$= 54°30'$

Sum of Included angles = $\angle A + \angle B + \angle C + \angle D$

$= 160°00' + 39°30' + 106°00' + 54°30'$

$= 360°00'$

Check:-

$= (2n-4)\,90°$

$= (2\times4-4)\,90°$

$= 360°00'$

So,

CHECK OK ✓

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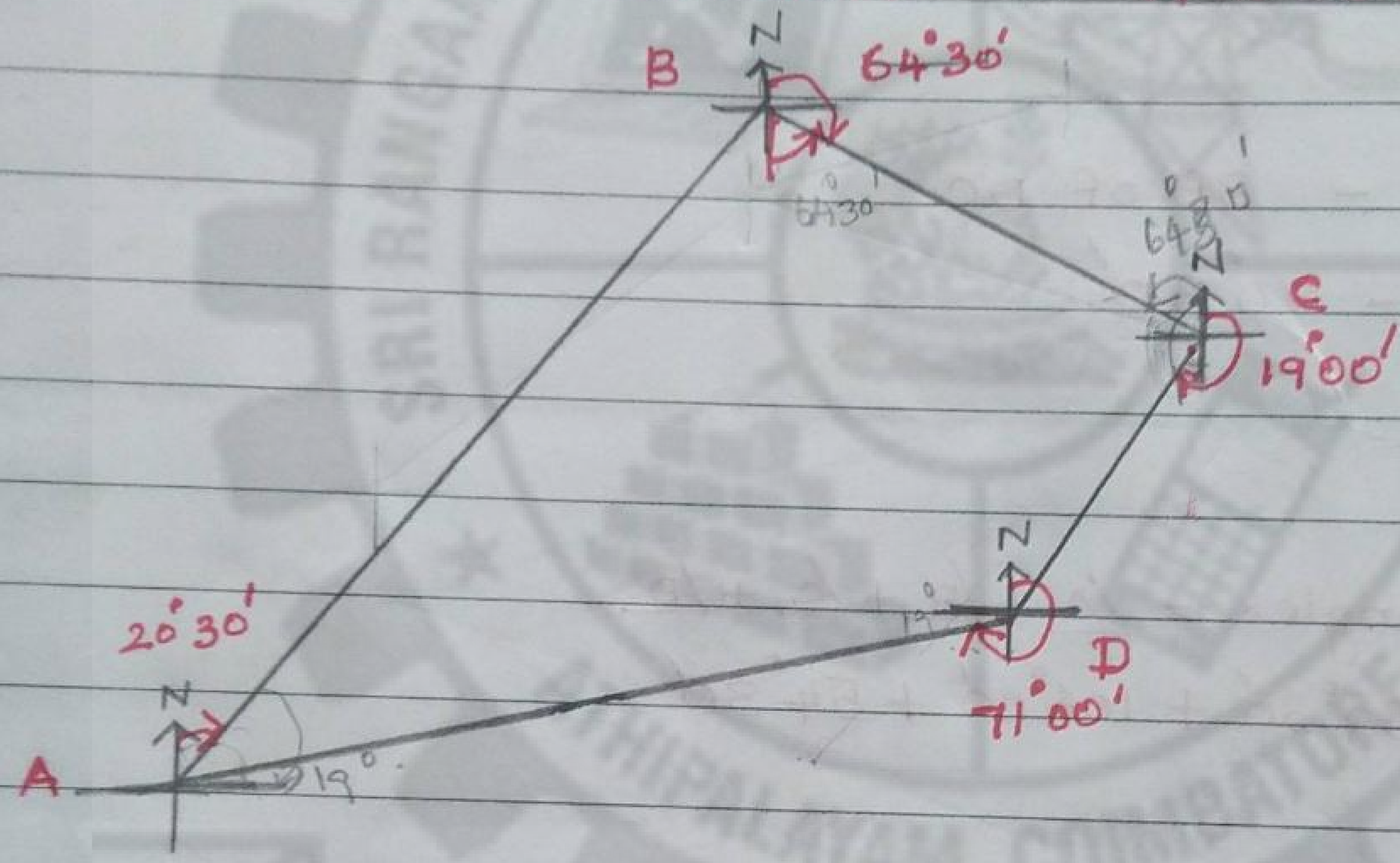
X Included angles in Reduced bearing :-

LINE	FB	BB
AB	N 20°30' E	S 20°30' W
BC	S 64°30' E	N 64°30' W
CD	S 19°00' W	N 19°00' E
DA	S 71°00' W	N 71°00' E



clockwise direction :-

~~Formula :- = BB − FB.~~

$\angle A$ = BB of AD − FB of AB

= 71°00' − 20°30'

= 50°30'.

= 90° − 20°30'

= 69°30' − 19°00'

= 50°30'

$\angle B$ = BB of BA + FB of BC.

= 20°30' + 64°30'

= 85°00'

= 20°30' − 64°30'

180° − 64°30'

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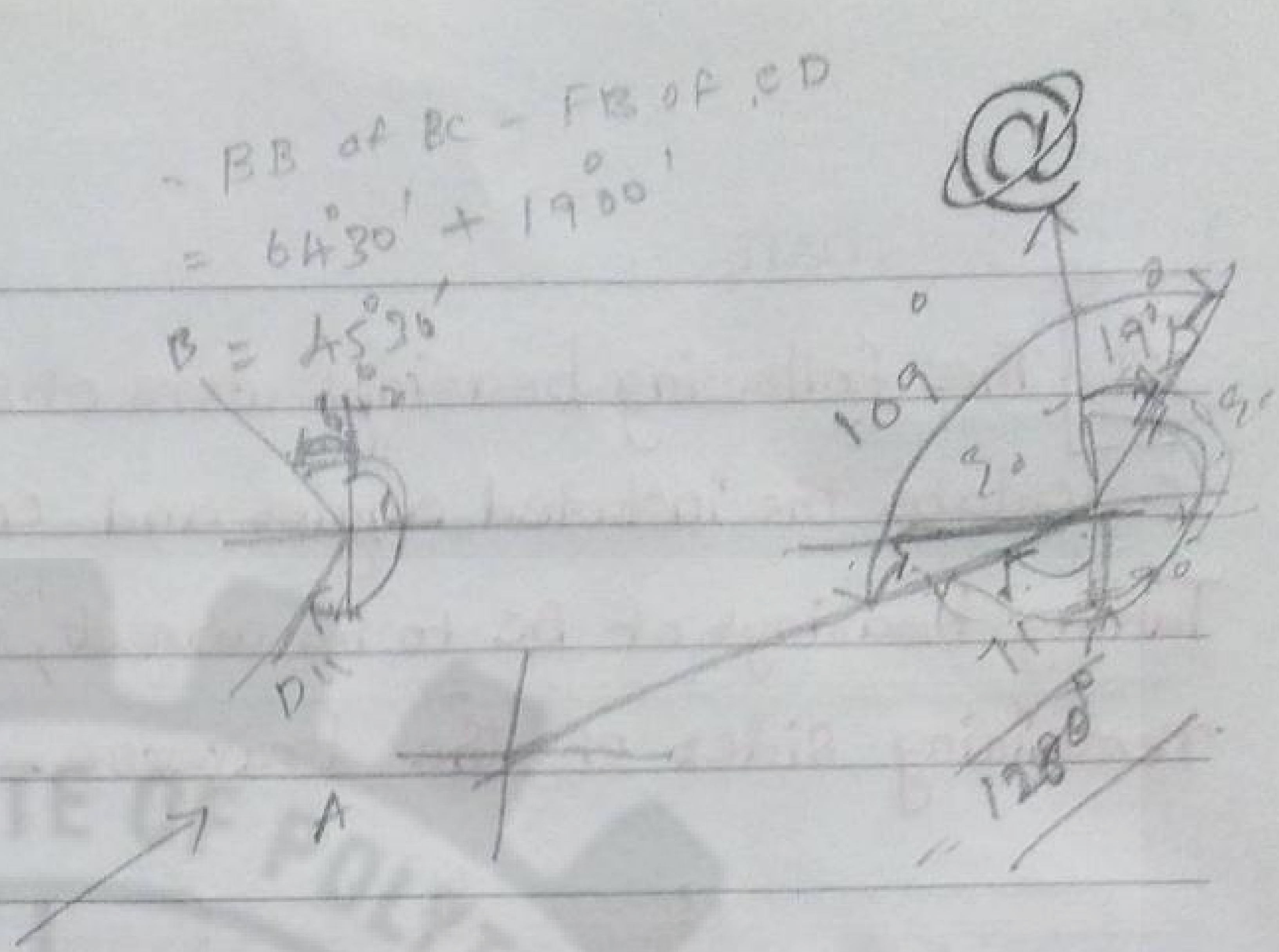
$\angle C = $ ~~AB~~ $\underset{(BC)}{BB} + \underset{(CD)}{FB}$

