University of Technology
Engineering Department of Building and Construction
Final Exam 2014-2015

Subject: Engineering Surveying **Year: 2nd year**
Division: All Divisions **Time: Three hours**
Examiner: Surveying Committee **Date: -- / 6 / 2015**

Answer Five Questions Only

Q1)A. Answer the following:(9 marks)

1-List the types of surveying.
Solution:

1- من حيث الدقة
2- من حيث الاجهزة المستخدمة
3- من حيث التطبيق

2- Convert 1.267_{rad} to grad.
Solution : $80^{g}\ 65^{cg}\ 97^{ccg}$

3- Find the scale of map if the distance (AB) on the ground =2500 m and the distance (ab) on map =27.5cm.
Solution: 1/ 9090.90909090909091

B. If x_1=205.321 ± 0.05 m, x_2=205.325 ± 0.01 m and x_3=205.327 ±0.03 m are the horizontal distances of line AB, compute the most probable value of the distance (AB) and its standard error. **(11 marks)**

$$Y = \frac{X_1 * P_1 + X_2 * P_2 + X_3 * P_3}{P_1 + P_2 + P_3}$$

$$P_1 = \frac{1}{0.05^2}, P_2 = \frac{1}{0.01^2}, P_3 = \frac{1}{0.03^2}$$

$$Y = \frac{205.321 * \frac{1}{0.05^2} + 205.325 * \frac{1}{0.01^2} + 205.327 * \frac{1}{0.03^2}}{\frac{1}{0.05^2} + \frac{1}{0.01^2} + \frac{1}{0.03^2}} = 205.3251\ m$$

$$v_i = \bar{x} - x_i$$

$$v_1 = 205.3251 - 205.321 = -0.0041$$

$$v_2 = 205.3251 - 205.325 = -0.0001$$

$$v_3 = 205.3251 - 205.327 = 0.0019$$

$$\delta_{xi} = \pm\sqrt{\frac{\sum Pv^2}{n-1}} = \pm 0.073604\ m$$

$$\delta\bar{x} = \pm\frac{\delta_{xi}}{\sqrt{P_1 + P_2 + P_3}} = \pm 0.000686\ m$$

Q2)A. Answer the following:- (12 marks)

1) A rectangular parcel having dimensions W= 120,00m ±0.01m and L= 250,00 m ±0.03m. Compute the area of the parcel and its standard error.

Solution:

$A=120.00 \times 250.00= 30000\ m^2$

$\delta_A = \sqrt{120^2 * 0.03^2 + 250^2 * 0.01^2} = \pm 4.3829\ m^2$

2) A (50 m) steel tape used to measure the horizontal distance (DC) , the measurements are: DC=50.032 m, 50.029 m, 50.034 m.
If the actual length of the tape = 49.98m. Compute the most probable value of the distance DC **only**.

$$X_1 = \frac{D_1}{L_T} L_{\bar{T}} = \frac{50.032}{50} 49.98 = 50.01199$$

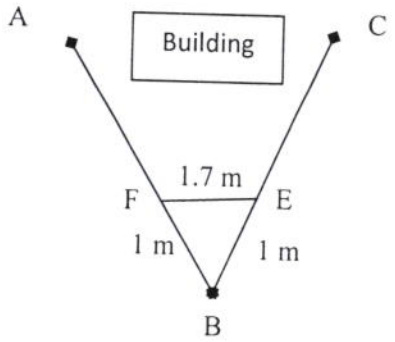
$$X_2 = \frac{D_2}{L_T} L_{\bar{T}} = \frac{50.029}{50} 49.98 = 50.00899$$

$$X_3 = \frac{D_3}{L_T} L_{\bar{T}} = \frac{50.034}{50} 49.98 = 50.01399$$

$$D_{DC} = \frac{X_1 + X_2 + X_3}{3}$$

$$D_{BC} = \frac{50.01199 + 50.00899 + 50.01399}{3} = 50.01165\ m$$

B. For the following figure:



If the horizontal distances AB= 45 m and BC =60 m, compute the horizontal distance AC. **(8 marks)**

$$\measuredangle B = 2 * \sin^{-1}\left(\frac{FE}{2}\right) = 2 * \sin^{-1}\left(\frac{1.7}{2}\right) = 116^o\ 25'\ 24"$$

$$\cos B = \frac{AB^2 + CB^2 - AC^2}{2 * AB * CB}$$

$$AC = \sqrt{AB^2 + CB^2 - 2 * AB * CB * \cos B} = \sqrt{45^2 + 60^2 - 2 * 45 * 60 * \cos 116^o\ 25'\ 24"} = 89.599\ m$$

Q3)A. The following table represent the field data for two routes (R_1, R_2) for differential leveling using the level and leveling rod.

