University of Technology
Engineering Department of Building and Construction
Final Exam 2012-2013

Subject: Engineering Surveying
Division: All Branches
Examiner: Surveying Community

Time: 3 hour
Date:22/06/2013

Answer FOUR Questions Only

Q.1)

The following table represent the field data in traversing using theodolite and steel tape:

Theodolite station	Observed station	Telescope	H.C.R	Horizontal Distance	
				Repetition	Measurement (m)
A	K	D	21°26'15"	1	AB=123.537
	B	D	86°51'30"	2	AB=123.486
	K	R	201°26'25"	3	AB=123.585
	B	R	266°52'10"	4	AB=123.456

Knowing that:

Azimuth of $\overrightarrow{AK} = AZ_{AK} = 15^{\circ}20'00" \mp 00"$, $X_A = 367m \pm 0.04$ m, $Y_A = 523m \pm 0.05m$

1) Compute the most probable value of the horizontal distance AB and its standard error. **(10 Marks)**
2) Compute the horizontal angle to the right $\prec$ KAB and its standard error. **(5 Marks)**
3) Compute the horizontal coordinates [X, Y] of point [B]. **(5 Marks)**
4) Compute the Standard error for the [X] coordinate of point [B]. **(5 Marks)**

Q.2)

The following table represents the field data for profile leveling along the center line of a road using the level and the leveling Rod;

Level Setup	Observed Station	Rod Reading (m)	Elevation (m)
1	BM1	1.542	31.750
	TP1	1.784	
2	TP1	0.658	
	A	1.235	
3	A	1.748	
	0+00	1.845	
	0+25	1.376	
	0+50	1.635	
	0+75	1.457	
	1+00	1.538	
	BM2	1.437	31.230

1) Compute the adjusted elevation of point A and its standard error. **(10 Marks)**
2) Compute the ground elevation of the road center line stations [0+00, 0+25, 0+50, 0+75, 1+00]. **(5 Marks)**
3) If the proposed center line having gradient = +2% and the grade elevation of station 0+50 = ground elevation of station [0+50]; compute the amount of cut or fill for all center line stations. **(10 Marks)**

Q.3)

A. The following table represent the field data for topographic surveying by the radiation method using theodolite and leveling Rod :

Theodolite station	Observed station	H.C.R	V.C.R	Rod Reading (m)		
				U	M	L
A	K	24°15'35"	87°16'35"		1.84	
	K		85°32'45"		2.34	
	B	61°33'15"	275°32'15"	1.70	1.05	0.40

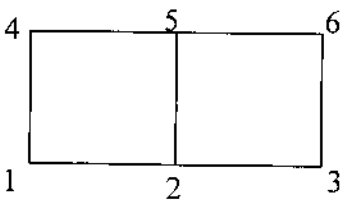
Knowing that: Azimuth of $\overrightarrow{AK}$ = AZ_{AK} = 24°15'35"

X_A= 472 m, Y_A=635 m, Z_K= 32.68 m

Compute the horizontal coordinates [X, Y] and the elevation of point [B]. **(10Marks)**

B. the following table represent the ground elevation of the points of the [20m ×20m] grid shown in the figure below

Point	1	2	3	4	5	6
Ground elevation (m)	30.6	29.9	31.4	33.8	33.3	31.9



1) List the contour lines that pass through the grid using contour interval = 0.5 m. **(2 Marks)**
2) Draw the 32.5 m contour line with a horizontal scale S_H= 1/500. **(5 Marks)**
3) Compute the volume of earth work required to level the ground into a final elevation = 32.5 m. **(8 Marks)**

Q.4)

A. The following table represent the final cross-sections of the transitional area of road having bed-width b = 14.0 m

Station	Cross- Section				Area (m^2)	
	Left		CL	Right	Cut	Fill
6+50					46.58	0
6+65	$\frac{f\,2.5}{14.5}$	$\frac{f\,1.3}{5.0}$	$\frac{0}{0}$	$\frac{C\,1.65}{10.3}$		
7+00					0	38.26

Compute the volume of earth work from station (6+50) to station (7+00) by End Area method.

(18 Marks)

B. Two grade lines having gradients of g1 = + 1.25 % , g2=-2.75 % to be connected by a symmetrical parabolic vertical curve having a length L =165 m , the elevation of the vertex (V) = Z_v=32.8 m and V station = 12+36 .
Compute the station and the elevation of the highest (lowest) point on the curve.