$64^\circ 30' + 19^\circ 00'$

$= 83^\circ 30'$

$= 180 - 83^\circ 30'$

$= 96^\circ 30'$



$\angle D = $ FB of DA − BB of CD

$= 71^\circ 00' - 19^\circ 00'$

$= 52^\circ 00'$ ~~+18000~~

$= 180^\circ - 52^\circ 00'$

$= 128^\circ 00'$

$= 90' - 19^\circ = 71^\circ 00'$

$= 19^\circ 00' + 90^\circ 00' + 19^\circ 00'$

$= 128^\circ$

Sum of included angles $= \angle A + \angle B + \angle C + \angle D = (2n-4) 90^\circ$

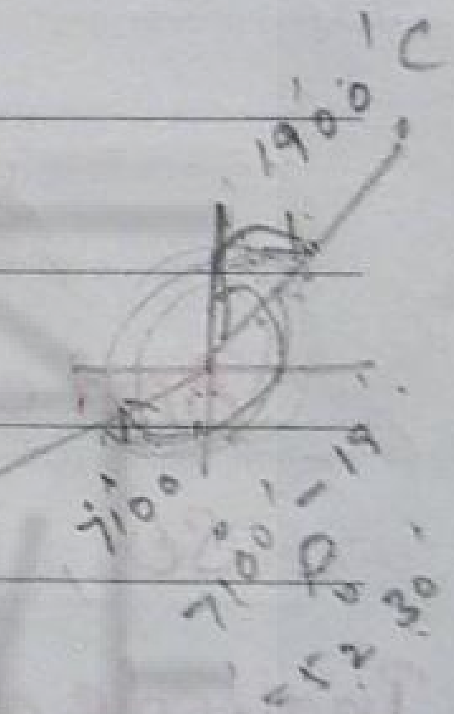
$136^\circ 00'$ $115^\circ 30'$

$= 50^\circ 30' + 85^\circ 00' + 96^\circ 30' + 128^\circ 00' = (2 \times 4 - 4) 90^\circ$

$= 360^\circ 00' = 360^\circ 00'$

= BB of DC − FB of AD

=



CHECK :-

CHECK OK ✓

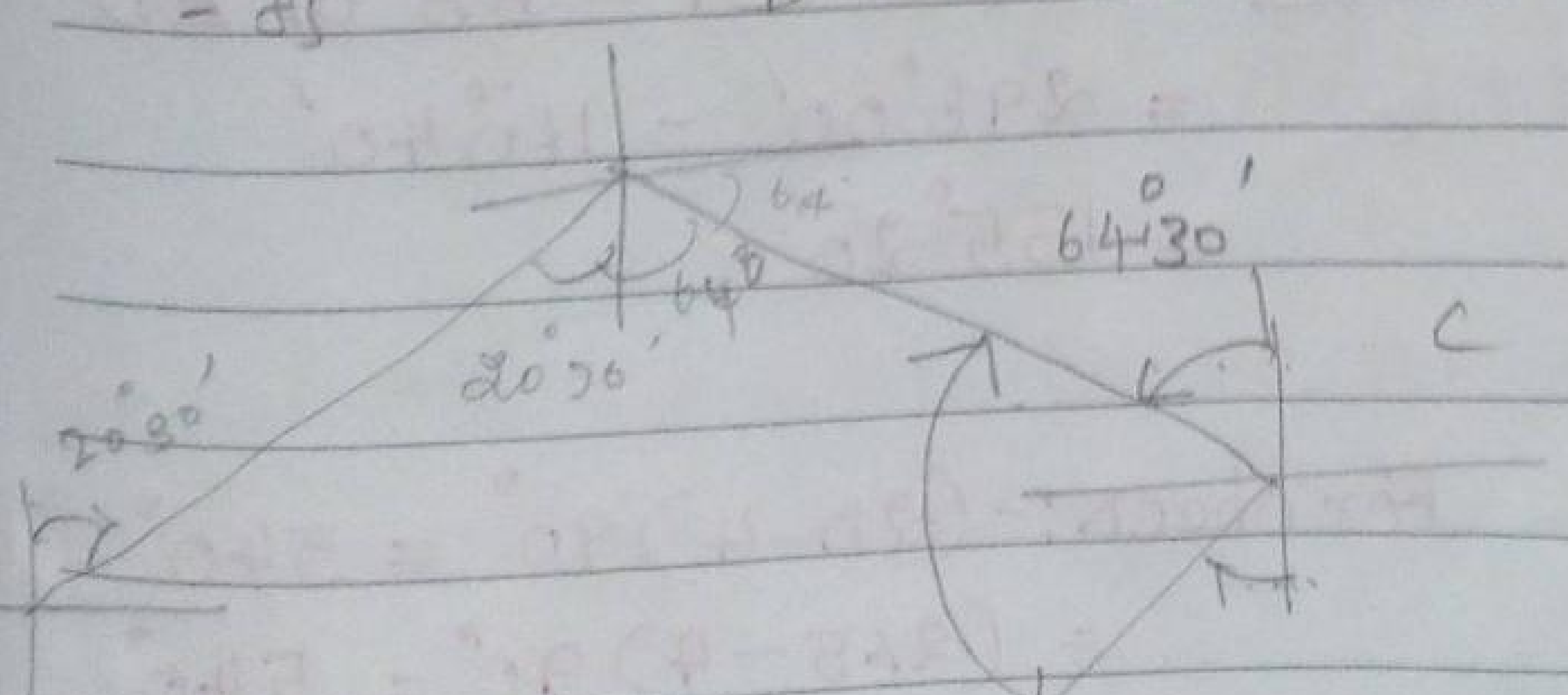
BB of AB − FB of BC.

