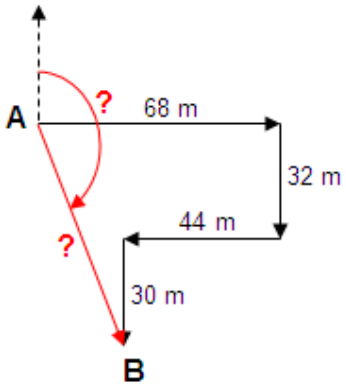
**MAD 256 – SURVEYING** **April 1st, 2010**
**1st MIDTERM EXAM – ANSWERS**

Name&Surname : ……

**(10 p) 1.** A person starts to walk from the point A. First he walks 68 m towards East, then 32 m towards South, then 44 m towards West and finally 30 m towards South. Thus, he reaches to the point B. Determine the horizontal distance between the points in meter and azimuth of line AB in degree.




**SOLUTION :**

Distance in horizontal direction ($\Delta E$) = 68-44 = 24 m
Distance in vertical direction ($\Delta N$) = 32+30 = 62 m
Horizontal distance = $(\Delta E^2+\Delta N^2)^{1/2} = (24^2+62^2)^{1/2}$ = **66.48 m**
Coordinate of point B (N, E) is (-62, 24)
$\tan \alpha = \Delta E/\Delta N = 24/-62 = -0.387$ then
$\alpha$ = atan (-0.387) = $-21.16^o$
$Az_{AB} = -21.16^o + 180 =$ **$158.84^o$**

**(15 p) 2.** A slope distance of 265 m was measured on a slope of 1.5%. If the temperature is 0°C and true length of the tape used is 30.004 m, determine the corrected horizontal distance.
(Temperature correction, $C_t = 0.0000116(T - 20)\times L$)

**SOLUTION :**

Temperature correction, $C_t = 0.0000116(T - 20)L = 0.0000116(0-20)*265 = -0.0615$ m
Errenous tape correction = -[(30-30.004)*(265/30)] = 0.035 m
Corrected slope distance = 265-0.0615+0.035 = 264.9735 m
Slope in degree, $\alpha$ = atan (1.5/100) = $0.859^o$
Corrected horizontal distance = 264.9735*cos $0.859^o$ = 264.944 m

**(10 p) 3.** Make the necessary conversions for the followings.
**a)** $34^o$ = ? gon **b)** $72^o$ = ? radian **c)** 3% = ? degree **d)** $5\pi/8$ = ? degree

**SOLUTION :**

**a)** $34^o = (34*400/360) = 37.78$ gon (grade)
**b)** $72^o = 72*2\pi/360 = 0.4\pi$ radian = 1.256 radian
**c)** 3% = atan(3/100) = 1.72 degree
**d)** $5\pi/8 = (5\pi/8)*360/2\pi$ = 112.5 degree

**(15 p) 4.** The interior angles of a triangle are measured as $75^o12'16"$, $38^o29'45"$ and $66^o17'38"$. Determine the error in this measurement and then correct the angles.

**SOLUTION :**

Sum of measured angles = $75^o12'16"+38^o29'45"+66^o17'38" = 179^o59'39"$
Error = measured-true = $179^o59'39"-180^o = 179^o59'39"-179^o59'60"$ = **-21"**
Correction for each angle = -error/3 = -(-21"/3) = +7"
Accuracy is 1: [((179*3600)+(59*60)+39)/21] = **1:30850**
Corrected angles;

$75^o12'16"+7"$ = **$75^o12'23"$**
$38^o29'45"+7"$ = **$38^o29'52"$**
$66^o17'38"+7"$ = **$66^o17'45"$**

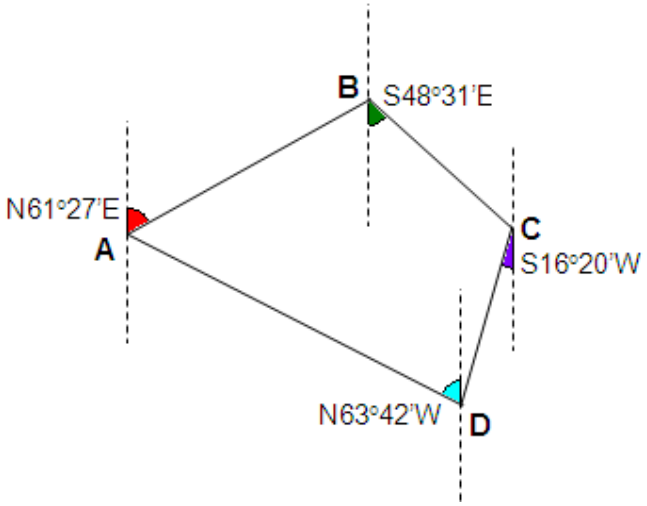
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sum $179^o58'120" = 179^o60' = 180^o$ (✓)

**(25 p) 5.** Sides of a closed traverse ABCD have the following bearings: AB=N61$^o$27'E, BC=S48$^o$31'E, CD=S16$^o$20'W, DA=N63$^o$42'W. Compute the interior angles and the azimuths of the sides.