Route	From	To	No. of level setup	Measured difference in elevation (m)	Elevation (m)
R_1	BM_1	A	4	- 0.825	BM_1=78.0 m
R_2	BM_2	A	?	?	BM_2=75.8 m

The field data for route R_2 are:

Route	Level setup	Observed points	Rod reading (m)	Elevation (m)
R_2	1	BM_2	2.648	75.8
		TP_1	1.941	
	2	TP_1	1.789	
		A	1.125	

Compute the adjusted (most probable value) elevation of point A.

(10 marks)

Point	B.S	ELS	FS	Elevation (m)
BM2	2.648	78.448		75.8
TP1	1.789	78.296	1.941	76.507
A	1.748		1.125	77.171=X3

$$Y = \frac{X_1 * P_1 + X_2 * P_2}{P_1 + P_2}$$

$$P_1 = \frac{1}{4}, P_2 = \frac{1}{2}$$

X1= 77.175

X2= 77.171

$$Y = \frac{77.175 * \frac{1}{4} + 77.171 * \frac{1}{2}}{\frac{1}{4} + \frac{1}{2}} = 77.172m$$

B. The table below represents the ground elevations of profile leveling using the level along the center line of a road. If the grade line pass throw station 0+00 and 0.5 m above station 2+00, compute the amount of cut or fill in all stations.

Station	0+00	1+00	1+50	2+00	3+00	3+50
Ground Elevation m	90.293	91.116	91.536	92.845	90.726	89.372

(10 marks)

$\therefore Z_1 = 90.293$

$\therefore Z_2 = 92.845 + 0.500$

$\therefore Z_2 = 93.345m$

$$\therefore g = \tan\theta = \frac{\Delta Z_{12}}{\Delta Z_{12}} = \frac{Z_2 - Z_1}{x_2 - x_1} = \frac{93.345 - 90.293}{200 - 0.00}$$

$$\therefore g = +0.01526 = +1.526\%$$

$$Z_{1+00} = Z_{0+00} + (100 - 0.0) \times \frac{1.526}{100} = 91.819\ m$$

$$Z_{1+50} = Z_{0+00} + (150 - 0.0) \times \frac{1.526}{100} = 92.582\ m$$

Station	Ground elev.	Grade elev,	Cut	Fill
0+00	90.293	90.293		0.00
1+00	91.116	91.819		0.703
1+50	91.536	92.582		1.046
2+00	92.845	93.345		0.500
3+00	90.726	94.871		3.145
3+50	89.372	95.634		6.262

Q4)A. The table below represent the field measurements of horizontal angle using theodolite:

Theodolite station	Observed station	Telescope D or R	H.C.R
B	A	D	$0^0 00' 00''$
		R	$180^0 00' 05''$
	C	D	$50^0 25' 30''$
		R	$230^0 25' 38''$
	A	D	$90^0 00' 00''$
		R	$269^0 59' 51''$
	C	D	$140^0 25' 32''$
		R	$320^0 25' 28''$

Compute the most probable value and standard error of the angle to the right (ABC). **(10 marks)**

Answer:

$X_1 = 50^0 25' 30'' - 0^0 00' 00'' = 50^0 25' 30''$

$X_2 = 230^0 25' 38'' - 180^0 00' 05'' = 50^0 25' 33''$

$X_3 = 140^0 25' 32'' - 90^0 00' 00'' = 50^0 25' 32''$

$X_4 = 320^0 25' 28'' - 269^0 59' 51'' = 50^0 25' 37''$

$$CBA = \frac{X_1 + X_2 + X_3 + X_4}{4}$$

$$CBA = \frac{50^O 25'30" + 50^O 25'33" + 50^O 25'32" + 50^O 25'37"}{4} = 50^O 25'33"$$

$$v_i = \bar{x} - x_i$$

$$v_1 = 50^O 25'33" - 50^O 25'30" = 3"$$

$$v_2 = 50^O 25'33" - 50^O 25'33" = 0"$$

$$v_3 = 50^O 25'33" - 50^O 25'32" = 1"$$

$$v_4 = 50^O 25'33\text{-}50^O 25'37 = -7"$$

$$\delta_{xi} = \pm\sqrt{\frac{\sum v^2}{n-1}} = \pm 4.434"$$

$$\delta\bar{x} = \pm\frac{\delta_{xi}}{\sqrt{n}} = \pm 2.217''$$

B. The table below represent a field measurements in traverse survey:

Line	Horizontal Distance (m)	Deflection angle (ABC)	Azimuth
AB	140.879	$65^0 50' 30''$ L	$170^0 00' 00''$
BC	135.945		