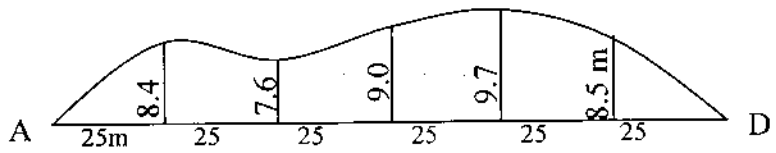
(7 Marks)

Q.5)

A. Simple circular horizontal curve having a radius of curvature R=223.152 m , PC station = 8+64 and PI station = 9+40 .
Compute the incremental chords and the deflection angles required for laying out stations (8+80 , 9+60) of the curve using $[\frac{1}{5}]$ station .

(18 Marks)

B. Find the Area of the parcel shown in figure below using the trapezoidal rule [All units in meter].



(7 Marks)

Q1)

1)

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

$$D_{AB} = \frac{123.537 + 123.486 + 123.585 + 123.458}{4} = 123.516m$$

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

$$v_1 = 123.537 - 123.458 = 0.021$$

$$v_2 = 123.486 - 123.516 = -0.03$$

$$v_3 = 123.585 - 123516 = 0.069$$

$$v_4 = 123.458 - 123.516 = -0.06$$

$$\delta_{xi} = \pm\sqrt{\frac{\sum v^2}{n-1}} = \pm 0.056868269m$$

$$\delta\bar{x} = \pm\frac{\delta_{xi}}{\sqrt{n}} = \pm 0.028434134\, m$$

2)

$x_1 = KAB1 = 86^O51'30"\text{-}21^O26'15" = 65^O25'15"$

$x_2 = KAB2 = 266^O52'10"\text{-}201^O26'25" = 65^O25'45"$

$$KAB = \frac{X_1 + X_2}{2}$$

$$KAB = \frac{65^O25'15" + 65^O25'45"}{2} = 65^O25'30"$$

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

$v_1 = 65^O25'30"\text{-}65^O25'15" = 15"$

$v_2 = 65^O25'30\text{-}65^O25'45 = -15"$

$$\delta_{xi} = \pm\sqrt{\frac{\sum v^2}{n-1}} = \pm 21.21"$$

$$\delta\bar{x} = \pm\frac{\delta_{xi}}{\sqrt{n}} = \pm 15"$$

3)

$AZ_{AB} = AZ_{AK} + \measuredangle KAB = 15^O20'00"+65^O25'30"=80^O45'30"$

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

$X_B = 367 + 123.516 \sin 80^O 45'30" = 488.912\ m$

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

$Y_B = 523 + 123.516 \cos 80^O 45'30" = 542.836\ m$

4)

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

$AZ_{AB} = AZ_{AK} + \measuredangle KAB = 15^O 20'00" + 65^O 25'30" = 80^O 45'30"$

$$\delta X_B{}^2 = \left(\frac{\partial X_B}{\partial X_A}\right)^2 \delta X_A{}^2 + \left(\frac{\partial X_B}{\partial D_{AB}}\right)^2 \delta D_{AB}{}^2 + \left(\frac{\partial X_B}{\partial AZ_{AB}}\right)^2 \delta AZ_{AB}{}^2$$

$$\frac{\partial X_B}{\partial X_A} = 1$$

$$\frac{\partial X_B}{\partial D_{AB}} = \sin AZ_{AB}$$

$$\frac{\partial X_B}{\partial AZ_{AB}} = D_{AB} \cos AZ_{AB}$$

$\delta AZ_{AB} = 0.0 + 15 = 15"$

$$\delta X_B{}^2 = 1 \times 0.04^2 + (0.987)^2 0.028434134^2 + (19.836)^2 \left(\frac{15}{3600} \times \frac{\pi}{180}\right)^2 = 0.00239$$

$\delta X_B = 0.04888\ m$

Q2)

1)

Point	B.S	ELS	FS	Elevation (m)
BM1	1.542	33.292		31.750
TP1	0.658	32.166	1.784	31.508
A	1.748	32.679	1.235	30.931=X1
BM2			1.437	31.242 -31.230 e=0.012

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

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

X1=30.931

X2= X1-e=30.919

$$Y = \frac{30.931 * \frac{1}{2} + 30.919 * \frac{1}{1}}{\frac{1}{2} + \frac{1}{1}} = 30.923\ m$$

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

$$v_1 = 30.923 - 30.931 = -0.008$$

$$v_2 = 30.923 - 30.919 = 0.004$$

$$\delta_{xi} = \pm\sqrt{\frac{\sum Pv^2}{n-1}} = \pm 0.008944272\ m$$

$$\delta\bar{x} = \pm\frac{\delta_{xl}}{\sqrt{P_1 + P_2}} = \pm 0.004472136\ m$$

2)