**SOLUTION :**

Azimuth of AB = Bearing angle of AB = **61$^o$27'**
Azimuth of BC = 180-Bearing angle of BC = 180-48$^o$31' = **131$^o$29'**
Azimuth of CD = 180+Bearing angle of CD = 180+16$^o$20' = **196$^o$20'**
Azimuth of DA = 360-Bearing angle of DA = 360-63$^o$42' = **296$^o$18'**
Interior angle A = $Az_{AD}$-$Az_{AB}$ = (296$^o$18'-180) - 61$^o$27' = **54$^o$51'**
Interior angle B = $Az_{BA}$-$Az_{BC}$ = (61$^o$27'+180) - 131$^o$29' = **109$^o$58'**
Interior angle C = $Az_{CB}$-$Az_{CD}$ = (131$^o$29'+180) - 196$^o$20' = **115$^o$09'**
Interior angle D = $Az_{DC}$-$Az_{DA}$ = (196$^o$20'-180) - 296$^o$18' = -279$^o$58'+360 = **80$^o$02'**
Check sum of interiors = 54$^o$51'+109$^o$58'+115$^o$09'+80$^o$02' = 360$^o$

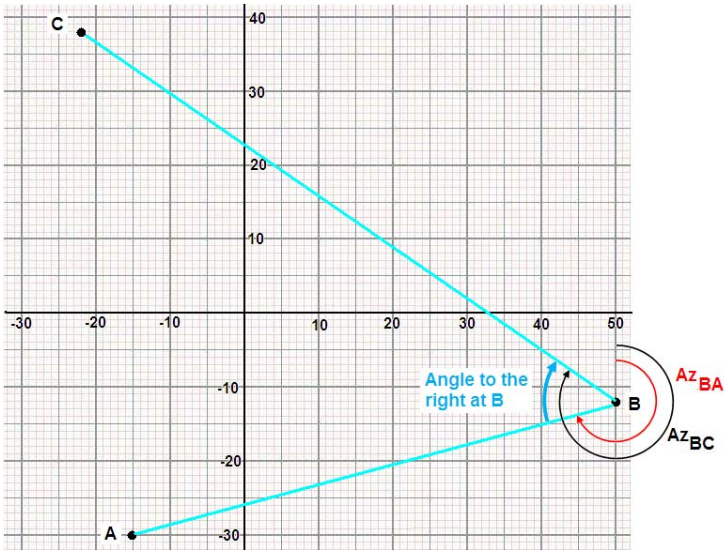



**(25 p) 6.** The coordinates of points A, B and C which belong to a broken line are given as follows. Calculate angle to the right at point B (in degree).

| | Coordinates (m) | |
|---|---|---|
| Point | Easting | Northing |
| A | -15 | -30 |
| B | 50 | -12 |
| C | -22 | 38 |

**SOLUTION :**

Azimuth of BA = atan ($\Delta$E/$\Delta$N) =
atan [($E_A$-$E_B$)/ ($N_A$-$N_B$)] =
atan [(-15-50)/(-30+12)] =
atan (-65/-18) = 74.52$^o$
Azimuth of BA = 74.52$^o$+180 = 254.52$^o$
Azimuth of BC = atan ($\Delta$E/$\Delta$N) =
atan [($E_C$-$E_B$)/ ($N_C$-$N_B$)] =
atan [(-22-50)/(38+12)] =
atan (-72/50) = -55.22$^o$
Azimuth of BC = -55.22$^o$+360 = 304.78$^o$
Since $Az_{BC}$> $Az_{BA}$ then
Angle to the right at point B =
304.78$^o$-254.52$^o$ = **50.26$^o$**



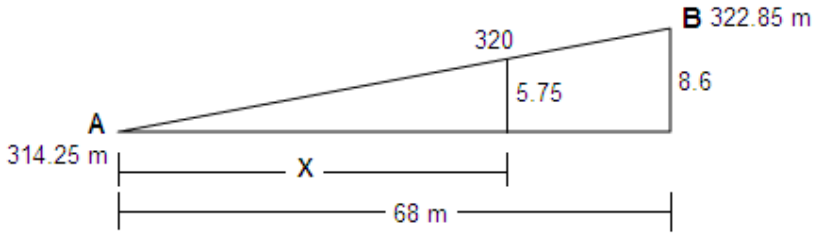
**MAD 256 – SURVEYING** **May 10th, 2010**
**2nd MIDTERM EXAM – 100 min**

Name&Surname : ……

**Notes :** i) Use maximum 3 digits for decimal parts of numbers (e.g., 25.127)
ii) Analytical solutions are required for all questions. You can use graphics to control your calculations.