$= 20^\circ 30' - (180 - 64^\circ 30')$

$= 20^\circ 30' - 115^\circ 30'$

$= -95^\circ + 180$

$= 85^\circ$



$\angle C$ = BB of BC − FB of CD

$= 64^\circ 30' - (180' - 19^\circ 00')$

$= 64^\circ 30' - (161^\circ 0')$

$= -96^\circ 30' + 180^\circ$

$= 83^\circ 30'$

$180 - 64^\circ 30' =$

$= 115^\circ 30' - 19^\circ 00'$

$= 96^\circ 30'$

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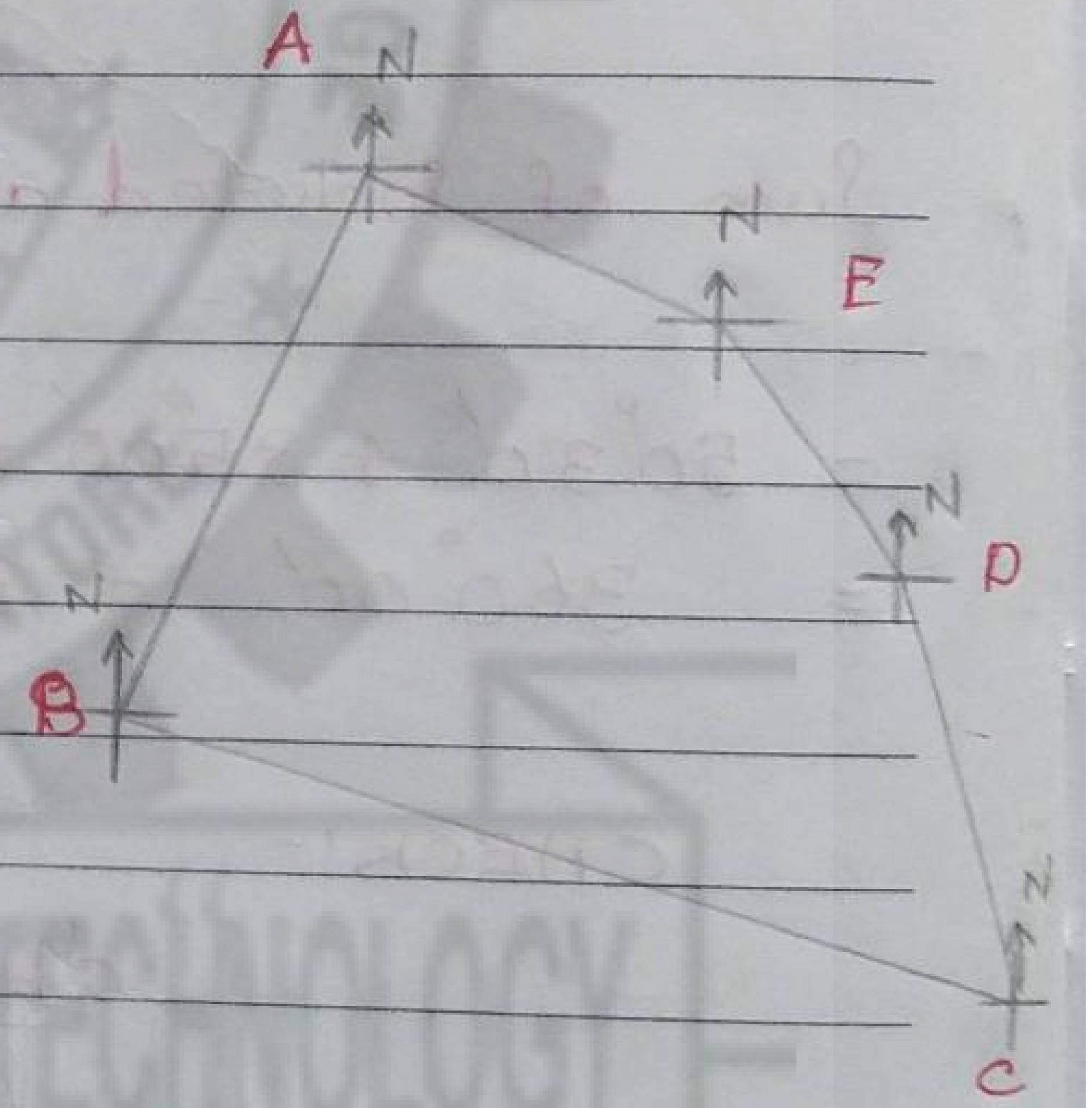
XI The following bearings were observed in running a closed compass traverse. Calculate the included angles and correct them for observational errors. Taking bearings of BC to be correct, find the corrected bearings for the remaining sides of the traverse. [OCT-2015]

LINE	FB	BB.
AB	191°15′	10°15′
BC	120°45′	300°45′
CD	349°05′	169°00′
DE	339°35′	160°40′
EA	296°00′	115°00′



Anticlockwise : (WCB).

so, FB − BB.

Included angles,

$\angle A$ = FB of AB − BB of EA

= 191°15′ − 115°00′

= 76°15′

$\angle B$ = FB of BC − BB of BA

= 120°45′ − 10°15′

= 110°30′

$\angle C$ = FB of CD − BB of CB.

= 349°05′ − 300°45′

= 48°20′

$\angle D$ = FB of DE − BB of DC

= 339°35′ − 169°00′

= 170°35′

$\angle E$ = FB of EA − BB of ED

= 296°00′ − 160°40′

= 135°20′

For check:- $(2n-4)90° = 540°$

$= (2\times5-4)90° = 540°$

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

$= 76°15' + 110°30' + 48°20' + 170°35' + 135°20'$

$= 541°00'$

So, Error $= 541°00' - 540°00' = 1°00'$

Correction Per angle $= \frac{1°00'}{5} = 0°12'$.

Angle	Calculated value	Correction	Corrected value.
$\angle A$	76°15'	−0°12'	76°03'
$\angle B$	110°30'	−0°12'	110°18'
$\angle C$	48°20'	−0°12'	48°08'
$\angle D$	170°35'	−0°12'	170°23'
$\angle E$	135°20'	−0°12'	135°08'
Total	541°00'	1°00'	540°00'

To find the corrected bearings, Taking bearings of BC,

So, Now. Bearing of BC $= 120°45'$

$\angle C$ = FB of CD − BB of CB

(ie) FB of CD = BB of CB + $\angle C$ [300°45' + 48°08'].

$= (120°45' + 180°) + 48°08'$

$= 348°53'$.

$\angle D$ = FB of DE − BB of DC.

FB of DE = BB of DC + $\angle D$

$= (348°53' - 180°) + 170°23'$

$= 339°16'$

$\angle E$ = FB of EA − BB of ED.

FB of EA = BB of ED + $\angle E$

$= (339°16' - 180°) + 135°08'$

$= 294°24'$

$\angle A$ = FB of AB − BB of AE

FB of AB $= (294°24' - 180°) + 76°03'$

$= 190°27'$

$\angle B$ = FB of BC − BB of BA

FB of BC = BB of BA + $\angle B$

$= (190°27' - 180°) + 110°18'$

$= 120°45'$

FB of BC $= 120°45'$

CHECKED OK ✓

Remaining sides are,

FB of CD $= 348°53'$

FB of DE $= 339°16'$

FB of EA $= 294°24'$

FB of AB $= 190°27'$

FB of BC $= 120°45'$

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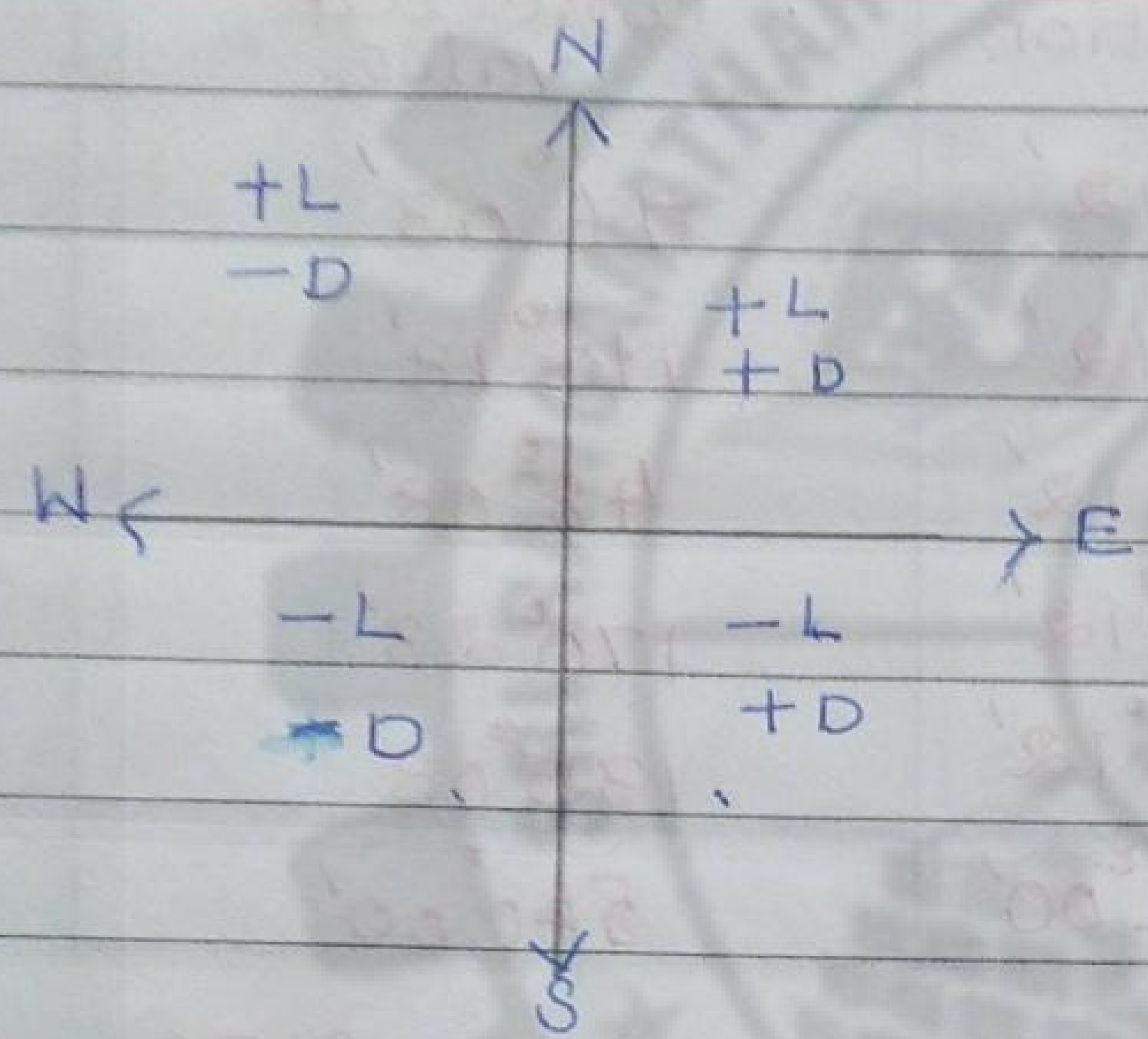
Tape corrections :-

1. Latitude and departure :-

Conversion of WCB to RB :-



Problems :-

1) Calculate the latitude and departure for the following observation of a closed traverse ABCD.

