



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

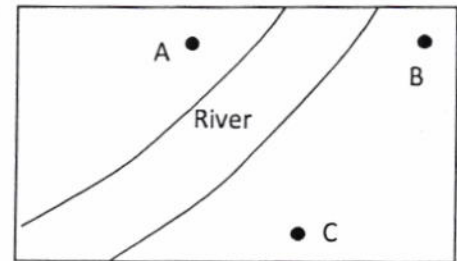
Year: 2<sup>nd</sup> year  
Time: Three hours  
Date: 7 / 6 / 2014

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  $\angle ACB = 85^\circ 24' 35'' \mp 32''$

Theodolite station	Observed station	Telescope	H.C.R
B	C	D	$65^\circ 16' 05''$
	C	R	$245^\circ 16' 25''$
	A	D	$95^\circ 23' 35''$
	A	R	$275^\circ 23' 45''$



- 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  $\angle CBA$  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  $\Theta = 64^\circ$ , 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)
$\angle KAB = 85^\circ 32' 15''$	KA = 123.568
	AB = 75.214

Knowing that: Azimuth of the line KA =  $AZ_{KA} = 136^\circ 15' 28''$   
 $X_K = 263.845$  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  $\angle BKA$ . (3 marks)
- 4- Compute the deflection angle  $\angle ABK$ . (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	

(7 marks)

Knowing that: the Horizontal distance  $AK = 76.385\text{m}$ .  
**Compute the elevation (Z) of point (B).**

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

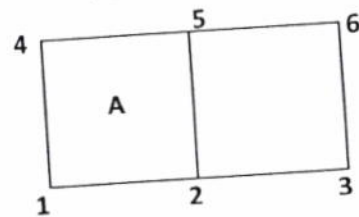
Station	Cross-section		
	Left	C.L	Right
14+50	$\frac{C1.3}{8.6}$	$\frac{C2.7}{0.0}$	$\frac{C1.6}{9.2}$

(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  $(25\text{ m} \times 25\text{ m})$  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



- Draw the contour line with elevation = 29.0 m using a horizontal scale = 1/1000. (9 marks)
- Compute the final elevation required to level the ground into a horizontal plane at which the volume of cut = volume of fill. (4 marks)
- 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  $BM1 = 31.562\text{ m}$   
 The grade elevation of Station  $0+25 = 31.43\text{ m}$   
 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) =  $Z_V = 27.5\text{ m}$ , station  $V = 12+35$ .  
**Compute the elevation of stations (12+00), (12+60) on the curve.**

(10 marks)



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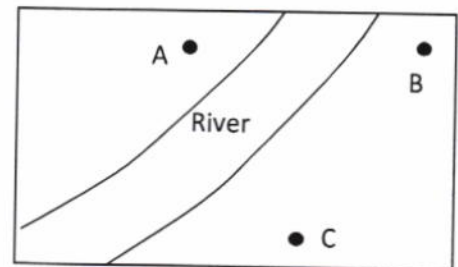
**Answer Four Questions Only**

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  $\angle ACB = 85^\circ 24' 35'' \mp 32''$

Theodolite station	Observed station	Telescope	H.C.R
B	C	D	$65^\circ 16' 05''$
	C	R	$245^\circ 16' 25''$
	A	D	$95^\circ 23' 35''$
	A	R	$275^\circ 23' 45''$



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  $\angle CBA$  and its standard error.

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

The answer :

$$x_1 = CBA1 = 95^\circ 23' 35'' - 65^\circ 16' 05'' = 30^\circ 07' 30''$$

$$x_2 = CBA2 = 275^{\circ}23'45'' - 245^{\circ}16'25'' = 30^{\circ}07'20''$$

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

$$CBA = \frac{30^{\circ}07'30'' + 30^{\circ}07'20''}{2} = 30^{\circ}07'25''$$

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

$$v_1 = 30^{\circ}07'30'' - 30^{\circ}07'25'' = 5''$$

$$v_2 = 30^{\circ}07'20'' - 30^{\circ}07'25'' = -5''$$

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

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

C- Compute the horizontal distance [AC].

The answer :

$$\angle BAC = 180 - 30^{\circ}07'25'' - 85^{\circ}24'35'' = 64^{\circ}28'00''$$

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

$$D_{AC} = \frac{D_{BC} \times \sin \angle CBA}{\sin \angle BAC} = \frac{162.1753 \times \sin 30^{\circ}07'25''}{\sin 64^{\circ}28'00''} = 90.1999 \text{ m}$$

Q2) A-The following table represent the field data for three routes (R<sub>1</sub>, R<sub>2</sub>, R<sub>3</sub>) of differential leveling using the level and leveling rod.

Route	From	To	No. of level setup	Measured difference in elevation (m)	Elevation (m)
R <sub>1</sub>	BM <sub>1</sub>	A	12	+ 1.660	BM <sub>1</sub> =31.8 m
R <sub>2</sub>	BM <sub>2</sub>	A	6	- 0.074	BM <sub>2</sub> =33.5 m

The field data for route R<sub>3</sub> are:

Route	Level setup	Observed points	Rod reading (m)	Elevation (m)
R <sub>3</sub>	1	BM <sub>3</sub>	1.568	32.6
		TP <sub>1</sub>	2.372	
	2	TP <sub>1</sub>	1.825	
		A	0.182	

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

The answer :

(17 marks)

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

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

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

$$X_1 = 33.46$$

$$X_2 = 33.426$$

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

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

$$v_1 = 33.438 - 33.46 = -0.022$$

$$v_2 = 33.438 - 33.426 = 0.012$$

$$v_3 = 33.438 - 33.439 = -0.001$$

$$\delta_{xi} = \pm \sqrt{\frac{\sum P v^2}{n-1}} = \pm 0.00569 \text{ m}$$

$$\delta \bar{x} = \pm \frac{\delta_{xi}}{\sqrt{P_1 + P_2 + P_3}} = \pm 0.0065 \text{ m}$$

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

(8 marks)

**The answer :**

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

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

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

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

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

**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 =  $AZ_{KA}=136^\circ 15' 28''$

$$X_K=263.845 \text{ m}, Y_K=384.734 \text{ m}$$

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

**The answer :**

$$AZ_{AB} = AZ_{AK} + \sphericalangle KAB = 136^\circ 15' 28'' + 85^\circ 32' 15'' = 401^\circ 47' 43'' - 360 = 41^\circ 47' 43''$$

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

$$X_A = 263.845 + 123.568 \sin 136^\circ 15' 28'' = 349.281 \text{ m}$$

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