**(10 p) 1.** Horizontal distance between the points A and B is 68 m. Elevations of the points A and B are 314.25 m and 322.85 m respectively. What is the distance of the 320 m contour from the point A (assume linear slope between the points).

**SOLUTION :**




Vertical distance at B = 322.85-314.25 = 8.6 m
Vertical distance at 320 = 320-314.25 = 5.75 m
Using similar triangles to determine X
(8.6/68) = (5.75/X) ➔ X = 5.75*68/8.6 = 45.46 m

**(30 p) 2.** Latitudes and departures of the courses of a four-sided closed traverse are given as follows. Determine its area by using DMD (Double Meridian Distance) method.

| Course | Latitude (m) | Departure (m) |
|---|---|---|
| AB | 80 S | 20 E |
| BC | 110 N | 120 W |
| CD | 40 N | 140 E |

**SOLUTION :**

First of all, latitude and departure of the missing course (DA) should be determined to satisfy ΣLatitude=0 and ΣDeparture=0. Then:
-80+110+40+LatDA =0 ➔ LatDA = 70 S and 20-120+140+DepDA =0 ➔ DepDA = 40 W
If we draw the reference meridian line passes the most westerly point (which is C), then:
DMD of course CD = Departure of itself = 140
DMD of course DA = DMD of CD+Dep.of CD+Dep.of DA = 140+140-40 = 240
DMD of course AB = DMD of DA+Dep.of DA+Dep.of AB = 240-40+20 = 220
DMD of course BC = DMD of AB+Dep.of AB+Dep.of BC = 220+20-120 = 120 (= dep.of AB)
Now we can determine double areas by using DMD*Latitude;
For course CD, Double area = 140*40 = + 5600
For course DA, Double area = 240*(-70) = - 16800
For course AB, Double area = 220*(-80) = - 17600
For course BC, Double area = 120*110 = +13200
Sum of double areas = abs(-15600) = 15600 $m^2$, then
**Area of traverse ABCDE = 15600/2 = 7800 $m^2$**

**(45 p) 3.** Courses of an open traverse with known coordinates of starting and ending points (A and B) are measured. Coordinates of A and B and also the lengths and the azimuth angles of the courses are given as follows.

Coordinates: $E_A$ = 170.00 m. $N_A$ = 125.00 m. $E_B$ = 232.60 m. $N_B$ = 121.00 m.

Lengths: $S_{A1}$ = 17 m. $S_{12}$ = 15 m. $S_{23}$ = 28 m. $S_{34}$ = 22 m. $S_{4B}$ = 20 m.

Determine :

a) Computed departure-latitude and coordinates,
b) Linear misclose at point B and accuracy of the measurement,
c) Amount of adjustments (dE&dN) in departure and latitude according to compass rule,
d) Adjusted departure and latitude, and then adjusted coordinates.

| Pnt | Course | Length (m) | Azimuth (gon) | Computed | | Computed | | Adjustments | | Adjusted | | Adjusted | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Departure (m) | Latitude (m) | Easting (m) | Northing (m) | dE (m) | dN (m) | Departure (m) | Latitude (m) | Easting (m) | Northing (m) |
| A | | | | | | 170.00 | 125.00 | | | | | 170.00 | 125.00 |
| | A1 | 17.00 | 55 | 12.93 | 11.04 | | | -0.03 | 0.05 | 12.90 | 11.09 | | |
| 1 | | | | | | 182.93 | 136.04 | | | | | 182.90 | 136.09 |
| | 12 | 15.00 | 75 | 13.86 | 5.74 | | | -0.03 | 0.05 | 13.83 | 5.79 | | |
| 2 | | | | | | 196.79 | 141.78 | | | | | 196.73 | 141.88 |
| | 23 | 28.00 | 205 | -2.20 | -27.91 | | | -0.06 | 0.08 | -2.26 | -27.83 | | |
| 3 | | | | | | 194.59 | 113.87 | | | | | 194.47 | 114.05 |
| | 34 | 22.00 | 65 | 18.76 | 11.49 | | | -0.04 | 0.07 | 18.72 | 11.56 | | |
| 4 | | | | | | 213.35 | 125.36 | | | | | 213.19 | 125.61 |
| | 4B | 20.00 | 115 | 19.45 | -4.67 | | | -0.04 | 0.06 | 19.41 | -4.61 | | |
| B | | | | | | 232.80 | 120.69 | | | | | 232.60 | 121.00 |
| TOTAL | | 102.00 | | | | | | -0.20 | 0.31 | | | | |