LINE	Length (m)	WCB
AB	235	338°22'
BC	317.5	82°20'
CD	215	167°10'
DA	218.5	259°42'

Convert WCB to RB :-

AB - 338°22' = 360° - 338°22' = N 21°48' W.

BC = 82°20' = N 82°20' E = N 82°20' E.

CD = 167°10' = 180° - 167°10' = S 12°50' E

DA = 259°42' = 259°42' - 180° = S 79°42' W.

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Latitude of AB, BC, CD and DA:-

Latitude of line = $l \cos\theta$

Now, Latitude of AB = $+235 \times \cos 21°48'$ = +218.194.

Latitude of BC = $+317.5 \times \cos 82°20'$ = +42.357.

Latitude of CD = $-215 \times \cos 12°50'$ = −209.629.

Latitude of DA = $-218.5 \times \cos 79°42'$ = −39.068.

Departure of AB, BC, CD and DA:-

Departure of line = $l . \sin\theta$.

Now, Departure of AB = $235 \times \sin 21°48'$ = 87.271.

Departure of BC = $+317.5 \times \sin 82°20'$ = +314.661.

Departure of CD = $+215 \times \sin 12°50'$ = +47.754.

Departure of DA = $-218.5 \times \sin 79°42'$ = −214.978.

Result:-

Latitude:-

AB = +218.194.

BC = +42.357.

CD = −209.629.

DA = −39.068.

Departure:-

AB = −87.271.

BC = +314.661.

CD = +47.754.

DA = −214.978.

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2] The following are the latitudes and departures of the sides of traverse ABCD. Calculate the consecutive and Independent co-ordinates of A, B, C and D. (April - 2019)

LINE	Latitude	Departure
AB	−440	+340
BC	+210	+510
CD	+630	−160
DE	+120	−300
EA	−520	−390

Consecutive co-ordinates - (along Y-axis) :-

A = Latitude of EA = − 520.

B = Latitude of AB = − 440.

C = Latitude of BC = + 210.

D = Latitude of CD = + 630.

E = Latitude of DE = + 120.

consecutive co-ordinates (along X-axis) :-

A = Departure of EA = − 390.

B = Departure of AB = + 340.

C = Departure of BC = + 510.

D = Departure of CD = − 160.

E = Departure of DE = − 300.

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Independent co-ordinates :- (Along y-axis):-

Assume the co-ordinates A = 500.

B = co-ordinate of A + consecutive co-ordinate of B.

= 500 + (-440) = 60.

C = co-ordinate of B + consecutive co-ordinate of C.

= 60 + (+210) = 270.

D = co-ordinates of C + consecutive co-ordinates of D.

= 270 + (+630) = 900.

E = co-ordinates of D + consecutive co-ordinates of E.

= 900 + (+120) = 1020.

A = co-ordinates of E + consecutive co-ordinates of A.

= 1020 + (-520) = 500.

check ok!

Along x-axis :-

Assume the co-ordinates A = 500.

B = co-ordinate of A + consecutive co-ordinate of B.

= 500 + (+340) = 840.

C = co-ordinate of B + consecutive co-ordinate of C.

= 840 + (+510) = 1350.

D = co-ordinate of C + consecutive co-ordinate of D.

= 1350 + (-160) = 1190.

E = co-ordinate of D + consecutive co-ordinate of E.

= 1190 + (-300) = 890.

A = co-ordinate of E + consecutive co-ordinate of A.

= 890 + (-390) = 500.

check ok!

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Result:-

Line	Lat	Dep	Points	consecutive co-ordinates Y-axis	X-axis	Independent co-ordinates Y-axis	X-axis
AB	-440	+340	A	-520	-390	500	500
BC	+210	+510	B	-440	+340	60	840
CD	+630	-160	C	+210	+510	270	1350
DE	+120	-300	D	+630	-160	900	1190
EA	-520	-390	E	+120	-300	1020	890.

3] The Latitude and departure of the lines of a closed traverse are given below. calculate the independent co-ordinates and calculate the area of the traverse.

Line	Northing	Southing	Easting	Westing.
AB	–	157.20	154.80	–
BC	210.50	–	52.50	–
CD	175.40	–	–	98.30
DA	–	228.70	–	109.00.

Solution:-

Line	Latitude	Departure.
AB	-157.20	+154.80.
BC	+210.50	+52.50
CD	+175.40	-98.30.
DA	-228.70	-109.00.

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Consecutive co-ordinates :-

Along y-axis :-

A = Latitude of DA = -228.70.

B = Latitude of AB = -157.20.

C = Latitude of BC = +210.50.

D = Latitude of CD = +175.40.

Consecutive co-ordinates :-

Along X-axis :-

A = Departure of DA = -109.00

B = Departure of AB = +154.80.

C = Departure of BC = +52.50.

D = Departure of CD = -98.30.

Independent co-ordinates (Along y-axis) :-

Assume the co-ordinates, A = 500.

B = co-ordinate of A + consecutive coordinate of B.

= 500 + (-157.20) = 342.80.

C = co-ordinate of B + consecutive co-ordinate of C.

= 342.80 + (+210.50) = 553.30.

D = co-ordinates of C + consecutive co-ordinates of D.

= 553.30 + (+175.40) = 728.70

A = co-ordinates of D + consecutive co-ordinates of A.

= 728.70 + (-228.70) = 500.

Hence check ok!

Independent co-ordinates (Along X-axis) :-

Assume the co-ordinates, A = 500.

B = co-ordinates of A + consecutive co-ordinate of B.

= 500 + (+154.80) = 654.80.

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C = co-ordinate of B + consecutive co-ordinates of C.

= 654.80 + (+52.50) = 707.30.

D = co-ordinate of C + consecutive co-ordinates of D.

= 707.30 + (−98.30) = 609.00.

A = co-ordinate of D + consecutive co-ordinates of A.

= 609.00 + (−109.00) = 500.

Hence check ok!

Line	Lat.	Dep.	Point	Consecutive co-ordinates		Independent co-ordinates	
				Y-axis	X-axis	Y-axis	X-axis
AB	−157.20	+154.80	A	−228.70	−109.00	+500	+500
BC	+210.50	+52.50	B	−157.20	+154.80	+342.80	+654.80
CD	+175.40	−98.30	C	+210.50	+52.50	+553.30	+707.30
DA	−228.70	−109.00	D	+175.40	−98.30	+728.70	+609.00

To find Area of closed traverse :-

		Y_1	Y_2	Y_3	Y_4	Y_5
Lat	=	500	342.80	553.30	728.70	500.
Dep.	=	500	654.80	707.30	609.00	500.
		X_1	X_2	X_3	X_4	X_5

$P = (Y_1 \cdot X_2) + (Y_2 \cdot X_3) + (Y_3 \cdot X_4) + (Y_4 \times X_5)$

$= (500 \times 654.80) + (342.80 \times 707.30) + (553.30 \times 609.00)$

$+ (728.70 \times 500)$

$\boxed{= 12,71,172.14 \text{ m}^2}$

$Q = (X_1 \cdot Y_2) + (X_2 \cdot Y_3) + (X_3 \cdot Y_4) + (X_4 \times Y_5)$

$= (500 \times 342.80) + (654.80 \times 553.30) + (707.30 \times 728.70) +$

$(609.00 \times 500).$ $\boxed{= 13,53,610.35 \text{ m}^2}$

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Area of the closed traverse (ABCD) = $\frac{1}{2}[P \sim Q]$

