UNIVERSITY OF RUHUNA

Faculty of Engineering

Semester 3 Examination in Engineering: February 2023

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. The following equation for a EDM can be derived with standard notations.

$$D = n\left(\frac{\lambda}{2}\right) + \left[\frac{\phi}{2\pi}\right]\left(\frac{\lambda}{2}\right)$$

a) Assuming that an EDM instrument emits two waves with wave lengths of 12 mm and 13 mm, find out the solution for unknown parameter "n" by considering all possible scenarios for D.

[3.0 Marks]

b) Calculate the maximum non ambiguous distance that can be measured using two mentioned waves in Q1 a).

[2.0 Marks]

b) A chain line **AB** was measured on uniformly sloping ground. The difference of level between points **A** and **B** was found to be 1.72 m. The length of the line was measured by using stepping, where a suspended chain of nominal length 30.0 m was to measure the horizontal length in catenary between two staff locations at the ends of chain. Total length measured was 414.5 m.
It was later found that chain used for the measurements was 30.15 m long. The measurements were done such that both the pull exerted on the chain and the ambient temperature were standard values. If the weight of the chain was 0.06 kg per meter, and the (standard) pull exerted was 10.0 kg, determine:

i) the corrected horizontal length of the line **AB**; and
ii) the length of the line **AB** along the slope

[7.0 Marks]

Q2. a) Explain the following terms with respect to Engineering levelling.

i. Datum
ii. Temporary benchmark
iii. Backsight
iv. Intermediate sight

[4.0 Marks]

b) It is required to estimate the elevation of two points "**P**" and "**Q**". The observations of a level line using a benchmark (BM) with level 130.30 m above the MSL is given in the Table Q2-1.

i. Obtain the reduced level of **P** and **Q** applying relevant checks and corrections.
ii. If the distance between **P** and **Q** is 3.977 km, find the gradient between **P** and **Q**.

[8.0 Marks]

Q3. a) How do you level a theodolite or total station which has four foot-screws in the levelling head?

[3.0 Marks]

b) The Table Q3-1 indicate 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 and 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. Coordinates of a point A are 1,000.000 mE and 2,000.000 mN.

[9.0 Marks]

Q4. a) Consider a closed anti clockwise traverse ABCD, whose stations have coordinates (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) A land parcel shown in Figure Q4-1 has straight boundaries **AB**, **BC**, **DE**, and **EA**, and a curved boundary CQRD which forms one edge of a road. Table Q4-1 shows the field measurement was made by running a traverse ABCDEA as shown in Figure Q4-1. Table Q4-2 was taken from the survey line **CD** to the irregular property boundary (edge of the road CQRD). Find the area enclosed by the property boundary ABCQRDEA.

[9.0 Marks]

Q5. a) List the three problems associate with the use of a theodolite in the measurement of angles in underground surveying.

[3.0 Marks]

b) Two wires hung from points **A** and **B** on surface, down a vertical shaft were used for the correlation of underground surveys to a surface coordinate system. The surface coordinates of A are 4,125.325 mE and 6,248.638 mN and those of B are 4,130.415 mE and 6,251.313 mN. **U** and **V** are two survey points underground on a horizontal excavation close to the shaft. The underground triangle ABU is in the clockwise order and **U** is closer to **B** than to **A**. The wires **A** and **B** wires observed from **U** and the values of clockwise angles recorded are, VUA = 97° 34′ 35″ and VUB = 97° 42′ 45″. The horizontal distances measured are, UB = 4.342 m and UV = 12.724 m. An inclined excavations planned between **V** and a point **X** whose coordinates 4,300.000 mE and 6,000.000 mN. The elevation of **X** is 125.000 m below that of **V**.

i. Show that the underground triangle ABU satisfies the conditions of Weissbach triangle.

ii. Calculate the coordinates of the point **U** and **V**.

iii. Calculate the horizontal angle UVX and the inclined length of line **VX**.

[9.0 Marks]

Tables, Figures, and Equations

Table Q2-1: Data for levelling

Back-sight	Inter-sight	Fore-sight	Remarks
2.44			BM
2.89		1.52	
3.14		1.44	
3.45		1.56	
0.92		0.89	P
1.46		2.78	
2.05		3.27	
2.25		2.36	Q
2.63		2.97	
1.02		3.19	
		2.28	BM

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

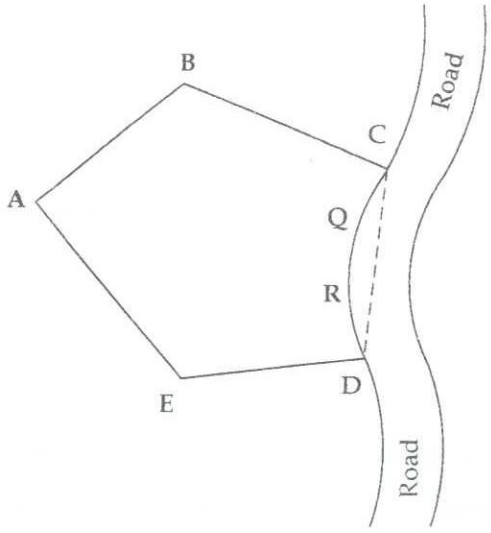

Figure Q4-1: Diagram of Land property

Table Q4-1: Field measurement of traverse "ABCDEA"

Line	Latitude ΔN (m)	Departure ΔE (m)
AB	+120	+179
BC	-141	+252
CD	-425	-57
DE	+38	-275
EA	+408	-99

Table Q4-2: Offset for irregular property boundary "CQPD"

Chaine from C (m)	0	40	80	120	160	210	260	310	360	410	428.8
Offset (m)	0	7	14	22	24	29	25	18	12	10	0

Useful Equations

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

$$C_t = KL\Delta t$$

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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