UNIVERSITY OF RUHUNA

Faculty of Engineering

Semester 3 Examination in Engineering: July 2022

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 quantity 'A' which is given by the addition of two independent quantities 'a' and 'b' (*i.e* $A = (a + b)$. Quantities 'a' and 'b' have standard errors of σ_a and σ_b respectively.

[3.0 Marks]

b) a, b, c, and d are angles at a station which add up to 360°. The observed values of the angles are as below,

a	=	103° 27′ 20″
b	=	91° 14′ 15″
c	=	94° 23′ 50″
d	=	70° 54′ 45″

Angle (b+c) was measured separately twice and found to have an average value of 185° 38′ 10″. Find the most probable values of the four angles given that all angle measurements are of the same accuracy.

[9.0 Marks]

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

[2.0 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.

[10.0 Marks]

Q3 a) Link traverse is a type of traverse used in Engineering surveying. Write short notes (with sketches) on other types of traverses in surveying.

[2.0 Marks]

b) A link traverse (Figure Q3-1) commences from known stations, A and B, and connects to known stations C and D. Co-ordinates of points B and C are (3,854.28 mE, 9,372.98 mN) and (7,575.56 mE, 8,503.21 mN), respectively. The WCB of lines AB and CD are 151° 27′ 38″ and 347° 37′4 1″ respectively. Table Q3-1 indicates the lines, observed angles, and lengths of the legs of the link traverse. Calculate the final coordinates of all traverse points and find the accuracy of the traverse.

[10.0 Marks]

Q4 a) Figure Q4-1 shows a rectangular plot which is to be excavated to a formation level of 10.0 m. The existing ground levels are in given Table Q4-1. Assuming the sides of the excavation to be vertical. Calculate its volume, considering it to be made up of prisms of rectangular sections.

[4.0 Marks]

b) The levels recorded during a levelling exercise between stations A and E are given in Table Q4-2. The reduced levels of TBM1 and TBM2 are 567.550 m and 576.810 m, respectively. IF the least count for levelling staff is 5 mm, determine the corrected reduced levels of all points using the rise and fall method, giving all the necessary checks.

[8.0 Marks]

Q5 a) List four types of support used during the tunnelling process (with a sketch).

[4.0 Marks]

b) The partial coordinates obtained during the correlation survey between wires in each of two shafts A and E. are given in Table Q5-1.

If the surface coordinates of A and E are E_A = 556 821.630 mE, N_A= 447 219.420 mN, E_E = 557 098.390 mE, N_E = 447 300.380 mN respectively determine the surface coordinates of points B, C, D, and E.

[8.0 Marks]

Tables, Figures, and Equations

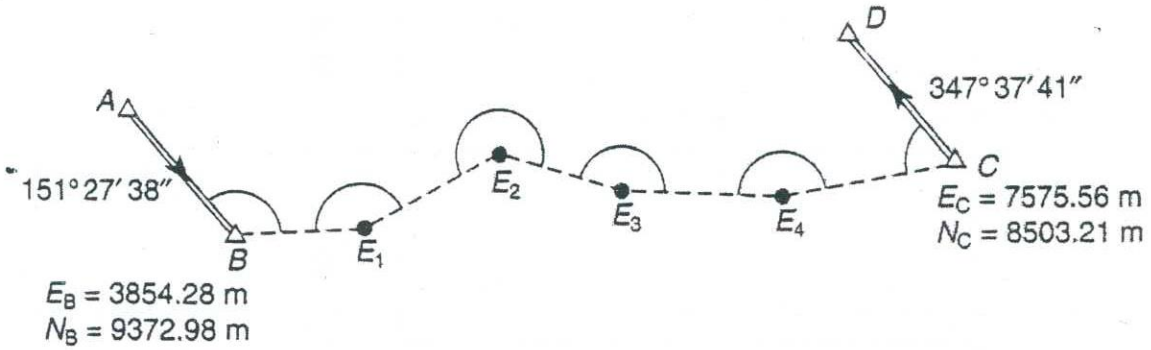

Figure Q3-1: Diagram of link traverse

Table Q3-1: Data for link traverse

Station		Observed angle			Length (m)
From	To	°	′	″	
A	B				
		143	54	47	
B	E_1				651.16
		149	08	11	
E_1	E_2				870.92
		224	07	32	
E_2	E_3				522.08
		157	21	53	
E_3	E_4				1,107.36
		167	05	15	
E_4	C				794.35
		74	32	48	
C	D				

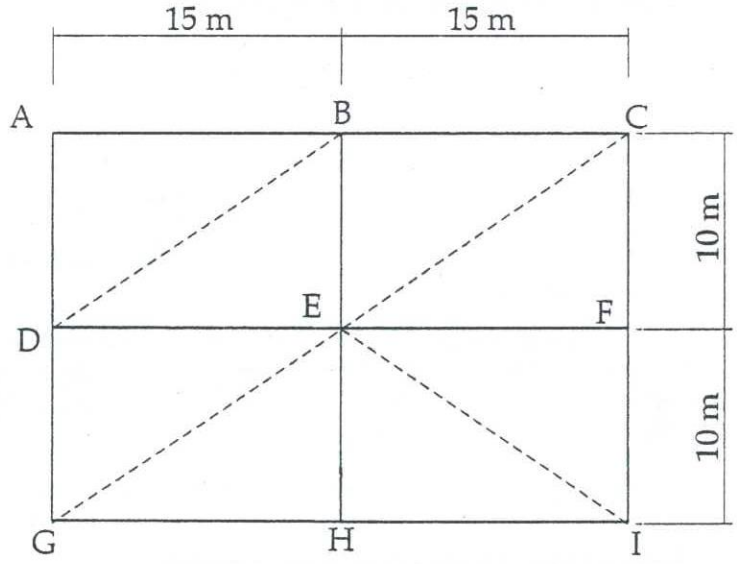

Figure Q4-1: Plane view

Table Q4-1: Existing ground levels

Station	A	B	C	D	E	F	G	H	I
Level (m)	13.2	13.75	14.30	14.00	14.75	15.05	15.25	16.20	14.60

Table Q4-2: Data for levelling

Instrument station	1st Reading	2nd Reading	3rd Reading	4th Reading
A	2.430 (TBM1)	2.310	2.015	0.970
B	3.070	3.270	2.040*	0.425
C	2.930	1.930	1.170	
D	2.420	2.210	1.370	
E	3.255	2.070	0.930 (TBM2)	

Note: * Inverted staff reading

Figure Q5-1: The partial coordinates

Line	Departure (ΔE), (m)	Latitude (ΔN), (m)
AB	119.662	-9.105
BC	79.498	13.958
CD	89.954	48.197
DE	-13.445	31.543

Useful Equations

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

$$C_t = KL\Delta t$$

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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