UNIVERSITY OF RUHUNA

Faculty of Engineering

Semester 3 Examination in Engineering: October 2019

Module Number: CE3302 **Module Name: Engineering Surveying**

[Three Hours]

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

Q1. a) Determine the error in 'A' which is the product of a, b, and c (i.e A = (a×b×c)). Where a, b and c have standard errors of σ_a, σ_b, and σ_c. Find the error in A in terms of their relative error.

[4.0 Marks]

b) The three angles of a triangle in a triangulation scheme, were measured and their mean values recorded as 50° 48' 18", 64° 20' 36", and 64° 51' 00". Analysis of each set gave a standard deviation of 4" for each of these means. At a later date, the angles were re-measured under better conditions, yielding mean values of 50° 48' 20", 64° 20' 39", and 64° 50' 58". The standard deviation of each value was 2". Calculate the most probable values of the three angles.

[8.0 Marks]

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

[2.0 Marks]

b) A baseline PQ of length 550 m is to be set out for a building complex. The whole circle bearing of PQ is 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.

[10.0 Marks]

Q3 a) Explain with sketches what is meant by the following terms relate to levelling:

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 of the levelling staff is 5 mm. Table Q3-1 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 if any
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]

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

[2.0 Marks]

b) Spot levels (RLs with respect to MSL) taken on grid points of a 20 m x 20 m grid over an area ABCD are as shown in Figure Q4-2. Calculate the volume of earth contained between the surface and a level plane of 79.0 m MSL within the area ABCD.

[4.0 Marks]

c) 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 at intervals of 30 m are show in Table Q4-1.

Assume that the natural ground is level in the transverse direction of the center line. Calculate the volume of the earthwork contained in a length of 150m by using

i. The Trapezoidal rule
ii. The Simpson's rule

[6.0 Marks]

Q5 a) List four problems associated with underground surveying.

[4.0 Marks]

b) The Table Q5-1 gives the whole circle bearing based on an assumed bearing of line AB and the lengths of different legs of an underground correction survey between two wires A and G hanging down from two vertical shafts.

The surface coordinates of A and G are E_A = 1936.447 mE, N_A = 2537.826 mN, E_G = 2414.495 mE, N_G = 2709.959 mN respectively. Determine the surface coordinates of points B, C, D, E, and F.

[8.0 Marks]

Tables, Figures, and Equations

Table Q3-1: The level sheet

(Please find the Table Q3-1 on Page no 7)

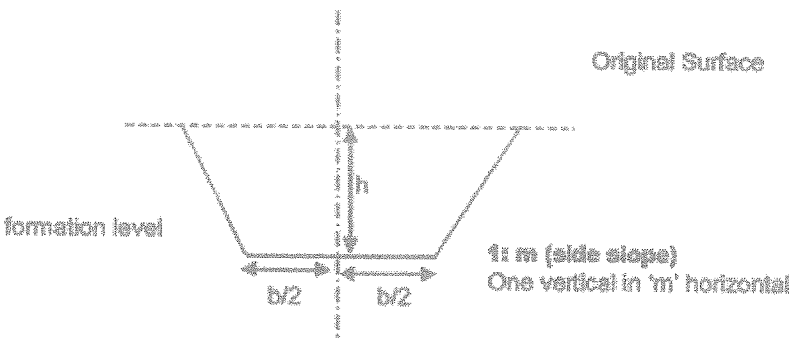

Figure Q4-1: Cross Section

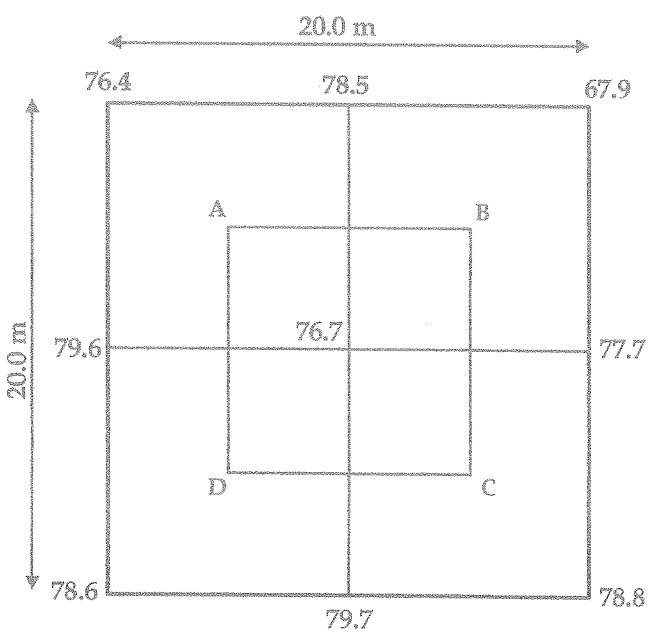

Figure Q4-2: The spot levels on grid points

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

Chainage along the center line (m)	0	30	60	90	120	150
R.L (m above the datum)	208.50	208.25	208.75	209.00	209.50	209.75

Table Q5-1: Underground survey data

Line	Whole Circle Bearing			Length (m)
	°	′	″	
AB	80	55	44	121.18
BC	80	02	30	80.71
CD	61	49	04	102.05
DE	23	05	09	34.29
EF	66	58	56	73.18
FG	36	54	54	122.98

Useful Equations

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

$$C_t = KL\Delta t$$

$$E_F = \frac{K_1E_A + K_2E_B + K_3E_C}{K_1 + K_2 + K_3}$$

$$N_F = \frac{K_1N_A + K_2N_B + K_3N_C}{K_1 + K_2 + K_3}$$

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

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

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

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

$$k = \frac{AB_S}{AB_U}$$

$$\theta = (\emptyset_{AB})_S - (\emptyset_{AB})_U$$

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

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

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

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

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

$$W \propto \frac{1}{\sigma_x^2}$$

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

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

$$(E_i)_S = (E_0)_S + k[(E_i)_U\,cos\theta + (N_i)_U\,sin\theta]$$

$$(N_i)_S = (N_0)_S + k[-(E_i)_U\,sin\theta + (N_i)_U\,cos\theta]$$

(NOTE: Detach Table Q3-1 and attach it to your answer script)

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Table Q3-1: Level sheet from A to B

Back sight	Inter. 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'