$= \frac{1}{2}[1271172.14 \sim 1353610.35]$

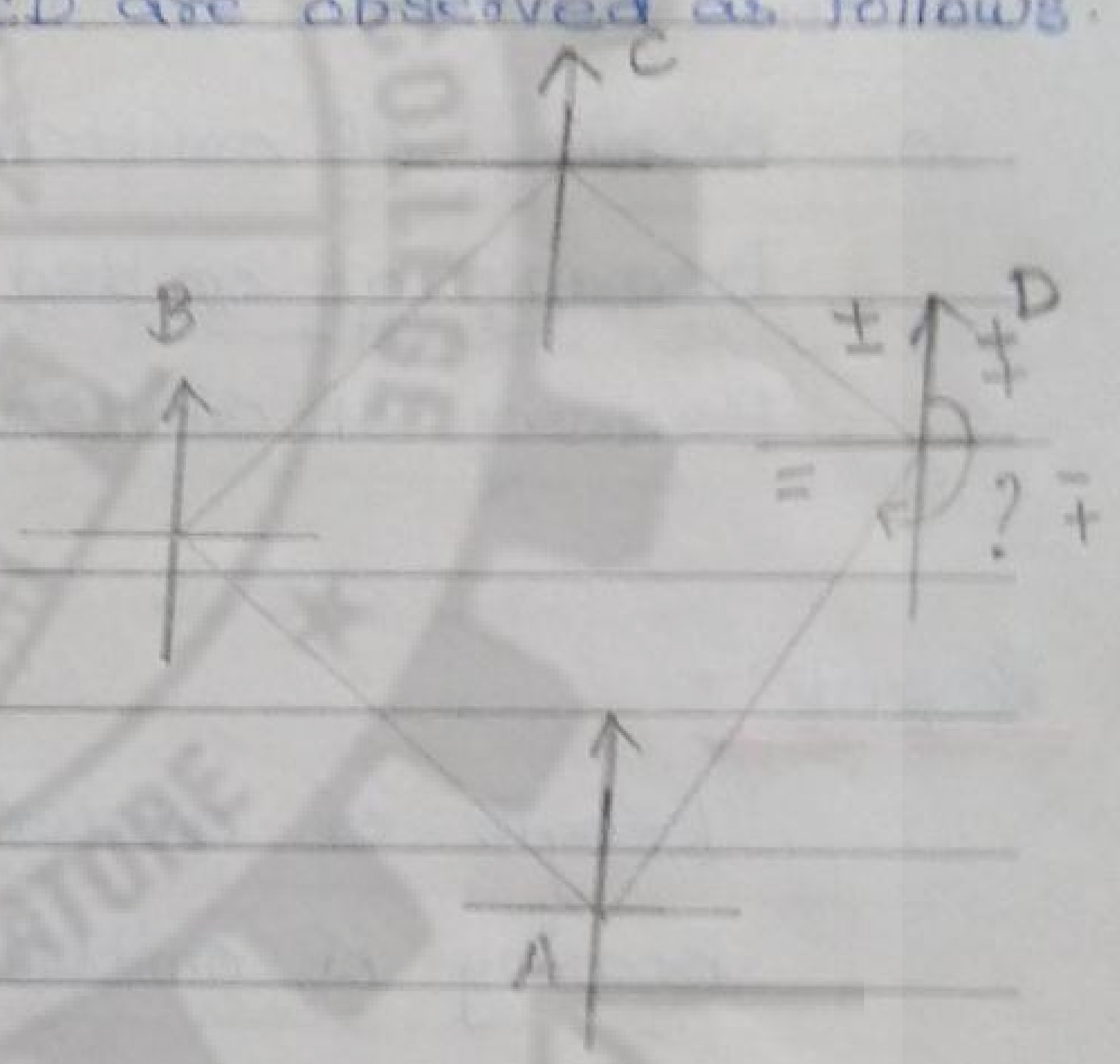
$= \frac{1}{2}[82,438.21]$

$= 41,219.105\ m^2$.

$\therefore$ Area of closed traverse = $\boxed{41,219.105\ m^2}$

4] The length and bearing of traverse ABCD are observed as follows.

Line	Length in m.	Bearing.
AB	485	314°48'
BC	1725	16°34'
CD	1050	142°06'



Calculate the length and bearing of DA.

Solution:-

Line	Length (m)	Bearing (WCB)	Bearing (RB)	Latitude $L\cos\theta$	Departure $L\sin\theta$
AB	485	314°48'	N45°12'W	+341.74	-344.14
BC	1725	16°34'	N16°34'E	+1653.39	+491.85
CD	1050	142°06'	S37°54'E	-828.53.	+644.99.

Sum of Latitudes, $\Sigma L = 1,166.6$.

Sum of Departures. $\Sigma D = 792.7$.

Latitude of DA = -1166.6

Departure of DA = -792.7

Length of omitted side (L) = $\sqrt{(\Sigma L)^2 + (\Sigma D)^2}$.

$= \sqrt{(1166.6)^2 + (792.7)^2}$

$= \sqrt{1360955.56 + 628373.29} = \sqrt{1989328.85} = \boxed{1410.435\ m.}$

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Bearing of omitted side $(\theta) = \tan^{-1}\left[\frac{\Sigma D}{\Sigma L}\right]$

$= \tan^{-1}\left[\frac{792.7}{1166.6}\right]$

$= \tan^{-1} 0.679$

$= 34.1959$

$= 34^\circ 11^\circ 45.42.$

Since the latitude and departure of omitted side is (−) ve. 'θ' lies on the third quadrant.

So, Bearing of omitted side (DA) RB = S $34^\circ 11' 45.42''$ W

Bearing of omitted side WCB = $34^\circ 11' 45.42'' + 180^\circ 00'$

Bearing of omitted side $(\theta) = 214^\circ 11' 45.4''$.

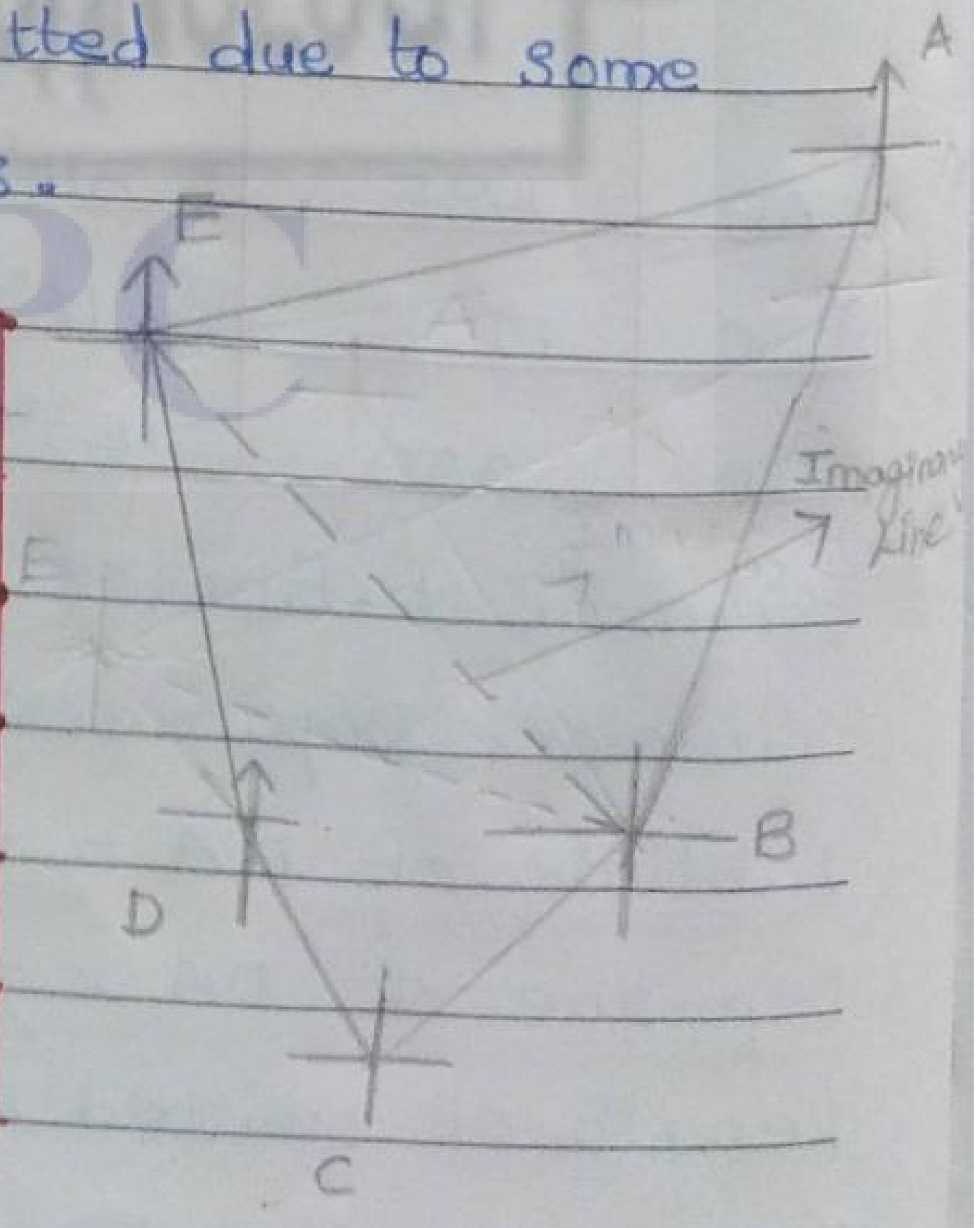
Result :-

Length of omitted side, DA = 1410.435 m.