If the X_A=500 m, Y_A=500 m compute the horizontal coordinates (X,Y) of point B and C. **(10 marks)**

The answer :

$AZ_{BC} = AZ_{AB} + \measuredangle ABC = 170^O 00'00" + (-65^O 50'30") = 104^O 09'30"$

$X_B = X_A + D_{AB} \sin AZ_{AB}$

$X_B = 500 + 140.879 \sin 170^O 00'00 = 524.463\ m$

$Y_B = Y_A + D_{AB} \cos AZ_{AB}$

$Y_B = 500 + 140.879 \cos 170^O 00'00 = 361.261\ m$

$X_C = X_B + D_{BC} \sin AZ_{BC}$

$X_C = 524.463 + 135.945 \sin 104^O 09'30" = 656.278\ m$

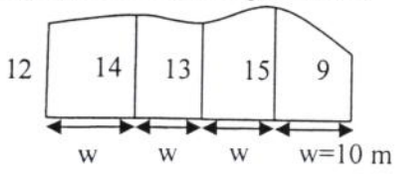
$Y_C = Y_B + D_{BC} \cos AZ_{BC}$

$Y_C = 361.261 + 135.945 \cos 104^O 09'30" = 328.008\ m$

Q5) Answer *two* of the following

A. Answer the following:- (10 marks)

1) Compute the area of following figure using Simpson Rule



$$Area = \frac{w}{3}\left[y_1 + 2\sum y_{odd} + 4\sum y_{even} + y_n\right] = \frac{10}{3}[12 + 2(13) + 4(14 + 15) + 9] = 543.333\ m^2$$

2) A planimeter was used to measure the area of a parcel of land drawn in a map of a scale 1/10000, so that the fixation point placed outside the borders of the parcel. The initial reading is ni= 0.000 and the final reading is nf= 5.368. and for the purpose of computing the constant of the instrument C, a square with 10cm side width has been draw, the initial reading is nci= 0.000 and the final reading is ncf= 2.572. what is the area of the parcel (on the ground) in square meters?

$$\therefore C = \frac{Area}{n}$$

$$C = \frac{10 * 10}{2.572} = 38.8802$$

$$Area = C * n = 38.8802 * 5.368 = 208.708\ cm^2\ on\ map$$

$Area = 208.708 * 10000 = 2087080\ m^2\ on\ ground$

B. The table below represent final cross-section of road having bed width b=12 m.

Station	Left	Center	Right
12+50	$\frac{f\ 7.0}{27.0}$	$\frac{f5.0}{0.0}$	$\frac{f2.0}{12.0}$

Compute the area of the cross-section by coordinate method. (10 marks)

The answer :

X	Y
6	0
12	2
0	5
-27	7
-6	0

$$A_{12+50} = \frac{1}{2}\sum_{i=1}^{5} y_i(x_{i+1} - x_{i-1})$$

$$A_{14+50} = \frac{1}{2}\,[-2 \times (0 - 6) + (-5) \times (-27 - 12) + (-7) \times (-6 - 0)] = 124.5\ m^2$$

C. For a simple circular horizontal curve having a radius R=150 m, the deflection angle Θ=35°, compute the basic elements of the curve. (10 marks)

$$T = R\tan\frac{\theta}{2}$$

$$T = 150\tan\frac{35}{2} = 47.294\ m$$

$$L = R\theta_{rad} = 150 \times 35 \times \frac{\pi}{180} = 91.629\ m$$

$$L_C = 2R\sin\frac{\theta}{2} = 2*150\sin\frac{35}{2} = 86.036$$

$$\frac{R}{R+E} = \cos\frac{\theta}{2} \Rightarrow E = R\left[\frac{1}{\cos\frac{\theta}{2}} - 1\right] = 7.279$$

$$\frac{R-M}{R} = \cos\frac{\theta}{2} \Rightarrow M = R\left[1 - \cos\frac{\theta}{2}\right] = 6.942$$

Q6)A. The table below represent a field measurements of topographic surveying:

