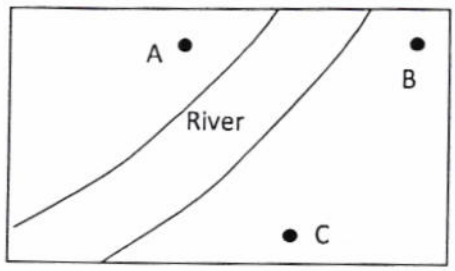
University of Technology
Engineering Department of Building and Construction
Final Exam 2013-2014

Subject: Engineering Surveying
Division: All Divisions
Examiner: Surveying Committee

Year:2nd year
Time: Three hours
Date: 7 / 6 / 2014

Answer Four Questions Only

Q1) For a precise computation of the horizontal distance (AC) shown in the figure, the following measurements were taken using a theodolite and steel tape:
Horizontal distance D_{BC}=162.153 m, 162.206 m, 162.124 m, 162.218 m
Horizontal Angle to the right $\prec ACB = 85^\circ\ 24'\ 35'' \mp 32''$



Theodolite station	Observed station	Telescope	H.C.R
B	C	D	65°16'"05
	C	R	245°16'25"
	A	D	95°23'35"
	A	R	275°23'45"

A- Compute the most probable value of the horizontal distance [BC] and its standard error. **(12 marks)**
B- Compute the most probable value of the horizontal angle to the right $\prec CBA$ and its standard error. **(8 marks)**
C- Compute the horizontal distance [AC]. **(5 marks)**

Q2) A-The following table represent the field data for three routes (R_1, R_2, R_3) of 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	12	+ 1.660	BM_1=31.8 m
R_2	BM_2	A	6	- 0.074	BM_2=33.5 m

The field data for route R_3 are:

Route	Level setup	Observed points	Rod reading (m)	Elevation (m)
R_3	1	BM_3	1.568	32.6
		TP_1	2.372	
	2	TP_1	1.825	
		A	0.182	

Compute the adjusted (Most Probable Value) elevation of point A and its standard error. **(17 marks)**

B- Simple circular horizontal curve having a radius R=137 m, the deflection angle Θ= 64°, and PI station = 12+40. **Compute the [PC, PT] stations.** **(8 marks)**

Q3) A- The following table represent the field data for the traverse [KAB] using theodolite and steel tape:

Measured Horizontal angle to the right	Measured Horizontal distance (m)
≺KAB=85°32'15"	KA=123.568
	AB=75.214

Knowing that: Azimuth of the line KA = AZ_{KA}=136°15'28"
X_K=263.845 m, Y_K=384.734 m

1- Compute the horizontal (X,Y) coordinates of points [A,B] **(8 marks)**
2- Compute the horizontal distance (KB) and its direction (AZ_{KB}). **(4 marks)**
3- Compute the Horizontal angle to the right ≺BKA. **(3 marks)**
4- Compute the deflection angle ≺ABK. **(3 marks)**

B- The following table represent the field data for topographic surveying by the radiation method using theodolite and leveling rod.

Theodolite Station	Observed Station	V. C. R	Rod reading (m)			Elevation (m)
			U	M	L	
A	K	87° 26′ 25″		1.85		32.650
	B	274° 32′ 15″	1.9	1.25	0.6	

Knowing that: the Horizontal distance AK= 76.385m. **(7 marks)**

Compute the elevation (Z) of point (B).

Q4)A- The following table represent the final cross-section for a road having bed width b=12 m.

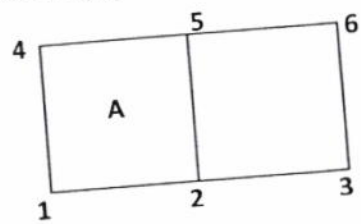
Station	Cross –section		
	Left	C.L	Right
14+50	$\frac{C1.3}{8.6}$	$\frac{C2.7}{0.0}$	$\frac{C1.6}{9.2}$

(7 marks)

Compute the area of the cross-section using the coordinates method.

B- The following table represent the ground elevation of the point of the (25 m × 25 m) grid shown in the figure below.

Point	1	2	3	4	5	6
Elevation (m)	28.5	27.8	29.3	31.7	31.2	29.8



a) Draw the contour line with elevation= 29.0 m using a horizontal scale =1/1000. **(9 marks)**

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

c) Compute the volumes of earthwork (cut, fill) that is required to level sub grid A into elevation 29.5 m. **(5 marks)**

Q5)

A- The following table represents the field data for apart of profile leveling along the center line of a road:-

Level Setup	Observed Station	Rod Reading (m)
1	0+00	1.385
	0+10	2.456
	0+25	0.842
	BM1	1.360
2	BM1	0.673
	0+50	2.473
	1+00	1.328

Knowing that: The elevation of BM1 = 31.562 m
The grade elevation of Station 0+25 = 31.43 m
The proposed center line has gradient = +2% **(15 marks)**

Compute the amount of cut or fill for all Center Line stations.

B- Two grade lines having gradients of g_1= +1.85%, g_2= -3.65% to be connected by a symmetrical parabolic vertical curve.
Knowing that the BVC station =11+75, the elevation of the vertex (V) =Z_V=27.5 m, station V= 12+35. **(10 marks)**

Compute the elevation of stations (12+00), (12+60) on the curve.

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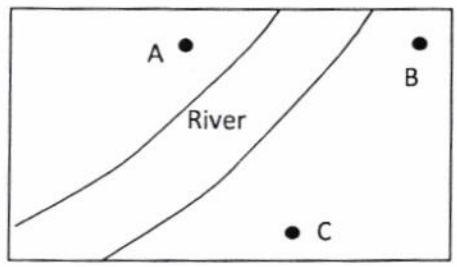

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B	C	D	65°16'"05
	C	R	245°16'25"
	A	D	95°23'35"
	A	R	275°23'45"

A- Compute the most probable value of the horizontal distance [BC] and its standard error.