Bearing of omitted side, DA = $214^\circ 11' 45.4''$.

5] Following are the lengths and bearings of a closed traverse ABCDE, in which the lengths of EA and AB were omitted due to some obstacle. calculate those omitted measurements.

Line	Length (m)	RB.
AB	−	S $18^\circ 59'$ W
BC	131.36	N $77^\circ 46'$ W
CD	80.00	N $39^\circ 47'$ W
DE	199.25	N $35^\circ 13'$ E
EA	−	S $75^\circ 46'$ E



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Solution:-

Line	Length	RB	Latitude	Departure
BC	131.36	N77°46'W	+27.834	-128.377
CD	80.00	N39°47'W	+61.477	-51.190
DE	199.25	N35°13'E	+162.782	+114.901
EB.	?	?		

Sum of Latitudes, $\Sigma L = +252.093$.

Sum of Departures, $\Sigma D = -64.666$.

Now,

As per diagram, Latitude and Departure for EB is $(-,+)$. SW.

Latitude of EB $= \Sigma L = -252.094$.

Departure of EB $= \Sigma D = +64.666$.

Length of EB $= \sqrt{(\Sigma L)^2 + (\Sigma D)^2}$.

$= \sqrt{(252.094)^2 + (64.666)^2}$

$= \sqrt{63551.384 + 4181.691}$

$= \sqrt{67733.075}$

$\boxed{EB = 260.255 \text{ m.}}$

Bearing of EB $= \tan^{-1}\left[\frac{\Sigma D}{\Sigma L}\right]$

$= \tan^{-1}\left[\frac{64.666}{252.093}\right]$

$= \tan^{-1}[0.2565]$

$= 14°23'13.57''$ (or) $14°23'14''$

Since latitude and departure of EB in SE ie $(-,+)$.

$\therefore$ Bearing of EB $= S14°23'13.57''E$. (or)

$= S14°23'14''E$.

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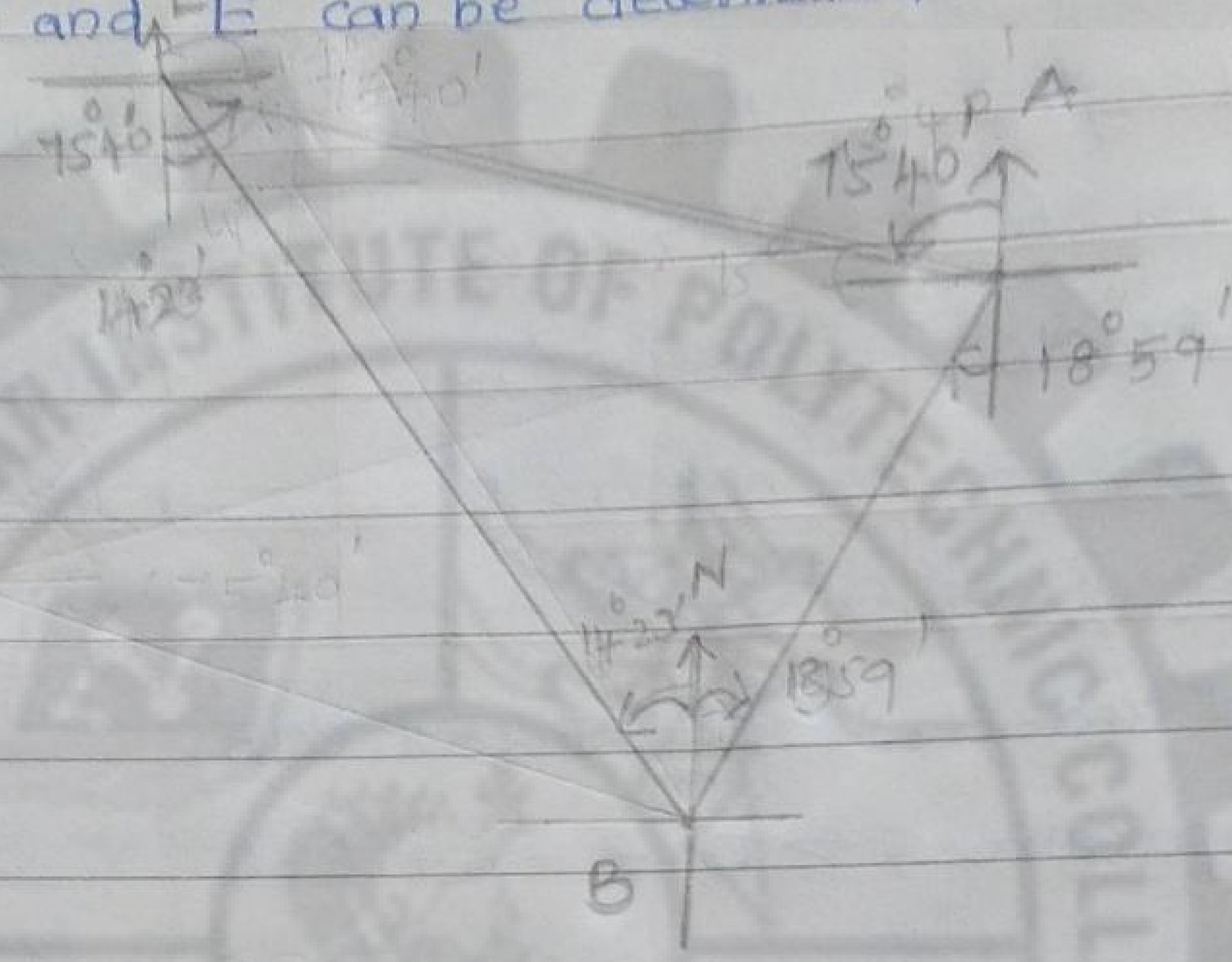
Now consider the triangle, ABE,

Included angles A, B and E can be determined from bearings EA, AB & BE



$\angle A = 180°00' - [18°59' + 75°40']$
$= 85°21'$

$\angle B = 18°59' + 14°23'14''$
$= 33°22'14''$

$\angle E = 75°40' - 14°23'14''$
$= 61°16'46''$

(or) $\angle A + \angle B + \angle C = 180°$
$85°21' + 33°22'14'' + \angle C = 180°$
$118°43'14'' + \angle C = 180°$
Now, $\angle C = 180° - 118°43'14''$
$= 61°16'46''$

In the triangle Δ^{le} ABE,

we know that, Length of EB = 260.255 m.

$\angle A = 85°21'$
$\angle B = 33°22'14''$
$\angle E = 61°16'46''$

So, Now Apply Sine rule.

$$\frac{EB}{\sin \angle A} = \frac{EA}{\sin \angle B} = \frac{AB}{\sin \angle E}$$
(1) (2) (3)

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Take the equation ① and ②

$$\frac{EB}{\sin\angle A} = \frac{EA}{\sin\angle B}$$

Now, $EA = \frac{EB}{\sin\angle A} \times \sin\angle B$

$$= \frac{260.255}{\sin 85^\circ 21'} \times \sin 33^\circ 22' 14''$$

$$= \frac{260.255}{0.9967} \times 0.5500$$

$$\boxed{EA = 143.614 \text{ m}}$$

Now Take ① and ③

$$\frac{EB}{\sin\angle A} = \frac{AB}{\sin\angle E}$$

Now, $AB = \frac{EB}{\sin\angle A} \times \sin\angle E$

$$= \frac{260.255}{0.9967} \times \sin 61^\circ 16' 14''$$

$$= \frac{260.255}{0.9967} \times 0.87689$$

$$\boxed{AB = 228.970 \text{ m}}$$

Result:-

Length of EA = 143.614 m.