**a)** Dep.A1 = $S_{A1}$ * Sin (Az.A1) = 17*Sin($55^g$) = 12.93 m. Lat.A1 = $S_{A1}$ * Cos (Az.A1) = 17*Cos($55^g$) = 11.04 m.
Dep.12 = $S_{12}$ * Sin (Az.12) = 15*Sin($75^g$) = 13.86 m. Lat.12 = $S_{12}$ * Cos (Az.12) = 15*Cos($75^g$) = 5.74 m.
Dep.23 = $S_{23}$ * Sin (Az.23) = 28*Sin($205^g$) = -2.20 m. Lat.23 = $S_{23}$ * Cos (Az.23) = 28*Cos($205^g$) = -27.91 m.
Dep.34 = $S_{34}$ * Sin (Az.34) = 22*Sin($65^g$) = 18.76 m. Lat.34 = $S_{34}$ * Cos (Az.34) = 22*Cos($65^g$) = 11.49 m.
Dep.4B = $S_{4B}$ * Sin (Az.4B) = 20*Sin($115^g$) = 19.45 m. Lat.4B = $S_{4B}$ * Cos (Az.4B) = 20*Cos($115^g$) = -4.67 m.

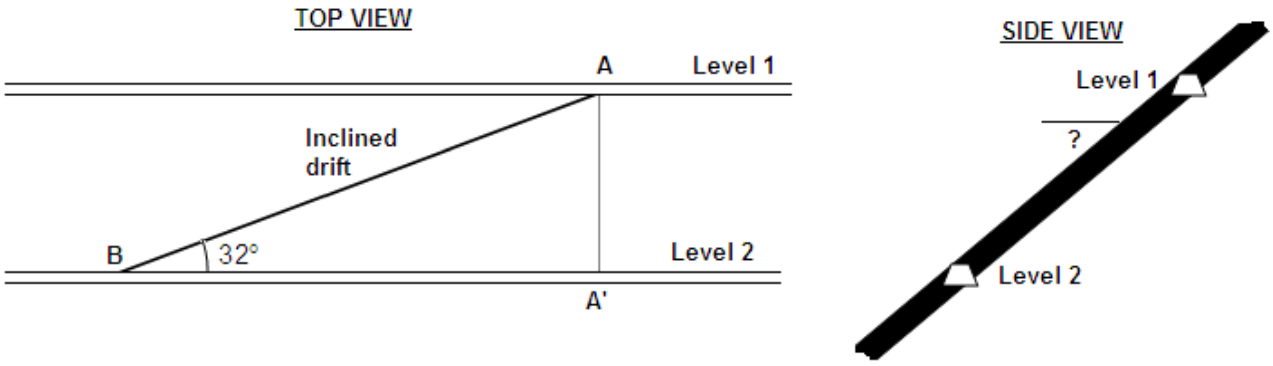
$E_1 = E_A$ + Dep.A1 = 170 + 12.93 = 182.93 m. $N_1 = N_A$ + Lat.A1 = 125 + 11.04 = 136.04 m.
$E_2 = E_1$ + Dep.12 = 182.93 + 13.86 = 196.79 m. $N_2 = N_1$ + Lat.12 = 136.04 + 5.74 = 141.78 m.
$E_3 = E_2$ + Dep.23 = 196.79 - 2.20 = 194.59 m. $N_3 = N_2$ + Lat.23 = 141.78 - 27.91 = 113.87 m.
$E_4 = E_3$ + Dep.34 = 194.59 + 18.76 = 213.35 m. $N_4 = N_3$ + Lat.34 = 113.87 + 11.49 = 125.36 m.
$E_B = E_4$ + Dep.4B = 213.35 + 19.45 = 232.80 m. $N_B = N_4$ + Lat.4B = 125.36 - 4.67 = 120.69 m.

