UNIVERSITY OF RUHUNA

Faculty of Engineering

Semester 3 Examination in Engineering: March / April 2026

Module Number: CE3303 **Module Name: Engineering Surveying (C-23)**

[Three Hours]

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

Q1. a) Parameter is "**A**" given by the division of a by b (i.e A = (a/b)). When "**a**" and "**b**" have standard errors of σ_a and σ_b, find the error in "**A**".

[3.0 Marks]

b) a, b, c, and d form a round of angle at a station so that their sum is equal to 360°. The observed values of these angles are;

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

The angle (a+b) was also measured separately twice and found to average of 185° 38′ 10″. Find the most probable values of the four angles if all the measurements of individual angles 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 = 1,947.372 mE N_A = 2,352.643 mN
E_B = 2,717.483 mE N_B = 2,428.078 mN
E_C = 3,227.637 mE N_C = 2,601.666 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) With the aid of neat sketches, write short notes on types of traverses in Engineering Surveying according to the survey technology.

[2.0 Marks]

b) The Table Q3-1 indicates the line, mean included angles, and length of a polygon traverse **ABCDEFA**. The whole circle bearing of line **AB** is 30° 02′ 20″.

i. Use the appropriate method of checking to find whether there is any error in angular measurements.
ii. Compute the closing error in distance measurements.
iii. Calculate the final coordinates of all traverse points. If the coordinates of a point **A** are 1,000.000 mE and 2,000.000 mN.

[10.0 Marks]

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

[2.0 Marks]

b) A road embankment is 8 m wide with side slope 1:2.5. The top (made) surface of a straight portion of this road embankment rises at a gradient of 1:120 along its centerline 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 centerline of the road embankment are given in Table Q4-1. Assume that the natural ground is level in the direction transverse to the centerline. Calculate the volume of the earth-work (cutting and filling volume) contained in a length of 560 m.

[5.0 Marks]

c) The areas within the contour lines of a reservoir are measured with a planimeter from a plan drawn to a scale 1:1,000 and shown in Table Q4-2. If the lowest raw-off level is 56 m and the maximum water level is 68 m, estimate the full storage capacity of the reservoir and find the water level when the reservoir is 50% capacity.

[5.0 Marks]

Q5. a) List four problems associated with underground surveying.

[2.0 Marks]

b) An underground traverse **APQRB** connects two wires **A** and **B** hung down two separate shafts.

The underground traverse observations recorded are given in Table Q5-1.

The **surface coordinates** of wires A and B determined by surface survey are:

- **A**: 5,210.480 mE, 3,418.275 mN
- **B**: 5,108.765 mE, 3,578.940 mN

Calculate the **surface coordinates** of points **P, Q,** and **R.**

[10.0 Marks]

Tables, Figures, and Equations

Table Q3-1: Data for polygon traverse ABCDEFA

Line	Mean Included Angle	Length (m)
AB	θ_A = 151° 53′ 55″	94.420
BC	θ_B = 102° 36′ 05″	67.970
CD	θ_C = 108° 44′ 44″	67.475
DE	θ_D = 153° 09′ 55″	89.173
EF	θ_E = 112° 22′ 45″	78.125
FA	θ_F = 91° 12′ 24″	82.273

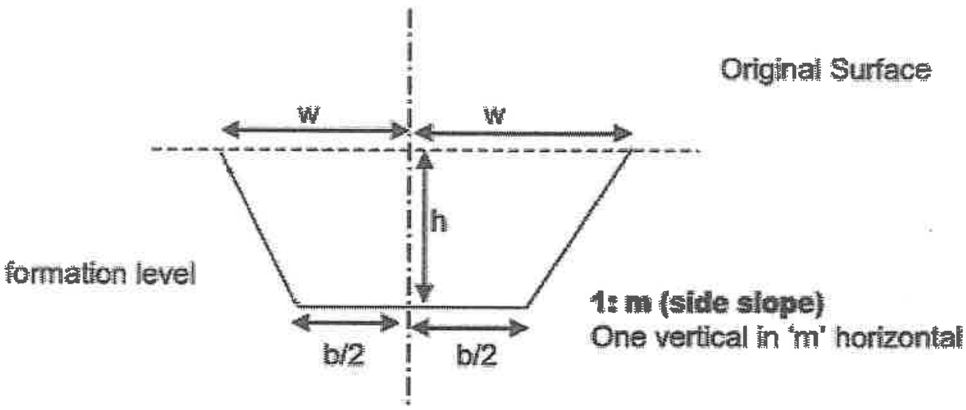

Figure Q4-1: Cross Section

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

Chainage (m)	0	40	80	120	160	210	260
Existing RL (m)	216.56	215.23	214.25	213.35	211.33	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 centerline

Contour level (m)	68	66	64	62	60	58	56
Area (mm^2)	84,960	80,050	70,500	62,030	57,100	39,880	17,200

Figure Q5-1: Data for underground survey APQRB

Station		Observed angle			Length (m)
From	To	°	'	"	
A	P				52.410
		121	18	50	
P	Q				64.820
		185	44	20	
Q	R				73.155
		248	52	10	
R	B				38.762

Useful Equations

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

$$C_t = KL\Delta t$$

$$E_F = \frac{K_1 E_A + K_2 E_B + K_3 E_c}{K_1 + K_2 + K_3}$$

$$N_F = \frac{K_1 N_A + K_2 N_B + K_3 N_c}{K_1 + K_2 + K_3}$$

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

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

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

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

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

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

$$V = \frac{D}{6}[A_1 + 4M + A_2]$$

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

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

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

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

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

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

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

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

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

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

$$\mathrm{V} = \mathrm{A}(\sum \mathrm{h}_1 + 2\sum \mathrm{h}_2 + 3\sum \mathrm{h}_3 + 4\sum \mathrm{h}_4)$$

$$A = \frac{d}{3}\left\{h_1 + 4\sum evenoffsets + 2\sum Oddoffsets + h_n\right\}$$

$$A = \left[\frac{h_1 + h_n}{2}\ d + h_2 + h_3 + h_4 + \dots \dots \dots \dots \dots + h_{n-1}\right] d$$