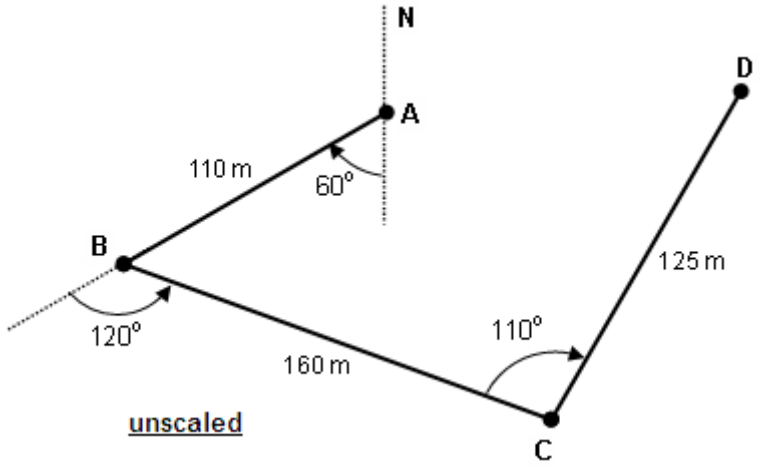
MAD 256 – SURVEYING **March 23rd, 2009**
1st MIDTERM EXAM – SOLUTIONS

(25 p) 1. Calculate the distance between the points A and D for the following figure.



SOLUTION :

To calculate the distance, first we have to determine the departures (ΔE) and latitudes (ΔN) of each lines.
Then; Distance AD = $[(\Delta E_{AD})^2+(\Delta N_{AD})^2]^{1/2}$

Azimuth AB = 180+60 = 240^o
Azimuth BC = Az.BA+(180-120) = 60+60 = 120^o
Azimuth CD = Az.BC+110-180 = 120-70 = 50^o

Departure of a line, ΔN=Line length*sin (azimuth) Latitude of a line, ΔE=Line length*cos (azimuth)

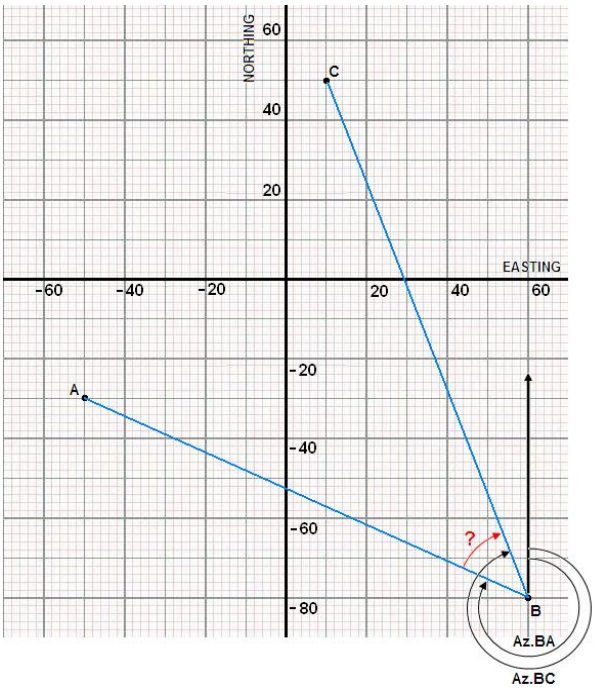
Dep.AB = 110*sin240 = -95.26 Lat.AB = 110*cos240 = -55
Dep.BC = 160*sin120 = 138.56 Lat.BC = 160*cos120 = -80
Dep.CD = 125*sin50 = 95.76 Lat.CD = 125*cos50 = 80.35
Dep.AD = -95.26+138.56+95.76 = 139.06 m Lat.AD = -55-80+80.35 = -54.65 m

Distance AD = $[(\Delta E_{AD})^2+(\Delta N_{AD})^2]^{1/2} = [(139.06)^2+(-54.65)^2]^{1/2} = (22324.31)^{1/2}$ = **149.41 m.**

(20 p) 2. The coordinates of the points ABC (a broken line) are given. Determine the angle to the right at point B in degree unit. Use the azimuths of lines.