**b)** Linear misclose at B = (Misclose in $Dep.^2$ + Misclose in $Lat.^2$)$^{1/2}$
Misclose in Dep. = Comp. Dep. of B – Given Dep. of B = 232.80 - 232.60 = 0.20 m.
Misclose in Lat. = Comp. Lat. of B – Given Lat. of B = 120.69 - 121.00 = -0.31 m.
Linear misclose at B = $(0.20^2 + 0.31^2)^{1/2}$ = 0.37 m.
Accuracy = 1 / (Total course length/Linear Misclose) = 1 / (102 / 0.37) = 1 / 275

**c)** $dE_{A1}$ = -Dep.Misc.* ($S_{A1}/\Sigma S$) = -0.20*(17/102) = -0.03 m. $dN_{A1}$ = Lat.Misc.* ($S_{A1}/\Sigma S$) = 0.31*(17/102) = 0.05 m.
$dE_{12}$ = -Dep.Misc.* ($S_{12}/\Sigma S$) = -0.20*(15/102) = -0.03 m. $dN_{12}$ = Lat.Misc.* ($S_{12}/\Sigma S$) = 0.31*(15/102) = 0.05 m.
$dE_{23}$ = -Dep.Misc.* ($S_{23}/\Sigma S$) = -0.20*(28/102) = -0.06 m. $dN_{23}$ = Lat.Misc.* ($S_{23}/\Sigma S$) = 0.31*(28/102) = 0.08 m.
$dE_{34}$ = -Dep.Misc.* ($S_{34}/\Sigma S$) = -0.20*(22/102) = -0.04 m. $dN_{34}$ = Lat.Misc.* ($S_{34}/\Sigma S$) = 0.31*(22/102) = 0.07 m.
$dE_{4B}$ = -Dep.Misc.* ($S_{4B}/\Sigma S$) = -0.20*(20/102) = -0.04 m. $dN_{4B}$ = Lat.Misc.* ($S_{4B}/\Sigma S$) = 0.31*(20/102) = 0.06 m.

**d)** Adj.Dep. A1 = Comp.Dep. A1 + $dE_{A1}$ = 12.93 - 0.03 = 12.90 m. Adj.$E_1$ = 170.00+12.90 = 182.90 m.
Adj.Lat. A1 = Comp.Lat. A1 + $dN_{A1}$ = 11.04 + 0.05 = 11.09 m. Adj.$N_1$ = 125.00+11.09 = 136.09 m.
Adj.Dep. 12 = Comp.Dep. 12 + $dE_{12}$ = 13.86 - 0.03 = 13.83 m. Adj.$E_2$ = 182.90+13.83 = 196.73 m.
Adj.Lat. 12 = Comp.Lat. 12 + $dN_{12}$ = 5.74 + 0.05 = 5.79 m. Adj.$N_2$ = 136.09+5.79 = 141.88 m.
Adj.Dep. 23 = Comp.Dep. 23 + $dE_{23}$ = -2.20 - 0.06 = -2.26 m. Adj.$E_3$ = 196.73-2.26 = 194.47 m.
Adj.Lat. 23 = Comp.Lat. 23 + $dN_{23}$ = -27.91 + 0.08 = -27.83 m. Adj.$N_3$ = 141.88-27.83 = 114.05 m.
Adj.Dep. 34 = Comp.Dep. 34 + $dE_{34}$ = 18.76 - 0.04 = 18.72 m. Adj.$E_4$ = 194.47+18.72 = 213.19 m.
Adj.Lat. 34 = Comp.Lat. 34 + $dN_{34}$ = 11.49 + 0.07 = 11.56 m. Adj.$N_2$ = 114.05+11.56 = 125.61 m.
Adj.Dep. 4B = Comp.Dep. 4B + $dE_{4B}$ = 19.45 - 0.04 = 19.41 m. Adj.$E_B$ = 213.19+19.41 = 232.60 m.
Adj.Lat. 4B = Comp.Lat. 4B + $dN_{4B}$ = -4.67 + 0.06 = -4.61 m. Adj.$N_B$ = 125.61-4.61 = 121.00 m.

**(15 p) 4.** As seen from the figure (top view), two levels driven in an inclined coal seam are connected at points A and B with an inclined drift. If it's true length and inclination is 430 m and $12^o$, respectively, determine true dip of coal seam.




