UNIVERSITY OF RUHUNA

Faculty of Engineering

Semester 3 Examination in Engineering: July 2016

Module Number: CE3203 **Module Name: Engineering Surveying**

[Three Hours]

[Answer all questions. Each question carries **TWELVE** marks]
All Standard Notations denote their regular meanings

Q1. a) An angle was measured by two different observers using the same instrument, as given in Table Q1-1.
Calculate:
 i. The standard deviation of each observers readings.
 ii. The standard error of the arithmetic means.
 iii. The most probable value (MPV) of the angle.

[5.0 Marks]

b) Measured angles surrounding a station "O" are as given below.

a	=	75°	16'	10"	wt. 1
b	=	80°	38'	27"	wt. 2
c	=	150°	28'	15"	wt 1
d	=	53°	37'	13"	wt 1
a+b	=	155°	54'	45"	wt. 2
c+d	=	204°	05'	30"	wt. 2

Starting from fundamentals, find the most probable values of a, b, c, and d using the direct method (Method of correlatives) of least squares.

[7.0 Marks]

Q2. a) Briefly explain the difference between "intersection" and "resection" methods in triangulation.

[4.0 Marks]

b) A baseline PQ of length 550 m is to be set out for a building complex. The bearing of PQ should be 90° 00' 00". The point P has already been selected on the ground and its coordinates are determined by taking angular observations from three control stations A,B, and C whose coordinates are;

E_A = 1947.372 mE N_A = 2352.643 mN
E_B = 2717.483 mE N_B = 2428.078 mN
E_C = 3227.637 mE N_C = 2601.666 mN

The values of clockwise angles measured from A,B, and C are as follows;
$P\hat{A}B = 57° 04' 30"$
$A\hat{B}P = 44° 22' 20"$
$B\hat{C}P = 32° 01' 30"$
Calculate the coordinates of P and Q.

[8.0 Marks]

Q3. a) Consider a closed traverse ABCD, whose stations have co-ordinates (E_1,N_1), (E_2, N_2), (E_3, N_3), and (E_4, N_4) relative to two axes with origin 'O'. Calculate the area enclosed by ABCD.

[3.0 Marks]

b) In a closed clockwise traverse ABCDEF the angles and lengths of sides were measured. The Table Q3-1 indicates the lines, mean included angles, and lengths of the legs of the closed traverse. Calculate the final coordinates of all traverse points. Co-ordinates of points A and B are (2000.000 mE, 1000.000 mN), (1964.369 mE, 1022.630 mN), respectively.

[9.0 Marks]

Q4. a) Derive a formula for the cross sectional area of the level section as show in Figure Q4-1 in terms of formation width b, side slope given by 1: m and central height h.

[2.0 Marks]

b) A road embankment is 8 m wide with side slope 1:2.5 (1vertical to 2.5 horizontal). The top (made) surface of a straight portion of this road embankment rises at a gradient of 1:120 along its center line in the longitudinal direction. At the start of this straight section, the reduced level of the center of the top made surface is 210.00 m above the datum. The reduced levels of the natural ground along the center line of the road embankment are given in Table Q4-1. Assume that the natural ground is level in the direction transverse to the center line. Calculate the volume of the earth-work contained in a length of 560 m.

[6.0 Marks]

c) Table Q4-2 is shows data for a reservoir. The areas are the ones that will be contained by a proposed dam and the corresponding contour lines. Calculate the volume of water impounded if the water level at peak volume is at elevation 630 m.

[4.0 Marks]

Q5. a) Explain with sketches what is meant by the following terms:
I. Line of collimation
II. Horizontal line
III. Level line
IV. Mean sea level

[4.0 Marks]

b) Levelling was done between two known points (TBM 'A' and TBM 'B') which are having reduced levels of 120.842 m and 120.100 m from MSL, respectively. Least count for levelling staff is 5 mm. Table Q5-1 shows the level sheet with the readings taken during the levelling work.

i. Calculate the uncorrected reduced levels at all points using Height of Collimation method.
ii. Carry out the arithmetic check
iii. Calculate the error in the levelling work
iv. What is the allowable error?
v. If the error is in allowable range, distribute the error and calculate the corrected reduced levels for all points.