Point	Coordinates (m) Northing	Easting
A	-30	-50
B	-80	60
C	50	10

SOLUTION :



Angle to right at point B can be determined after finding azimuth angles of the lines BC and BA. Then;

$\alpha_{BA} = \tan^{-1}(\Delta E/\Delta N) = \tan^{-1}[(E_A-E_B)/(N_A-N_B)]$
$= \tan^{-1}[(-50-60)/(-30+80)] = \tan^{-1}(-110/50) = -65.56^o$
Az.BA = $-65.56^o+360 = 294.44^o$

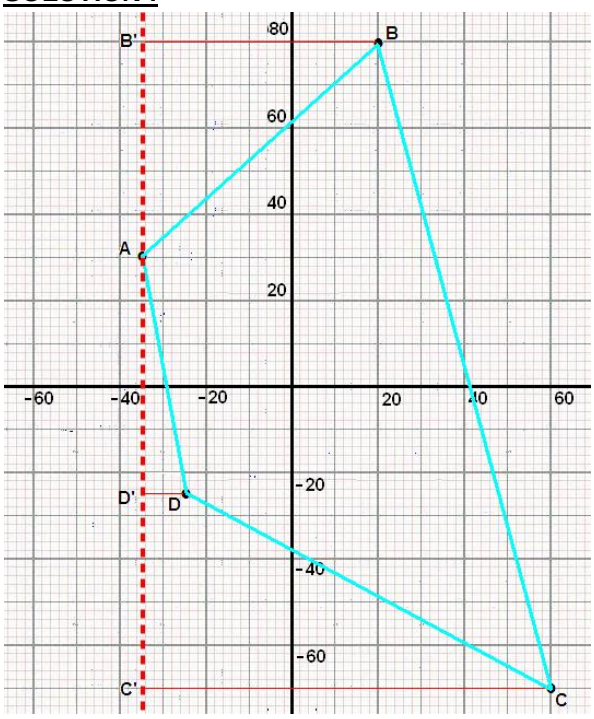
$\alpha_{BC} = \tan^{-1}(\Delta E/\Delta N) = \tan^{-1}[(E_C-E_B)/(N_C-N_B)]$
$= \tan^{-1}[(10-60)/(50+80)] = \tan^{-1}(-50/130) = -21.04^o$
Az.BC = $-21.04^o+360 = 338.96^o$

Angle to the right at B = $(\alpha_{BC}-\alpha_{BA})$ where $\alpha_{BC}>\alpha_{BA}$
= $(338.96^o-294.44^o)$ = **44.52^o**

(25 p) 3. The coordinates of the points ABCD (a tetragon) are given. Determine its area by using trapezoid shapes (area=[(a+b)/2]*h).

Point	Coordinates (m) Northing	Easting
A	30	-35
B	80	20
C	-70	60
D	-25	-25

SOLUTION :



$Area_{ABCD} = Area_{B'BCC'} - (Area_{B'BA} + Area_{ADD'} + Area_{D'DCC'})$

$2*Area_{ABCD}$ = [(B'B+C'C)*(B'C')] - (B'A*B'B) - (AD'*D'D)

- [(D'D+C'C)*(D'C')]

= {[(20+35)+(60+35)]*(80+70)} - [(80-30)*(20+35)]

- [(30+25)*(35-25)] - {[(35-25)+(60+35)]*(70-25)}

= {(55+95)*150} - (50*55) – [(55*10)] - {(10+95)*45}

= (150*150) - (2750) – (550) - (105*45) =

22500 – 2750 – 550 - 4725 = 14475 m^2

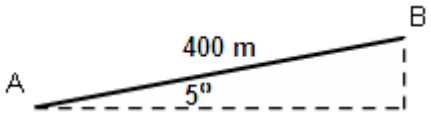
$2*Area_{ABCD}$ = 14475 m^2 ➔

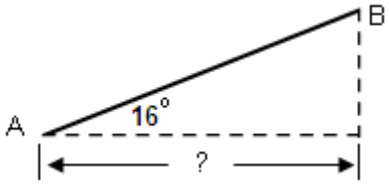
$Area_{ABCD}$ = 14475/2 m^2 = **7237.5 m^2**

(20 p) 4. Determine the missing parameters in the following questions.

a) Map distance of AB = 8 cm — Field distance of AB = 4 km — The scale of the map = ??

b) Map scale = 1/250000 — Field distance of CD = 6400 m — Map distance of CD = ?? mm





c) Elevation of point A = 416 m
Elevation of point B = ??

d) Elevation of point B = 838 m
Elevation of point A = 717 m
Horizontal distance of AB = ??