Length of AB = 228.970 m.

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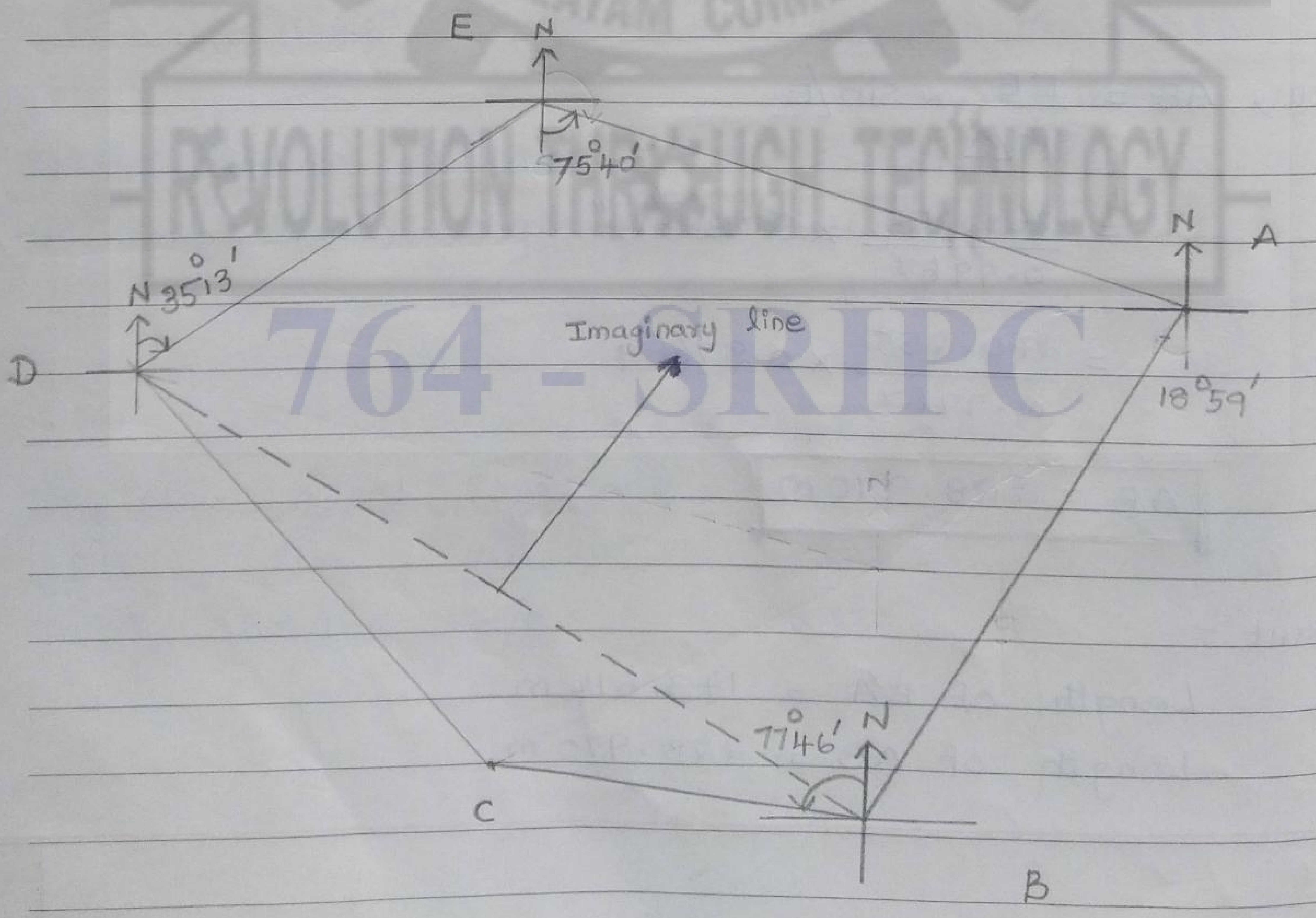
6] The following are the lengths and bearings of a closed traverse ABCDE, in which the length and bearing of BC and CD respectively were omitted due to some obstacle. Calculate those omitted measurements.

Line	Length (m)	R.B.
AB	229.00	S 18°59′ W
BC	—	N 77°46′ W
CD	80.00	—
DE	199.25	N 35°13′ E
EA	143.62	S 75°40′ E

Here Join B and D to form an imaginary line BD.
Now, ABDE becomes closed traverse.
First determine the length and bearing of BD,
then solve the triangle Δ^{le} BCD for length of BC and bearing of CD.



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Line	Length (m)	RB	Latitude (m)	Departure (m)
AB	229.0	S 18°59' W	−216.545	−74.492
BD		−		
DE	199.25	N 35°13' E	+162.782	+114.901
EA	143.62	S 75°40' E	−35.554	+139.149

Sum of Latitudes, $\Sigma L = -89.317 = +89.317$.

Sum of Departures $\Sigma D = 179.558 = -179.558$.

Length of BD $= \sqrt{(\Sigma L)^2 + (\Sigma D)^2}$

$= \sqrt{(89.317)^2 + (179.558)^2}$

$= \sqrt{7977.526 + 32241.075}$

$= \sqrt{40218.601}$

$= 200.545\,m.$

$\boxed{\text{Length of BD} = 200.545\,m.}$

Bearing of BD $= \tan^{-1}\left[\dfrac{\Sigma D}{\Sigma L}\right]$

$= \tan^{-1}\left[\dfrac{179.558}{89.317}\right]$

$= \tan^{-1}[2.010]$

$= 63°33'10''$

$\boxed{\therefore \text{Bearing of BD} = N\ 63°33'10''\ W.}$

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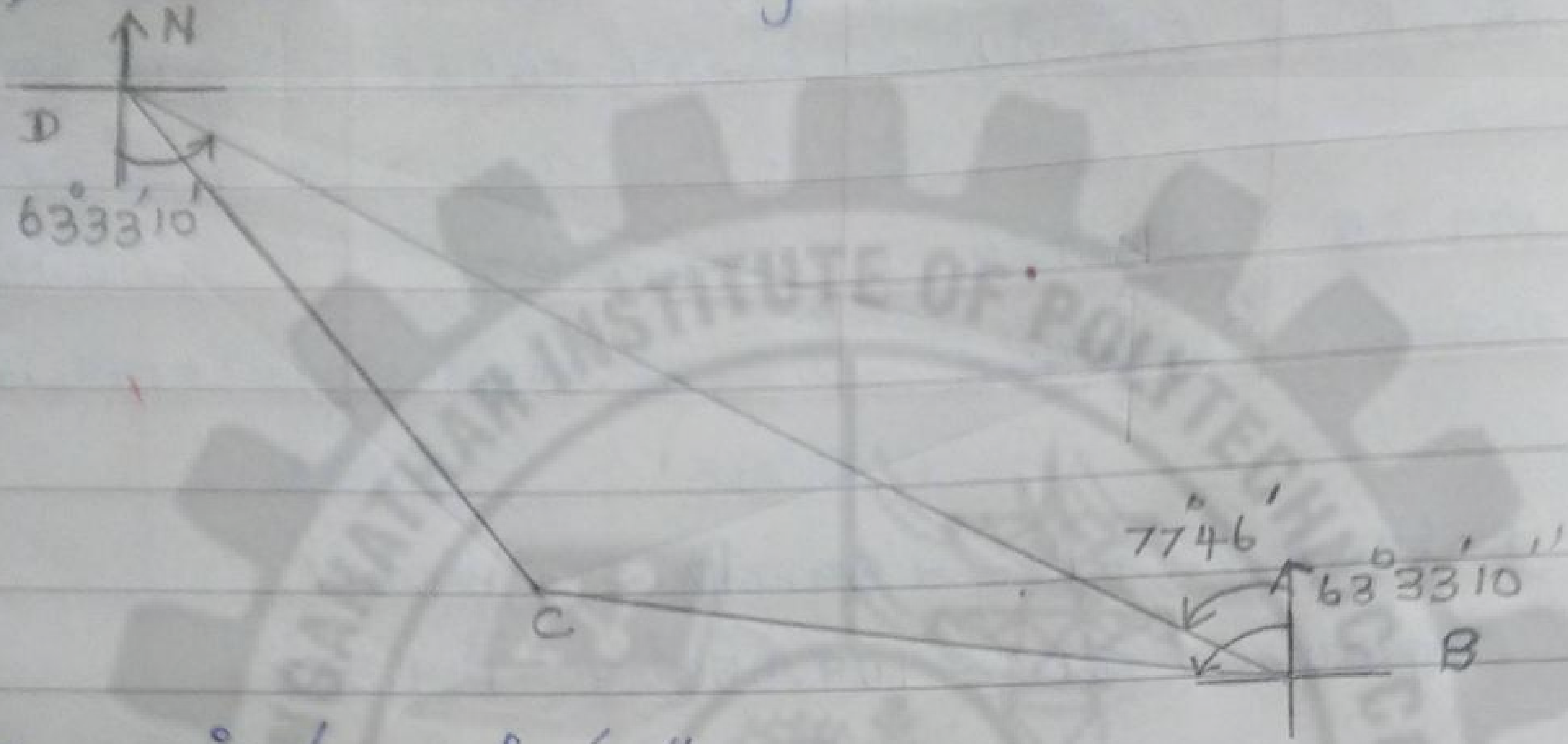
Now, consider the triangle, Δ^{le} BCD,



