UNIVERSITY OF RUHUNA

Faculty of Engineering

Semester 3 Examination in Engineering: August 2015

Module Number: CE3203 **Module Name: Engineering Surveying**

[Three Hours]

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

All Standard Notations denote their regular meanings

Q1. a) Explain the difference between "accuracy" and "precision".

[1.0 Marks]

b) A length was measured eleven times and the following readings were recorded in meters.

75.231 75.425 75.098 75.340 75.189 75.212 75.304 75.401 75.143 75.265 and 75.154

Find the followings:

i. Mean and standard error of the above length measurements.

ii. 95% confidence interval for the mean of above length measurements. (Assuming that above data set follows Normal distribution)

[4.0 Marks]

c) Table Q1-2 shows the data obtained during the measurement in catenary of a survey line of four bays. Using a tape which has a mass of 0.026 kg/m and cross sectional area of 3.24 mm^2. The tape was standardized on a flat at 20°C under a pull of 89 N. The coefficient of linear expansion for the material of the tape is 0.000011/°C and Young's modulus is 20.7×10^4 MN/m^2. The mean elevation of the line is 26.89 m above mean sea level. Determine the absolute length of the survey line reduced to sea level. The radius of the Earth may be taken as 6,367 km.

[5.0 Marks]

Q2. a) Errors in linear measurements of surveying can be classified as systematic errors and random errors. Briefly explain them with examples.

[2.0 Marks]

b) Write short notes (with sketches) on major types of traverse in surveying.

[2.0 Marks]

c) Data shown in the Table Q2-1 and Table Q2-2 were obtained for a closed traverse. The whole circle bearing (WCB) of line CG is 50° 00′ 00″ and coordinate of point C is (500.00 mE, 500.00 mN).

i. Assuming that there is no linear misclosure in the traverse, find the value of "a" and "b".

ii. Find the coordinates of points D, E, F, and G.

[6.0 Marks]

Q3. a) Briefly explain the difference between "intersection" and "resection" methods in triangulation.

[2.0 Marks]

b) What are the two types of errors in a loop traverse? Briefly explain them with figures.

[2.0 Marks]

c) A point P was established within the triangle formed by control stations, A [1020 mE, 2560 mN], B [1360 mE, 252 0mN], 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?

[6.0 Marks]

Q4. Using phase comparison technique following equation can be derived.

$$D = n\lambda + L$$

a) Assuming that an EDM instrument emits two waves with wave lengths of λ_1=12 mm and λ_2=13 mm, find out the solution for unknown parameter "n" by considering all possible scenarios for D.

[4.0 Marks]

b) Calculate the maximum non ambiguous distance that can be measured using above mentioned waves in Q4 a).

[2.0 Marks]

c) A closed clockwise traverse ABCDEF was done using Total Station. The measured coordinates are shown in Table Q4-1. Calculate the area enclosed by the traverse ABCDEF.

[4.0 Marks]

Q5. a) With the aid of neat sketches briefly explain the following terms.

i. Level Line
ii. Horizontal Line
iii. Line of Collimation

[3.0 Marks]

b) Levelling was done between two known points (BM1 and BM2) which are having reduced levels of 156.875 m and 152.000 m from MSL. Least count for levelling staff is 10 mm. Table Q5-1 shows the level sheet with the readings taken during the levelling work.
(NOTE: Detach Table Q5-1 and attach it to answer script)

i. Calculate the uncorrected reduced levels at all points
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 allowable range, distribute the error and calculate the corrected reduced levels for all points.

[7.0 Marks]

Q6. a) Derive a formula for the cross sectional area given in Fig. Q6-1 in terms of formation width b, side slope given by 1:s and central height h.

[2.0 Marks]

b) A proposed road is 10 m wide with side slope 1:3 (1 vertical to 3 horizontal). Road is straight and rises at a gradient of 1:100 along the centre line in the longitudinal direction. At the start of this straight section, the reduced level of the centre of the top made surface is 206.00 m above the datum. The reduced levels of the natural ground along the centre line of the road embankment is given in Table Q6-1.