The answer :

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

$$D_{BC} = \frac{162.153 + 162.206 + 162.124 + 162.218}{4} = 162.1753m$$

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

$$v_1 = 162.153 - 162.1753 = -0.0223$$

$$v_2 = 162.206 - 162.1753 = 0.0307$$

$$v_3 = 162.124 - 162.1753 = -0.0513$$

$$v_4 = 162.218 - 162.1753 = 0.0427$$

$$\delta_{xi} = \pm\sqrt{\frac{\sum v^2}{n-1}} = \pm 0.044327m$$

$$\delta\bar{x} = \pm\frac{\delta_{xi}}{\sqrt{n}} = \pm 0.0221635\ m$$

B- Compute the most probable value of the horizontal angle to the right $\prec CBA$ and its standard error.

Theodolite station	Observed station	Telescope	H.C.R	
B	C	D	65°16'"05	30°07'30"
	C	R	245°16'25"	30°07'20"
	A	D	95°23'35"	
	A	R	275°23'45"	

The answer :

$x_1 = CBA1 = 95^O23'35"\text{-}65^O16'05" = 30^O07'30"$

$x_2 = CBA2 = 275^o23'45"\text{-}245^o16'25" = 30^o07'20"$

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

$$CBA = \frac{30^o07'30" + 30^o07'20"}{2} = 65^o25'25"$$

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

$$v_1 = 65^o25'25\text{-}30^o07'30 = -5"$$

$$v_2 = 65^o25'25"\text{-}30^o07'30" = 5"$$

$$\delta_{xi} = \pm\sqrt{\frac{\sum v^2}{n-1}} = \pm 7.07"$$

$$\delta\bar{x} = \pm\frac{\delta_{xi}}{\sqrt{n}} = \pm 5"$$

C- Compute the horizontal distance [AC].

The answer :

$$\measuredangle BAC = 180 - 65^o25'25" - 85^\circ\ 24'\ 35'' = 29^\circ\ 10'\ 00''$$

$$\frac{D_{AC}}{\sin \measuredangle CBA} = \frac{D_{BC}}{\sin \measuredangle BAC}$$

$$D_{AC} = \frac{D_{BC} \times \sin \measuredangle CBA}{\sin \measuredangle BAC} = \frac{162.1753 \times \sin 65^o25'25"}{\sin 29^\circ\ 10'\ 00''} = 302.622 \text{ m}$$

Q2) A-The following table represent the field data for three routes (R_1, R_2, R_3) of 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	12	+ 1.660	BM_1=31.8 m
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The field data for route R_3 are:

Route	Level setup	Observed points	Rod reading (m)	Elevation (m)
R_3	1	BM_3	1.568	32.6
		TP_1	2.372	
	2	TP_1	1.825	
		A	0.182	

Compute the adjusted (Most Probable Value) elevation of point A and its standard error. **(17 marks)**

The answer :

Point	B.S	ELS	FS	Elevation (m)
BM3	1.568	34.168		32.6
TP1	1.825	33.621	2.372	31.796
A	1.748		0.182	33.439=X3

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

$P_1 = \frac{1}{12}, P_2 = \frac{1}{6}, P_3 = \frac{1}{2}$

X1=33.46

X2= 33.426

$$Y = \frac{33.46 * \frac{1}{12} + 33.426 * \frac{1}{6} + 33.439 * \frac{1}{2}}{\frac{1}{12} + \frac{1}{6} + \frac{1}{2}} = 33.438\ m$$

$v_i = \bar{x} - x_i$

$v_1 = 33.438 - 33.46 = -0.022$

$v_2 = 33.438 - 33.426 = 0.012$

$v_3 = 33.438 - 33.439 = -0.001$

$$\delta_{xi} = \pm\sqrt{\frac{\sum Pv^2}{n-1}} = \pm 0.017\ m$$

$$\delta\bar{x} = \pm\frac{\delta_{xi}}{\sqrt{P_1 + P_2 + P_3}} = \pm 0.019\ m$$

B- Simple circular horizontal curve having a radius R=137 m, the deflection angle Θ= 64°, and PI station = 12+40. **Compute the [PC, PT] stations.**

(8 marks)

The answer :

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

$T = 137\tan\frac{64}{2} = 85.607\ m$

$L = R\theta_{rad} = 137 \times 64 \times \frac{\pi}{180} = 153.030\ m$

$Station\ PC = Station\ PI - T = 1240 - 85.607 = 1154.393 = 11 + 54.393$

$Station\ PT = Station\ PC + L = 1154.393 + 153.030 = 1307.423 = 13 + 07.423$

Q3) A- The following table represent the field data for the traverse [KAB] using theodolite and steel tape:

Measured Horizontal angle to the right	Measured Horizontal distance (m)
< KAB=85°32'15"	KA=123.568
	AB=75.214

Knowing that: Azimuth of the line KA = AZ_{KA}=136°15'28"

X_K=263.845 m, Y_K=384.734 m

1- Compute the horizontal (X,Y) coordinates of points [A,B]

The answer :

$AZ_{AB} = AZ_{AK} + \sphericalangle KAB = 316^O15'28"+85^O32'15=401^O47'43 - 360 = 41^O47'43"$

$X_A = X_K + D_{AK}\sin AZ_{KA}$

$X_A = 263.845 + 123.568\sin 136^O15'28 = 349.281\ m$

$Y_A = Y_K + D_{AK}\cos AZ_{KA}$