**SOLUTION :**

Vertical distance of AB = 430xsin $12^o$ = 89.40 m (Vertical distance between the levels)
Horizontal distance of AB = 430xcos $12^o$ = 420.60 m
Horizontal distance AA' = 420.6xsin $32^o$ = 222.88 m
Dip of coal seam = arctan (89.40/222.88) = $21.86^o$

**MAD 256 – SURVEYING** **June 4th, 2010**
**FINAL EXAM – SOLUTIONS**

**(30 p) 1.** Elevations of the bench marks BM20 and BM21 are given as 299.780 m and 299.630 m respectively. Determine the elevations of the points and check it for point BM21. If the given elevation is not obtained, make necessary corrections according to compass rule and make necessary arithmetic checks. (Show details of your calculations, write the results on the table).

| Point | Hori.Dist. (m) | BS (m) | FS (m) | ΔH (m) | Elevation (m) | Corrected ΔH (m) | Corrected Elevation (m) |
|---|---|---|---|---|---|---|---|
| BM 20 | | 1.780 | | | 299.780 | | 299.780 |
| | 50.00 | | | | | | |
| A | | 0.570 | 2.130 | -0.350 | 299.430 | -0.384 | 299.396 |
| | 68.00 | | | | | | |
| B | | 1.670 | 0.700 | -0.130 | 299.300 | -0.176 | 299.220 |
| | 34.00 | | | | | | |
| C | | 1.090 | 0.750 | 0.920 | 300.220 | 0.897 | 300.117 |
| | 82.00 | | | | | | |
| D | | 1.730 | 2.280 | -1.190 | 299.030 | -1.246 | 298.871 |
| | 76.00 | | | | | | |
| BM 21 | | | 0.920 | 0.810 | 299.840 | 0.759 | 299.630 |
| TOTAL | 310.00 | 6.840 | 6.780 | 0.060 | | -0.150 | |

**SOLUTION :**

Arithmetic check ➔ ΣBS-ΣFS = 6.84-6.78 = 0.06 m. is equal to ΣΔH = 0.06 m.
Also BM21-BM20 = 299.84-299.78 = 0.06 m.
Elevation of BM21 is given as 299.63 m. Therefore, error is;
Error in BM21=299.84-299.63=0.21 m.
Correlation=-0.21/310=-0.00068 m for per meter of horizontal distance. Therefore
At line BM20&A, correction = -0.00068*50=-0.034 m
At line A&B, correction = -0.00068*68=-0.046 m
At line B&C, correction = -0.00068*34=-0.023 m
At line C&D, correction = -0.00068*82=-0.056 m
At line D&BM21, correction = -0.00068*76=-0.051 m
TOTAL =-0.210 m (equals to total error)
Corrected ΔH=ΔH+ correction = -0.350+(-0.034)= -0.384 m. and so on for the others.
Total Corrected ΔH=-0.150 m. which is equal to
Corr.El.BM21- El.BM20=299.630-299.780= -0.150 m.
After finding corrected ΔH values, corrected elevations are determined accordingly and the elevation of point BM21 is obtained as given (299.630)

**(15 p) 2.** The coordinates of the points A and B are given. Determine the azimuth of AB (in degree) and the distance between the points (in meter).

| | Coordinates (m) | |
|---|---|---|
| Point | Easting | Northing |
| A | -20.50 | 42.30 |
| B | -65.20 | -50.10 |

**SOLUTION :**

$\tan \alpha = \Delta E/\Delta N = (E_B-E_A)/(N_B-N_A) = [-65.20-(-20.50)]/[-50.10-42.30] = [-44.70]/[-92.40]$
$\tan \alpha = 0.4838$ then $\alpha = 25^o.816$
If ΔE and ΔN are both negative, then Azimuth AB = $\alpha+180 = 25^o.816+180^o =$ **$205^o.816$**
Distance = $[(\Delta E)^2+(\Delta N)^2]^{1/2} = [(44.70)^2+(92.40)^2]^{1/2} = [10535.85]^{1/2} =$ **102.64 meter**

**(25 p) 3.** Determine the area ($m^2$) of the following parcel by using trapezoid method.

| | Coordinates (m) | |
|---|---|---|
| Point | Easting | Northing |
| A | -80 | 20 |
| B | 100 | 220 |
| C | 80 | -30 |
| D | 200 | -150 |
| E | -20 | -210 |

**SOLUTION :**

For easier calculation, shift axes to Point A (most westerly point) and to Point E (most southerly point).

| | Coordinates (m) | | Shifted Coordinates (m) | |
|---|---|---|---|---|
| Point | Easting | Northing | Easting | Northing |
| A | -80 | 20 | 0 | 230 |
| B | 100 | 220 | 180 | 430 |
| C | 80 | -30 | 160 | 180 |
| D | 200 | -150 | 280 | 60 |
| E | -20 | -210 | 60 | 0 |

Area of ABCDE is composition of trapezoidal areas.

