



UNIVERSITY OF RUHUNA

Faculty of Engineering

Semester 3 Examination in Engineering: July 2017

Module Number: CE3203

Module Name: Engineering Surveying

[Three Hours]

[Answer all questions. Each question carries **TWELVE** marks]

All Standard Notations denote their regular meanings

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- Q1. a) Consider a value A given by the product of a , b , and c (i.e $A = (a \times b \times c)$). Where a , b and c have standard errors of σ_a , σ_b , and σ_c . Find the error in A . [4.0 Marks]
- b) From a station P , the angles subtended by points Q , R , S , and T were measured by two observers A and B . The results are given the Table Q1-1. In order to apportion weights to their observations, a separate test was carried out, in which both A and B measured a given angle for many times. Analysis of the test showed that the standard error of B was twice that of A . Apply the appropriate weights to the observations and determine the most probable value of the angles to the nearest $0.1''$. [8.0 Marks]
- Q2. a) An EDM instrument emits two waves with wave lengths of $\lambda_1=12$ mm and $\lambda_2=13$ mm. Using the equation derive from phase comparison technique,
$$D = n(\lambda/2) + (\phi/2\pi)(\lambda/2)$$
Derive equation for unknown parameter " n " by considering all possible scenarios of D . Determine the maximum non-ambiguous distance that can be measured using above mentioned waves. [6.0 Marks]
- b) A base line was measured in catenary in four bays giving 30.126, 29.973, 30.066, and 22.536 m. The differences of level were 0.45, 0.60, 0.30, and 0.45 m respectively for each bay. Temperature during the observations was 10°C and the straining mass was 15 kg. The tape was standardized as 30 m, at 20°C , on the flat with a straining mass of 5 kg. The coefficient of expansion is 0.000 011 per $^\circ\text{C}$, the mass of the tape is 1 kg, the cross-sectional area is 3 mm^2 . $E = 210\text{ kN/mm}^2$, gravitational acceleration is 9.80665 m/s^2 . Calculate the length of the base. [6.0 Marks]

Q3. a) Briefly explain the setting up procedure of total station or theodolite when setup with a plumb-bob.

[3.0 Marks]

b) In a closed anticlockwise traverse ABCDEF, the angles and lengths of sides were measured. The Table Q3-1 indicates the lines, mean included angles, and lengths of the legs of the closed traverse. Calculate the final coordinates of all traverse points and find the accuracy of the traverse. Coordinates of points A and B are (2,000.000 mE, 1,000.000 mN) and (1,964.369 mE, 1,022.630 mN), respectively.

[9.0 Marks]

Q4. a) Derive formulae for the cross sectional cutting and filling areas of the level section shown in Figure Q4-1 in terms of the formation width b , side slopes given by $1:m$ and $1:n$, height of cutting and filling embankment h_1 and h_2 , and gradient of existing ground level given by $1:k$.

[3.0 Marks]

b) 30 m x 20 m land plot shown in the Figure Q4-2 is to be excavated to a formation level of 12.0 m. The Existing ground levels are given in the Table Q4-1. Assuming the sides of excavation to be vertical, find the excavation volume of land.

[4.0 Marks]

c) A reservoir is to be formed in a river valley by building a dam across it. The entire area that will be covered by the reservoir has been contoured and contours are drawn at 1.5 m intervals. The lowest point in the reservoir is at a reduced level of 249 m above datum, whilst the top water level will not be above a reduced level of 264.5 m. The area enclosed by each contour in the upstream face of the dam is shown in the Table Q4-2. Estimate the full capacity of the reservoir when is full using the end area formula. What will be the reduced level of the water surface, if in a time of drought, when this volume is reduced to 25% of full volume?

[5.0 Marks]

Q5. a) Explain the meaning of the following terms:

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

[4.0 Marks]

- b) Levelling 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 Q5-1 shows the level sheet with the readings taken during the levelling work.
- 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]

Tables, Figures, and Equations

Table Q1-1: Results of Observation

Observer			Angle		
A	QPR	16	02	51	
A	RPS	40	34	08	
A	SPT	22	11	04	
B	QPS	56	37	01	
B	RPT	62	45	09	

Table Q3-1: Data for closed traverse ABCDEFA

Station		Measured included angle			Length (m)
From	To	β	α	γ	
A	B				
		163	52	09	
B	C				24.389
		108	39	37	
C	D				44.571
		120	24	55	
D	E				39.915
		125	51	57	
E	F				33.206
		114	08	10	
F	A				61.064
		87	04	12	
A	B				