Theodolite station	Observed station	V.C.R	Rod Reading (m)		
			U	M	L
A	B	$89^0 30' 30''$	1.985	1.243	0.500
	C	$70^0 48' 10''$	---	0.314	---
		$80^0 34' 05''$	---	2.136	---

Knowing that the elevation of point B=90.648m.
Compute the elevation of point C. (8 marks)

The answer :

$D_{AB} = K\,S\,\cos\emptyset^2 = 100 * (1.985 - 0.500) * \cos(90\text{-}\,89^o30'30")^2 = 148.489\ m$

$BS_{AB} = Rm - D_{AB} * \tan\alpha$

$= 1.243 - 148.489 * \tan(90 - 89^o30'30") = -0.3125\ m$

$$D_{AB} = \frac{Rm2 - Rm1}{\tan\alpha_2 - \tan\alpha_1}$$

$\alpha_1 = 90 - 70^o48'10" = 19^o11'50"$

$\alpha_2 = 90 - 80^o34'05" = 9^o25'55"$

$$= \frac{-2.136 - (-0.314)}{\tan 9^o25'55" - \tan 19^o11'50"} = 10.007m$$

$FS_{AC} = Rm - D_{AC} * \tan\alpha$

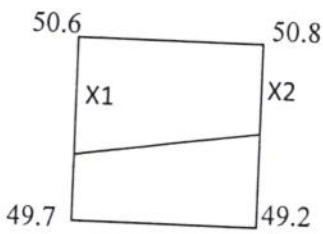
$= -0.314 - 10.007 * \tan(19^o11'50") = -3.798\ m$

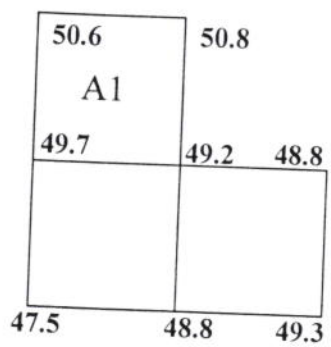
$Elev.B = Elev.K + BS - FS$

$Elev.B = 90.048 - 0.3125 - (-3.798) = 93.5335m$

B. The figure below represent a grid for a parcel with (25 m x 25 m) sub-grid dimensions .

1- Draw the contour line 50 using a horizontal scale =1/1000. **(4 marks)**





$$\frac{1}{1000} = \frac{X}{2500}$$

$X = 2.5cm$ إبعاد المربع على الخارطة

THE HIGHTEST CONTOR LINE =50 m

$$\frac{50.6 - 49.7}{25} = \frac{50.6 - 50}{\times 1}$$

$X_1 = 1.6\ cm$

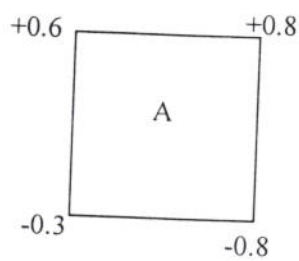
$$\frac{50.8 - 49.2}{25} = \frac{50.8 - 50}{\times 2}$$

$X_2 = 1.25\ cm$

2- Compute the volumes of earthwork (cut, fill) that is required to level sub grid A_1 into elevation 50.00 m. **(4 marks)**

$$v_{Fi} = \frac{\left[\sum f_i\right]^2}{\sum(C+f)_i} * \frac{A_i}{4}$$

$$v_{Ci} = \frac{\left[\sum c_i\right]^2}{\sum(C+f)_i} * \frac{A_i}{4}$$



$$v_{fill} = \frac{(0.3 + 0.8)^2}{(0.6 + 0.8 + 0.3 + 0.8)} * \frac{25 * 25}{4} = 75.625\ m^3$$

$$v_{cut} = \frac{(0.6 + 0.8)^2}{(0.6 + 0.8 + 0.3 + 0.8)} * \frac{25 * 25}{4} = 122.5\ m^3$$

3- Compute the final elevation required to level the ground into a horizontal plane at which the volume of cut = volume of fill. **(4 marks)**

$$\overline{Z_G} = \frac{(n_1 * z_1) + (n_2 * z_2) + \ldots\ldots\ldots + (n_K * z_K)}{4 * M}$$

$$\sum (1 * Z_1) = (50.6 + 50.8 + 48.8 + 49.3 + 47.5) = 247$$

$$\sum\sum (2 * Z_1) = 2 * (49.7 + 48.8) = 197$$

$$\sum\sum (3 * Z_1) = 3 * (49.2) = 147.6$$

$$\bar{Z} = \frac{153 + 119 + 93.6}{3 * 4} = 49.3m$$