Area(ABCDE) = Area(B'BCC')+Area(C'CDD')+Area(D'DEE')-Area(B'BAA')-Area(A'AEE')

Area of trapezoid =(Sum of Eastings/2)(Difference of Northings)

Area(B'BCC') = [(180+160)/2]*(430-180) = 170*250 = 42500 $m^2$

Area(C'CDD') = [(160+280)/2]*(180-60) = 220*120 = 26400 $m^2$

Area(D'DEE') = [(280+60)/2]*(60-0) = 170*60 = 10200 $m^2$

Area(B'BAA') = [(180+0)/2]*(430-230) = 90*200 = 18000 $m^2$

Area(A'AEE') = [(60+0)/2]*(230-0) = 30*230 = 6900 $m^2$

Area(ABCDE) = 42500+26400+10200-18000-6900 = 79100-24900 = 54200 $m^2$

Correlated according to coordinates method

| | Easting | Northing | | Plus | Minus |
|---|---|---|---|---|---|
| A | 0 | 230 | | 0 | 41400 |
| B | 180 | 430 | | 32400 | 68800 |
| C | 160 | 180 | | 9600 | 50400 |
| D | 280 | 60 | | 0 | 3600 |
| E | 60 | 0 | | 13800 | 0 |
| A | 0 | 230 | | 55800 | 164200 |
| | | | Area = | 54200 | $m^2$ |

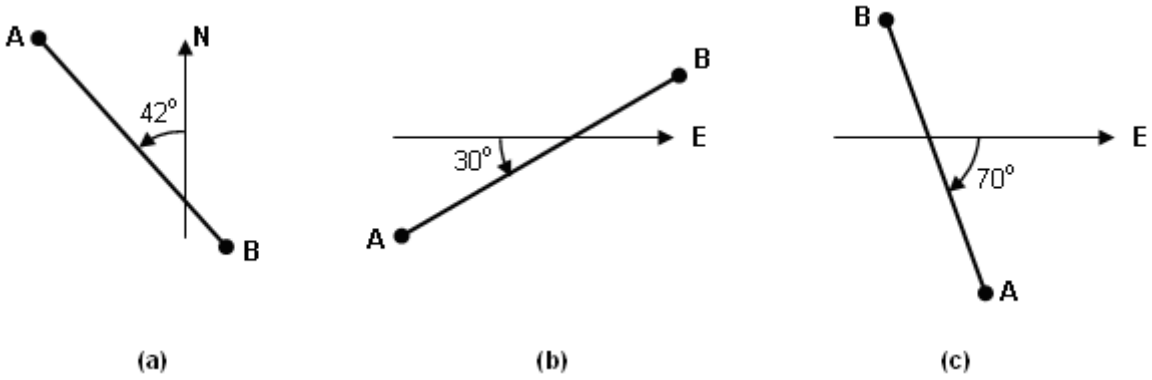
**(15 p) 4.** The side lengths of a rectangle on the plan are 5 cm and 10 cm. It represents a property with an area of 5000 $m^2$. Determine the scale of the plan.

**SOLUTION :**

$f/F=1/M^2$ ➔ $M = (F/f)^{1/2} = [50000000\ cm^2/(5*10\ cm^2)]^{1/2} = [1000000]^{1/2} = 1000$

then, scale = 1:1000

**(15 p) 5.** Determine the bearing and the azimuth angles of the lines AB in each of the following figures. (Show your drawings and calculations)




(a) (b) (c)