[8.0 Marks]

Tables, Figures, and Equations

Table Q1-1: Observation

Observer A			Observer B		
°	'	"	°	'	"
86	34	10	86	34	05
86	33	50	86	34	00
86	33	40	86	33	55
86	34	00	86	33	50
86	33	50	86	34	00
86	34	10	86	33	55
86	34	00	86	34	15
86	34	20	86	33	44

Table Q3-1 Data for closed traverse ABCDEFA

Station		Measured included angle			Length (m)
From	To	°	'	"	
A	B				
		153	52	09	
B	C				24.389
		108	39	37	
C	D				44.571
		120	24	55	
D	E				39.915
		125	51	57	
E	F				33.206
		114	08	10	
F	A				61.064
		87	04	12	
A	B				

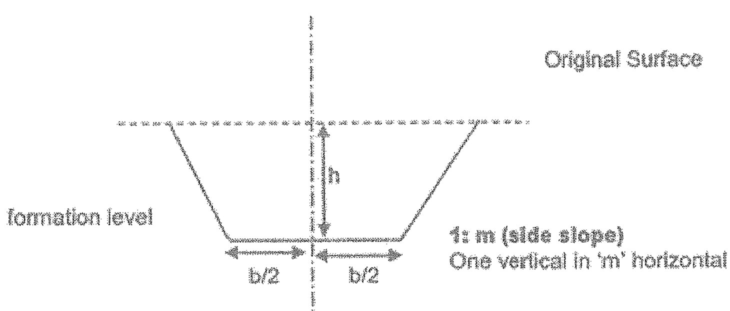

Figure Q4-1: Cross Section

Table Q4-1: The reduced levels of the natural ground along the center line

Chainage (m)	0	40	80	120	160	210	260
Existing RL (m)	207.55	207.94	209.22	208.61	209.09	209.92	210.17

Chainage (m)	310	360	460	560
Existing RL (m)	211.16	211.98	211.52	213.56

Table Q4-2: The reduced levels of the natural ground along the center line

Contour (m)	610	615	620	625	630
Areas enclosed in hectares ($x 10^4$ m^2)	22	110	410	890	1158

Table Q5-1: The level sheet

Back-sight	Intermediate sight	Fore-sight	Remarks
1.361			TBM 'A'
	2.844		
	2.018		
0.855		3.015	C.P.
	0.611		
2.741		1.805	C.P.
2.855		1.711	C.P.
	1.362		
	2.111		
	0.856		
		2.015	TBM 'B'

Useful Equations

$$t_a = \frac{C_t}{KL} + t_s$$

$$C_t = KL\Delta t$$

$$E_F = \frac{K_1E_A + K_2E_B + K_3E_c}{K_1 + K_2 + K_3}$$

$$N_F = \frac{K_1N_A + K_2N_B + K_3N_c}{K_1 + K_2 + K_3}$$

$$\sigma_{\bar{x}} = \frac{S}{n^{\frac{1}{2}}}$$

$$C_T = L\ \frac{\Delta T}{AE}$$

$$S = \left(\frac{\sum(x_i - \bar{x})^2}{n-1}\right)^{\frac{1}{2}}$$

$$K_3 = \frac{1}{(\cot c - \cot z)}$$

$$C_s = -\frac{w^2L^3}{24T^2}$$

$$C_s = -\frac{w^2L^3}{24}\left(\frac{1}{T_A^2} - \frac{1}{T_S^2}\right)$$

$$K_1 = \frac{1}{(\cot a - \cot x)}$$

$$W \propto \frac{1}{\sigma_{\bar{x}}^2}$$

$$C_\theta = -L\,(1 - cos\theta)$$

$$K_2 = \frac{1}{(\cot b - \cot y)}$$

$$C_\theta = -\frac{h^2}{2L}$$

$$C_M = \frac{LH}{R}$$