SOLUTION :

a) Scale = Map distance/Field distance = 8 cm / 400000 cm = **1/50000**

b) Map distance = Field distance*Scale = 6400000 mm / 250000 = **25.6 mm**

c) Elevation difference between B and A = 400*sin45 = 282.84 m

Elevation B = Elevation A + Difference = 416+282.84 = **698.84 m**

b) Elevation difference between A and B = 838-717 = 121 m

Elevation diff. = Horizontal distance*tan 16° ➔ Hor.dist. = 121/tan16 = **421.98 m**

(10 p) 5. The true length of a 20 m tape is 19.98 m. The sides of a rectangular field were measured as 162 m and 346 m. Determine the correct lengths.

SOLUTION :

The true length of 162 m. = (162/20)*19.98 = **161.84 m**

The true length of 346 m. = (346/20)*19.98 = **345.65 m**

MAD 256 – SURVEYING **May 8th, 2009**
2nd MIDTERM EXAM - SOLUTIONS

Name & Surname : .....

(30 p) 1. Determine the area of the traverse by using DMD (Double Meridian Distance) method.

	Coordinate (m)	
Point	Northing	Easting
A	90	-40
B	40	50
C	-60	40
D	-50	-20

---------- start here to solve ----------

Point A has the lowest Easting value that shows the most westerly point. Therefore reference meridian passes through A. Now, we determine departure and latitude values of the sides.

Departure of AB = $E_B - E_A$ Latitude of AB = $N_B - N_A$

Dep.of AB = 50-(-40) = +90 (≡ E90) ...m Lat.of AB = 40-90 = -50 (≡ S50) ...m

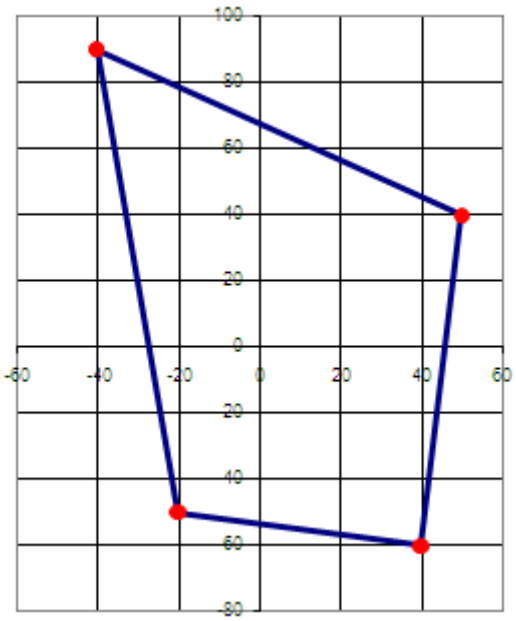
Dep.of BC = 40-50 = -10 (≡ W10) ...m Lat.of BC = -60-40 = -100 (≡ S100) ...m

Dep.of CD = -20-40 = -60 (≡ W60) ...m Lat.of CD = -50-(-60) = +10 (≡ N10) ...m

Dep.of DA = -40-(-20) = -20 (≡ W20) ...m Lat.of DA = 90-(-50) = +140 (≡ N140) ...m

Total departure = 0 Total latitude = 0 (checking done)

Departure of AB	= + 90	= ***DMD of AB***
Departure of AB	= + 90	
Departure of BC	= - 10	
	+ 170	= ***DMD of BC***
Departure of BC	= - 10	
Departure of CD	= - 60	
	+ 100	= ***DMD of CD***
Departure of CD	= - 60	
Departure of DA	= - 20	
	+ 20	= ***DMD of DA*** Checking done



				Double Areas	
Course	Latitude	Departure	DMD	+	-
AB	S 50	E 90	+ 90		4500
BC	S 100	W 10	+ 170		17000
CD	N 10	W 60	+ 100	1000	
DA	N 140	W 20	+ 20	2800	
Total	0.00	0.00		3800	21500

Double area = Absolute(-21500+3800) = 17700 m^2

Area of the field = 17700/2 = 8850 m^2

(45 p) 2. Angles and distances of an open traverse are given as follows. Also the coordinates of point A as 200N and 200E, point D as 387.87N and 348.01E, and the azimuth of side AB as 12.00^g are given. Compute (use 2 digits for decimals);

a) Coordinate miscloses (ΔN and ΔE) at point D,

b) Linear misclosure, its azimuth and accuracy of measurement,

c) Adjusted coordinates by applying compass rule (weighted according to the lengths).

