UNIVERSITY OF RUHUNA

Faculty of Engineering

Semester 3 Examination in Engineering: March 2021

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) 'A' is a quotient of a and b (i.e A = (a/b)). Where, "a" and "b" have standard errors of σ_a and σ_b respectively. Determine the error in A in terms of their relative errors.

[4.0 Marks]

b) Observations of angles on a station with relative weight of each observation are given in bellow.

a	=	25° 17′ 10″	Weight 1
b	=	28° 22′ 16″	Weight 2
c	=	32° 40′ 29″	Weight 2
a + b	=	53° 39′ 23″	Weight 2
a + b +c	=	86° 19′ 58″	Weight 1

Find the most probable values of the angles a, b, and c.

[8.0 Marks]

Q2 Using phase comparison technique following equation for a EDM can be derived with standard notation.

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

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.

[5.0 Marks]

b) Calculate the maximum non ambiguous distance that can be measured using above mentioned waves in Q2 a).

[2.0 Marks]

c) A chain line AB was measured on uniformly sloping ground. The difference of level between points A and B was found to be 1.65 meters. The length of the line was measured by using stepping, where a suspended chain of nominal length

30.0 meters was to measure the horizontal length in catenary between two staff locations at the ends of chain. The length measured was 384.4 m.
It was later found that chain used for the measurements was actually 29.8 meters 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 0.05 kg per meter, and the (standard) pull exerted was 10.0 kg, find:

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

[5.0 Marks]

Q3 a) A point P was established within the triangle formed by control stations, A [1020 mE, 2560 mN], B [1360 mE, 2520 mN], and C [1150 mE, 2070 mN] such that angles $A\hat{P}B = 128°20'20''$ and $B\hat{P}C = 135°47'40''$.

i. What is the distance between point R [1200 mE, 2450 mN] and point P?
ii. What is the whole circle bearing (WCB) of PR?

[4.0 Marks]

b) In a closed anticlockwise traverse ABCDEF, the whole circle bearing and lengths of sides were measured. The Table Q3-1 indicates the lines, mean whole circle bearing and lengths of the legs of the closed traverse.

i) Check angular observations and adjust any angular misclosure
ii) Check whether there is a closing error resulting from linear measurements (after the angular misclosure) and adjust it.
iii) Calculate the corrected coordinate values of B, C, D, E, and F, assuming the values 2000.00 mN and 1000.00 mE for A.

[8.0 Marks]

Q4 a) Explain the meaning of the following terms with respect to Engineering levelling.

i. Datum
ii. Temporary Bench Mark
iii. Backsight
iv. Intermediate sight

[4.0 Marks]

b) Levelling exercise was done between two known points (TBM 'A' and TBM 'B') having reduced levels of 221.100 m and 220.900 m from MSL, respectively. Least count of levelling staff is 5 mm. Table Q4-1 shows the level sheet with the readings taken during the levelling work. At point F, level was measured with invited level staff.

i. Calculate the uncorrected reduced levels at all points using the "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 the allowable range, distribute the error and calculate the corrected reduced level for point F

[8.0 Marks]

Q5 a) Consider a closed anti clockwise 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.

[4.0 Marks]

b) The Table Q5-1 shows coordinates were obtained for a closed traverse ABCDEFA using the Total Station. Find the area enclosed by the polygon ABCDEFA.

[3.0 Marks]

c) The Table Q5-2 shows offset wee taken from a chain line to an irregular boundary. Calculate the area enclosed by the chain line, the irregular boundary and the end offsets by Trapezoidal Rule.

[5.0 Marks]

Tables, Figures, and Equations

Table Q3-1: Data for closed traverse ABCDEFA

Station		Whole Circle Bearing			Length (m)
From	To	°	'	"	
A	B	302	25	14	42.210
B	C	286	17	23	24.389
C	D	214	57	00	44.571
D	E	155	21	55	39.915
E	F	101	13	52	33.206
F	A	35	22	02	61.064

Figure Q5-1: Coordinate for closed traverse ABCDEFA

Point	E(m)	N(m)
A	1162.416	1006.595
B	1198.953	973.966
C	1304.918	988.838
D	1319.237	1071.205
E	1228.145	1105.237
F	1170.314	1058.050

Table Q5-2: The offset reading from chain line

Chainage along the survey line (m)	0	30	50	70	90	110	140	170	200	230	270	310
Offset (m)	23	28	16	24	28	21	25	27	24	08	22	18

(NOTE: Detach Table Q4-1 and attach it to answer script)

Table Q4-1: The level sheet

Back-sight	Inter. sight	Fore-sight						Remarks
3.150								TBM 'A'
	1.770							
	2.200							
2.430		3.930						C.P.
	2.440							
2.800		1.340						C.P.
1.185		2.010						C.P.
	-2.735							**Point F (Inverted staff)**
0.720		1.685						C.P.
	1.350							
	0.845							
		1.525						TBM 'B'
Arithmetic. Check:								
				Error				
Allowable error				Correction				

Useful Equations

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

$$C_t = KL\Delta t$$

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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