Level setup	Observed station	Rod reading m	Adjusted Elevation m	E.L.S M	Weight P
1	A	1.748	30.923	x_1=32.671	$P_1 = \frac{1}{1} = 1$
	BM2	1.437	31.230	x_2=32.667	$P_2 = \frac{1}{1} = 1$

$$\therefore E.L.S_1 = \frac{P_1x_1 + P_2x_2}{P_1 + P_2} = \frac{(1*32.671) + (1*32.667)}{1+1} = 32.669\ m$$

station	B.S m	E.L.S m	F.S m	I.F.S m	Ground Elevation m
A	1.748				30.923
0+00				1.845	30.824
0+25				1.376	31.293
0+50		32.669		1.635	31.034
0+75				1.457	31.212
1+00				1.538	31.131
BM2			1.437		31.230

3)

station	B.S m	E.L.S m	F.S m	I.F.S m	Ground Elevation m	grade Elevation m	Cut M	Fill m
A	1.748				30.923			
0+00				1.845	30.824	30.034	0.79	
0+25				1.376	31.293	30.534	0.759	
0+50		32.669		1.635	31.034	31.034	0	
0+75				1.457	31.212	31.534		-0.322
1+00				1.538	31.131	32.034		-0.903
BM2			1.437		31.230			

Q3)

A)

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

$\alpha_1 = 90 - 87^O16'35" = 2^O43'25"$

$\alpha_2 = 90 - 85^O32'45" = 4^O27'15"$

$$= \frac{2.340 - 1.840}{\tan 4^O27'15" - \tan 2^O43'25"} = 16.488\,m$$

$D_{AB} = K\,S\,\cos\emptyset^2 = 100 * (1.7 - 0.40) * \cos(275^O32'15" - 270)^2 = 128.789\,m$

$\measuredangle KAB = 61^O33'15\text{-}24^O15'35 = 37^O17'40"$

$AZ_{AB} = AZ_{AK} + \measuredangle KAB = 24^O15'35{+}37^O17'40{=}61^O33'15$

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

$X_B = 472 + 128.789\sin 61^O33'15 = 585.240\,m$

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

$Y_B = 635 + 128.789\cos 61^O33'15 = 696.345\,m$

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

$= 1.84 - 16.488 * \tan(90 - 87^O16'35") = 1.055\,m$

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

$= 1.05 - 128.789 * \tan(275^O32'15" - 270) = -11.436\,m$

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

$= 32.68 + (1.055) + (-11.436) = 22.299\,m$

B)

1)

30

30.5

31

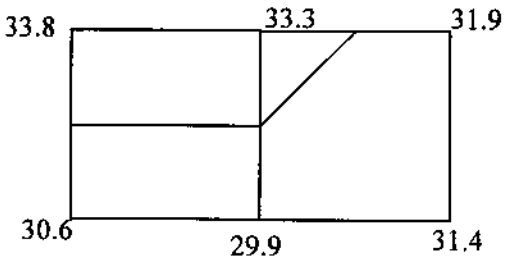
31.5

32

32.5

33

33.5



2)

$$\frac{1}{500} = \frac{X}{2000}$$

$X = 4\,cm$ إبعاد المربع على الخارطة

THE CONTOR LINE =32.5 m

$$\frac{33.8 - 30.6}{20} = \frac{33.8 - 32.5}{\times 1}$$

$X_1 = 1.6\,cm$

$$\frac{33.3 - 29.9}{20} = \frac{33.3 - 32.5}{\times 2}$$

$X_2 = 0.9\,cm$

$$\frac{33.3 - 31.9}{20} = \frac{33.3 - 32.5}{\times 3}$$

$X_3 = 2.3\,cm$

3)