**SOLUTION :**

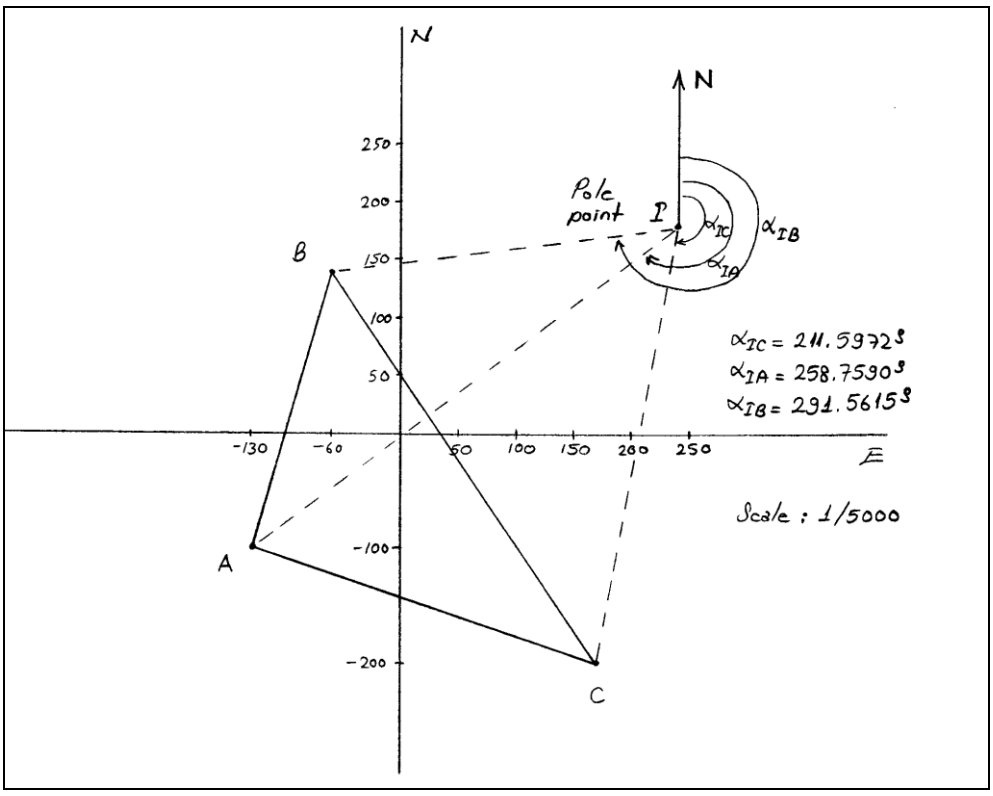
**a)** Azimuth AB = $180^o$-$42^o$= $138^o$ Bearing (SE quadrant) = S ($180^o$-$138^o$) E = S $42^o$ E

**b)** Azimuth AB = $90^o$-$30^o$= $60^o$ Bearing (NE quadrant) = N $60^o$ E

**c)** Azimuth AB = $360^o$-($90^o$-$70^o$)= $340^o$ Bearing (NW quadrant) = N ($360^o$-$340^o$) W=N $20^o$ W

**(10 p) 6.** The corner coordinates of a triangular property (ABC) and location coordinate of pole point (I) are given as follows. If the azimuth angles are measured from the pole point, determine the area of the property in $m^2$ by using the equation A=(a.b.Sin$\alpha$)/2.

| Point | Coordinate (m) Northing | Easting | Course | Azimuth (Gon) |
|---|---|---|---|---|
| A | -100 | -130 | IA | $258.7590^g$ |
| B | 140 | -60 | IB | $291.5615^g$ |
| C | -200 | 170 | IC | $211.5972^g$ |
| I (Pole Pnt.) | 180 | 240 | | |




Before the area, we need to determine the distances IB, IA and IC. These can be achieved by using the coordinates of the points. Thus:

IB = $\sqrt{\Delta E^2 + \Delta N^2} = \sqrt{(240-(-60))^2 + (180-140)^2} = \sqrt{300^2 + 40^2} = 302.655$ m

IA = $\sqrt{\Delta E^2 + \Delta N^2} = \sqrt{(240-(-130))^2 + (180-(-100)^2} = \sqrt{370^2 + 280^2} = 464.004$ m

IC = $\sqrt{\Delta E^2 + \Delta N^2} = \sqrt{(240-170))^2 + (180-(-200))^2} = \sqrt{70^2 + 380^2} = 386.394$ m

From azimuths and distances we can determine the areas of triangles by using given equation

$Area_{IBA}$ = [IB*IA*sin($\alpha_{IB}$ - $\alpha_{IA}$)] /2 = [302.655*464.004*sin(291.5615-258.7590)] /2
= (140433.13*0.4927) / 2 = 34599.92 $m^2$

$Area_{IAC}$ = [IA*IC*sin($\alpha_{IA}$ - $\alpha_{IC}$)] /2 = [464.004*386.394*sin(258.7590-211.5972)] /2
= (179288.36*0.6749) / 2 = 60499.96 $m^2$

$Area_{IBC}$ = [IB*IC*sin($\alpha_{IB}$ - $\alpha_{IC}$)] /2 = [302.655*386.394*sin(291.5615-211.5972)] /2
= (116944.07*0.9509) / 2 = 55600.07 $m^2$

$Area_{ABC} = Area_{IBA} + Area_{IAC} - Area_{IBC}$ = 34599.92+60499.96-55600.07 = 39499.81 $m^2$

**$Area_{ABC}$ = 39499.81 $m^2$**