$\angle B = 77°46' - 63°33'10''$

$\boxed{\angle B = 14°12'50''}$

Now, we know that,

Length of BD = 200.545 m.

Length of CD = 80.00 m.

Use Sine rule,

$$\frac{CD}{\sin\angle B} = \frac{BD}{\sin\angle C}$$

$$\frac{80}{\sin 14°12'50''} = \frac{200.545}{\sin\angle C}$$

$$\sin\angle C = \left[\frac{200.545 \times \sin 14°12'50'}{80}\right]$$

Now $\angle C = \sin^{-1}\left[200.545 \times 3.069273\right]$

$\angle C = 37°59'25''.25$

It is abtuse and less than 180°.

So, $\therefore \angle C = 180° - 37°59'25.25'' = 142°0'34''.75$

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So, $\angle C = 142°0'34.75''$

Hence $\boxed{\angle C = 142°0'34.75''}$

Now, $\angle C + \angle B + \angle D = 180°$

$\angle D = 180° - [\angle C + \angle B]$

$= 180° - [142°0'34.75'' + 14°12'50'']$

$= 180° - [156°13'24.7'']$

$\boxed{\angle D = 23°46'35.25''}$

Now, To find the length of BC, using sine rule,

$$\frac{BD}{\sin \angle C} = \frac{BC}{\sin \angle D}$$

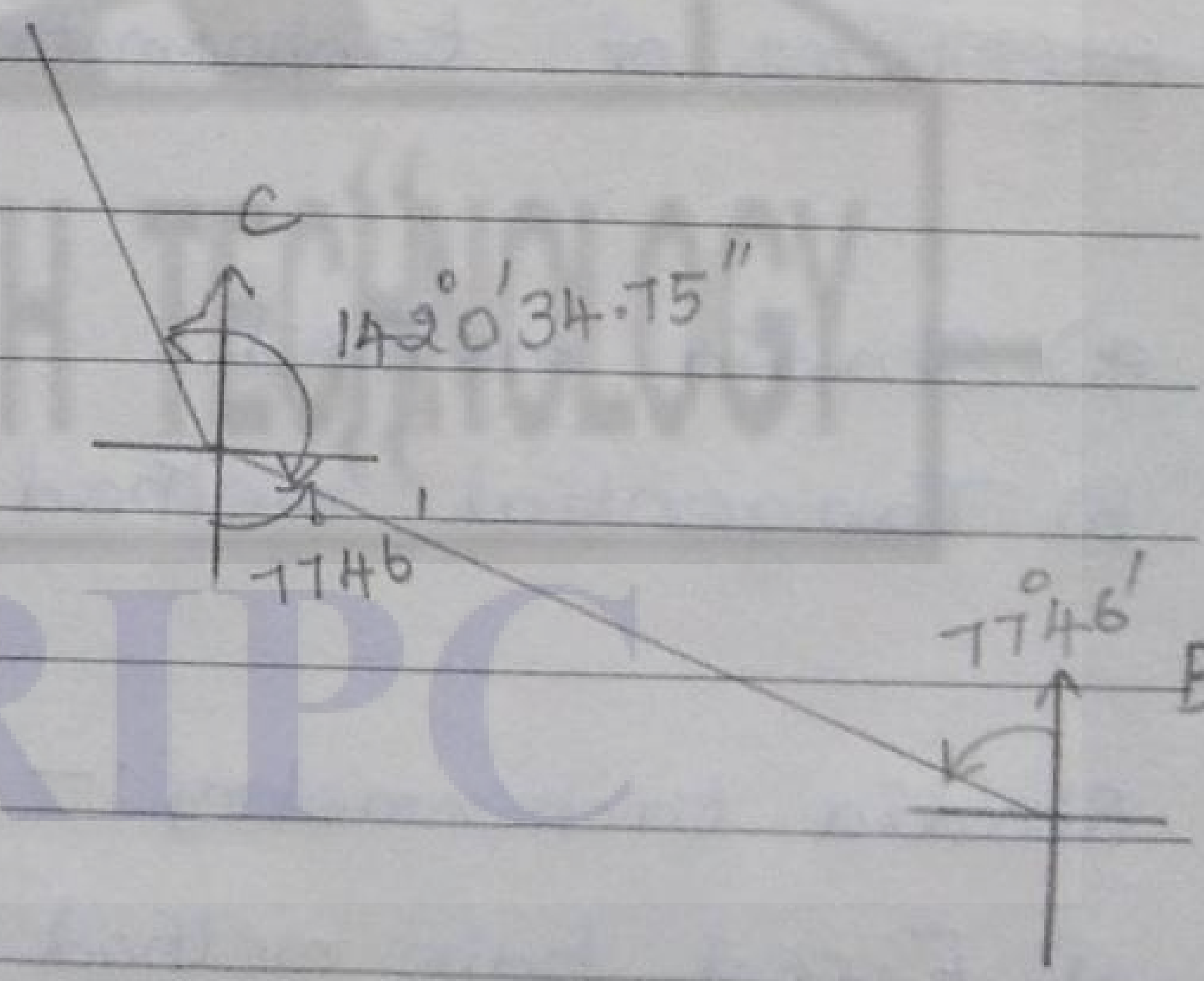
$$\therefore BC = \frac{BD}{\sin \angle C} \times \sin \angle D$$

$$BC = \frac{200.545}{\sin 142°0'35.25} \times \sin 23°46'35.25''$$

$$= 325.8103 \times \sin 23°46'35.25''$$

$$= 131.3567\ m.$$

$\boxed{BC = 131.3567\ m}$



Bearing of CD = $142°0'34.75 + 77°46'$

$= 219°46'34.7''$

It is greater than 180°

So, $219°46'34.7'' - 180°$

Bearing of CD = $39°46'34.75''$

$\boxed{= N\,39°46'35''\,W.}$

Result:-

Length of BC = 131.3567 m.

Bearing of CD = N 39°46'35" W.

TACHEOMETRIC SURVEYING.

Angular Survey in which horizontal and vertical distances of Points obtained by instrumental observations. In this Surveying chaining is totally avoided. The main object of tacheometry is Preparation of contoured maps or Contour plans.

Tacheometer:-

A transit theodolite fitted with a stadia diaphragm is called tacheometer.

Stadia diaphragm:-

It consists of two horizontal hairs called stadia hairs in addition to regular cross hairs. The additional hairs are equal distance from the central hair and they are known as stadia lines.

Systems of tachoometry :-

a) Stadia method.
b) Tangential method.

Stadia tacheometry :-
a) Fixed hair method.
b) Movable hair method.

Anallatic lens :-

The fixation of lens between the eye view and object view in the centre.

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contour Surveying :-

It is a method of Surveying conducted to find the elevation of the various points on the earth Surface.

contour:-

The line Joining points of equal elevations on the Surface of the earth.

Assignment : NO:- 3.

1. Write about the applications of total station.
2. Describe setting of measurements (angles, distance and bearings) in total station.
3. What is meant by differential GPS.
4. Explain the element component of GPS.
5. Explain the observation, data processing ~~of~~ of GPS and its applications in civil engineering.