Point	1	2	3	4	5	6
Cut or fill (m)	-1.9	-2.6	-1.1	1.3	0.8	-0.6

$$V_{F1} = \frac{[1.9+2.6]^2}{[1.9+2.6+1.3+0.8]} * \frac{20*20}{4} = \frac{4.5^2}{6.6} * 100 = 306.818m^3$$

$$V_{C1} = \frac{[1.3+0.8]^2}{[1.9+2.6+1.3+0.8]} * \frac{20*20}{4} = \frac{2.1^2}{6.6} * 100 = 66.818m^3$$

$$V_{F2} = \frac{[2.6+1.1+0.6]^2}{[2.6+0.8+1.1+0.6]} * \frac{400}{4} = \frac{4.3^2}{5.1} * 100 = 362.549m^3$$

$$V_{C2} = \frac{[0.8]^2}{[2.6+0.8+1.1+0.6]} * \frac{400}{4} = \frac{0.8^2}{5.1} * 100 = 12.549m^3$$

$$V_{cut} = \sum_{i=1}^{4} V_{ci} = V_{c1} + V_{c2}$$

$$\therefore V_{cut} = 66.818 + 12.549 = 79.367m^3$$

$$V_{fill} = \sum_{i=1}^{4} V_{fi} = V_{f1} + V_{f2}$$

$$\therefore V_{fill} = 306.818 + 362.549 = 669.367m^3$$

Q4)

Station	Area Cut m^2	Area fill m^2	Cross-section Left	CL	Right
6+50	46.58	0			
6+65			$\frac{f2.5}{14.5}$	$\frac{f1.3}{5.0}$ $\frac{0}{0}$	$\frac{c1.65}{10.3}$
7+00	0	38.26			

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

$$A_{fill\ 6+65} = \frac{1}{2}(18.85 + 5) = 11.925\ m^2$$

$$A_{cut\ 6+65} = \frac{1}{2}(1.65(7-0)) = 5.775\ m^2$$

$$V_{1cut} = (46.58 + 5.775) * \frac{15}{2} = 392.662\ m^3$$

$$V_{1\,fill} = \frac{L}{3} * A_{fill} = \frac{15}{3} * 11.925 = 59.625\ m^3$$

l2=35

$$V_{2\,cut} = \frac{L}{3} * A_{cut} = 67.375\ m^3$$

$$V_{2fill} = (11.925 + 38.26) * \frac{35}{2} = 439.11875\ m^3$$

$V_{cut} = 392.662 + 67.375 = 460.037\ m^3$

$V_{fill} = 59.625 + 439.1187 = 498.743757\ m^3$

B)

$$BVC\ Station = V.Sta. - \frac{L}{2} = 1236 - 165/2 = 1153.5 = 11 + 53.5$$

$$Z_{BVC} = Z_V - g_1 * \frac{L}{2} = 32.8 - \frac{1.25}{100} * 165/2 = 31.768\ m$$

$$r = \frac{g_2 - g_1}{L} = \frac{\frac{1.25}{100} - \frac{(-2.75)}{100}}{165} = \frac{4}{16500} = 0.0002424$$

$$X = -\frac{g_1}{r}$$

$$X = -\frac{\frac{1.25}{100}}{0.0002424} = 51.567m$$

$$station = 1153.5 + 51.567 = 12 + 05.067$$

$$Z_i = Z_{BVC} + g_1 * X + \frac{1}{2} * r * x^2$$

$$Z_i = 31.768 + \tfrac{1.25}{100} * 51.567 + \tfrac{1}{2} * 0.0002424 * 51.567^2 = 32.73488\ \text{m}$$

Q5)

A

$$T = 940 - 864 = 76\ m$$

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

$$76 = 223.152 * \tan\frac{\theta}{2}$$

$$\frac{\theta}{2} = \tan^{-1}\frac{76}{223.252}$$

$$\theta = 37^O36'54.4"$$

$$l_1 = 880 - 864 = 16\ m \qquad\qquad l = \frac{1}{5} * 100 = 20\ m$$

$$d_1 = \frac{l_1}{R} * \frac{180}{\pi} = 4^O6'29.2"$$

$$C_1 = 2R \sin\frac{d_1}{2} = 2 * 223.152 * \sin 4^O6'29.2"/2 = 15.9966m$$

$$l = 20m \longrightarrow d = \frac{l}{R} * \frac{180}{\pi} = \frac{20}{223.152} * \frac{180}{\pi} = 5^O8'6.5"$$

$$C \quad = 2R \sin\frac{d}{2} = 2 * 223.152 * \sin 5^{O}8'6.5"/2 = 19.9933m$$

STATION	Chord (m)	Deflection angle
PC= 8+64		
8+80	15.9966	$\frac{d_1}{2} = 2^{O}3'14.6"$
9+00		
9+20		
9+40		
9+60	19.9933	$\frac{d_1}{2} + \frac{4d}{2} = 12^{O}19'27.56"$

B)

$$Area = \frac{25}{2} * \left(0 + 0 + 2 * (8.4 + 7.6 + 9.0 + 9.7 + 8.5)\right) = 25 * 43.2 = 1080\, m^2$$