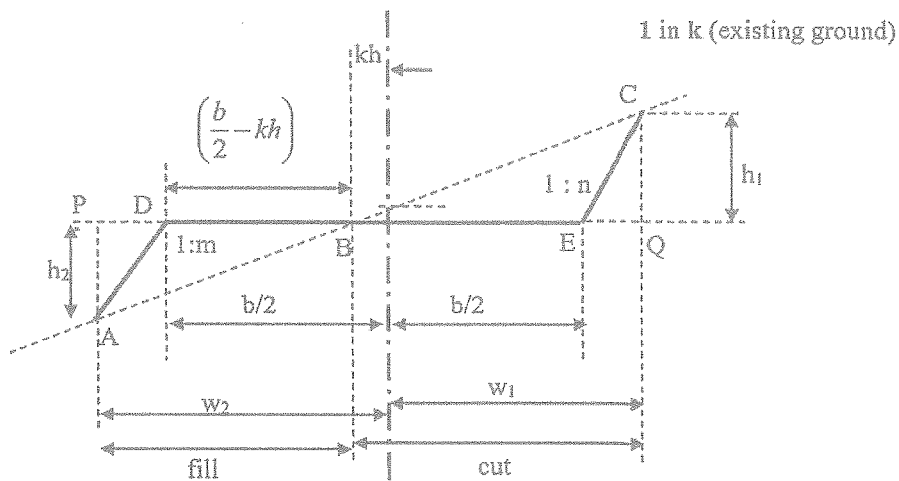


Figure Q4-1: Cross Section

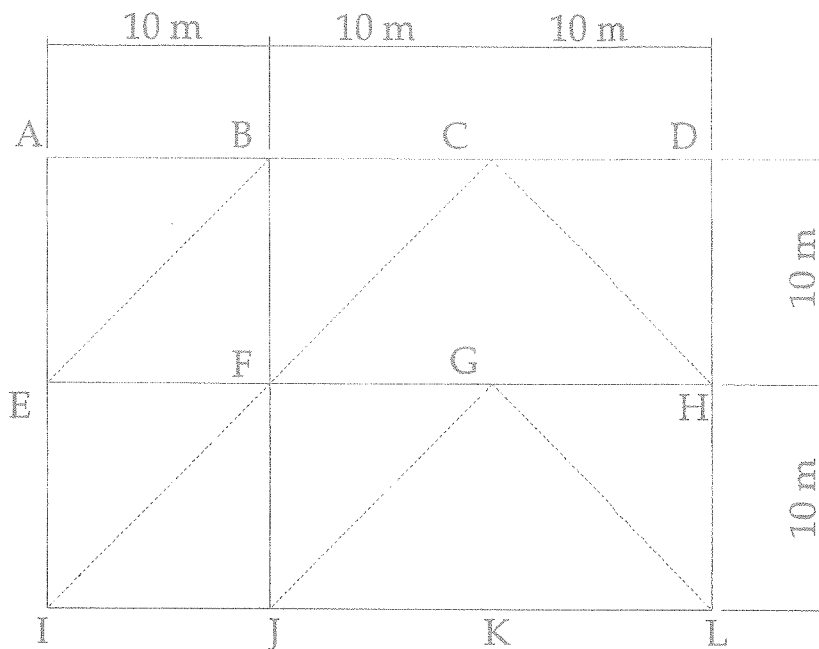


Figure Q4-2: Plot of land

Table Q4-2: The existing ground levels of the points

Point	A	B	C	D	E	F	G
Ground level (m)	24.36	25.12	24.90	23.75	26.80	27.18	27.56
Point	H	I	J	K	L		
Ground level (m)	26.04	27.95	28.63	28.88	29.23		

Table Q4-2: The area enclosed by each contour in the upstream face of the dam

Contour (m)	Areas enclosed (m ²)
250.0	1,874
251.5	6,355
253.0	11,070
254.5	14,152
256.0	19,310
257.5	22,605
259.0	24,781
260.5	26,349
262.0	29,830
263.5	33,728
265.0	37,800

(NOTE: Detach Table Q5-1 and attach it to answer script)

Table Q5-1: The level sheet

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

Useful Equations

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

$$C_t = KL\Delta t$$

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

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

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

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

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

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

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

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

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

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

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

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

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

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