Pnt	Side	Length (m)	Angle to the right (gon)	Azimuth (gon)	Latitude (m)	Depar-ture (m)	Comp. Northing (m)	Comp. Easting (m)	Adjusted Latitude (m)	Adjusted Depar-ture (m)	Adjusted Northing (m)	Adjusted Easting (m)
A							200.00	200.00			200.00	200.00
	AB	87.00		12.00^g	85.46	16.30			85.29	16.39		
B			286^g				285.46	216.30			285.29	216.39
	BC	58.00		98.00^g	1.82	57.97			1.70	58.03		
C			142^g				287.28	274.27			286.99	274.42
	CD	125.00		40.00^g	101.13	73.47			100.88	73.59		
D							388.41	347.74			387.87	348.01
		270.00			188.41	147.74			187.87	148.01		

a) Azimuth AB=12^g (given)
Azimuth BC=$12^g+286^g-200^g=98^g$
Azimuth CD=$98^g+142^g-200^g=40^g$

Latitude AB=87*cos12^g=85.46 m. Northing AB=200+85.46=285.46 m
Departure AB=87*sin12^g=16.30 m. Easting AB=200+16.30=216.30 m
Latitude BC=58*cos98^g=1.82 m. Northing BC=285.46+1.82=287.28 m
Departure BC=58*sin98^g=57.97 m. Easting BC=216.30+57.97=274.27 m
Latitude CD=125*cos40^g=101.13 m. Northing AB=287.28+101.13=388.41 m
Departure CD=125*sin40^g=73.47 m. Easting AB=274.27+73.47=347.74 m

Error in departure (ΔE) = 347.74-348.01=-0.27 m
Error in latitude (ΔN) = 388.41-387.87=0.54 m

b) Linear misclose= $[(\Delta E)^2+(\Delta N)^2]^{1/2}= [(0.27)^2+(0.54)^2]^{1/2}= [0.365]^{1/2}$=0.60 m
Its azimuth = $\tan^{-1}[(\Delta E)/(\Delta N)]= \tan^{-1}[(-0.27)/(0.54)]= \tan^{-1}[-0.5]=-29.5^g$
ΔE is negative and ΔN is positive, therefore Azimuth= $-29.5^g+200= 170.50^g$
Accuracy=1/(270/0.6)=1/450

c) Correction factor for departure = 0.27/270 = 0.001 m/m
Correction factor for latitude = -0.54/270 = -0.002 m/m

Adjusted departures
AB=16.30+0.001*87 = 16.39 m
BC=57.97+0.001*58 = 58.03 m
CD=73.47+0.001*125 = 73.59 m

Adjusted latitudes
AB=85.46-0.002*87 = 85.29 m
BC=1.82-0.002*58 = 1.70 m
CD=101.13-0.002*125 =100.88 m

(25 p) 3. Reduce the accompanying set of profile notes (ΔH, Elevation) and perform the arithmetic check. (Show details of your calculations, write the results on table)

Station	BS (m)	IS (m)	FS (m)	ΔH (m)	Elevation (m)
BM 20	3.27				299.78
TP #1	4.21		2.60	0.67	300.45
0 + 00		3.30		0.91	301.36
0 + 50		2.60		0.70	302.06
0 + 80		3.71		-1.11	300.95
1 + 00		1.10		2.61	303.56
TP #2	2.33		1.66	-0.56	303.00
1 + 50		3.80		-1.47	301.53
2 + 00		2.97		0.83	302.36
BM 21			3.88	-0.91	301.45
TOTAL	9.81		8.14	1.67	

ΔH for TP#1 = 3.27-2.60 = 0.67 m. Elevation = 299.78+0.67 = 300.45
ΔH for 0+00 = 4.21-3.30 = 0.91 m. Elevation = 300.45+0.91 = 301.36
ΔH for 0+50 = 3.30-2.60 = 0.70 m. Elevation = 301.36+0.70 = 302.06
ΔH for 0+80 = 2.60-3.71 = -1.11 m. Elevation = 302.06-1.11 = 300.95
ΔH for 1+00 = 3.71-1.10 = 2.61 m. Elevation = 300.95+2.61 = 303.56
ΔH for TP#2 = 1.10-1.66 = -0.56 m. Elevation = 303.56-0.56 = 303.00
ΔH for 1+50 = 2.33-3.80 = -1.47 m. Elevation = 303.00-1.47 = 301.53
ΔH for 2+00 = 3.801-2.97 = 0.83 m. Elevation = 301.53+0.83 = 302.36
ΔH for BM21 = 2.97-3.88 = -0.91 m. Elevation = 302.36-0.91 = 301.45

Arithmetic check ➔ ΣBS-ΣFS = 9.81-8.14 = 1.67 m. is equal to ΣΔH = 1.67 m.
Also BM21-BM20 = 301.45-299.78 = 1.67 m.