(NOTE: Detach Table Q6-1 and attach it to answer script)

i. Calculate the fill depth and the area at each chain-age
ii. Calculate the fill volume using "End Area" method.

[8.0 Marks]

Tables, Figures, and Equations

Table Q1-1: Area under the Normal Distribution curve

z	*0.00*	*0.01*	*0.02*	*0.03*	*0.04*	*0.05*	*0.06*	*0.07*	*0.08*	*0.09*
0.0	0.5000	0.5040	0.5080	0.5120	0.5160	0.5199	0.5239	0.5279	0.5319	0.5359
0.1	0.5398	0.5438	0.5478	0.5517	0.5557	0.5596	0.5636	0.5675	0.5714	0.5753
0.2	0.5793	0.5832	0.5871	0.5910	0.5948	0.5987	0.6026	0.6064	0.6103	0.6141
0.3	0.6179	0.6217	0.6255	0.6293	0.6331	0.6368	0.6406	0.6443	0.6480	0.6517
0.4	0.6554	0.6591	0.6628	0.6664	0.6700	0.6736	0.6772	0.6808	0.6844	0.6879
0.5	0.6915	0.6950	0.6985	0.7019	0.7054	0.7088	0.7123	0.7157	0.7190	0.7224
0.6	0.7257	0.7291	0.7324	0.7357	0.7389	0.7422	0.7454	0.7486	0.7517	0.7549
0.7	0.7580	0.7611	0.7642	0.7673	0.7704	0.7734	0.7764	0.7794	0.7823	0.7852
0.8	0.7881	0.7910	0.7939	0.7967	0.7995	0.8023	0.8051	0.8078	0.8106	0.8133
0.9	0.8159	0.8186	0.8212	0.8238	0.8264	0.8289	0.8315	0.8340	0.8365	0.8389
1.0	0.8413	0.8438	0.8461	0.8485	0.8508	0.8531	0.8554	0.8577	0.8599	0.8621
1.1	0.8643	0.8665	0.8686	0.8708	0.8729	0.8749	0.8770	0.8790	0.8810	0.8830
1.2	0.8849	0.8869	0.8888	0.8907	0.8925	0.8944	0.8962	0.8980	0.8997	0.9015
1.3	0.9032	0.9049	0.9066	0.9082	0.9099	0.9115	0.9131	0.9147	0.9162	0.9177
1.4	0.9192	0.9207	0.9222	0.9236	0.9251	0.9265	0.9279	0.9292	0.9306	0.9319
1.5	0.9332	0.9345	0.9357	0.9370	0.9382	0.9394	0.9406	0.9418	0.9429	0.9441
1.6	0.9452	0.9463	0.9474	0.9484	0.9495	0.9505	0.9515	0.9525	0.9535	0.9545
1.7	0.9554	0.9564	0.9573	0.9582	0.9591	0.9599	0.9608	0.9616	0.9625	0.9633
1.8	0.9641	0.9649	0.9656	0.9664	0.9671	0.9678	0.9686	0.9693	0.9699	0.9706
1.9	0.9713	0.9719	0.9726	0.9732	0.9738	0.9744	0.9750	0.9756	0.9761	0.9767
2.0	0.9772	0.9778	0.9783	0.9788	0.9793	0.9798	0.9803	0.9808	0.9812	0.9817
2.1	0.9821	0.9826	0.9830	0.9834	0.9838	0.9842	0.9846	0.9850	0.9854	0.9857
2.2	0.9861	0.9864	0.9868	0.9871	0.9875	0.9878	0.9881	0.9884	0.9887	0.9890
2.3	0.9893	0.9896	0.9898	0.9901	0.9904	0.9906	0.9909	0.9911	0.9913	0.9916
2.4	0.9918	0.9920	0.9922	0.9925	0.9927	0.9929	0.9931	0.9932	0.9934	0.9936
2.5	0.9938	0.9940	0.9941	0.9943	0.9945	0.9946	0.9948	0.9949	0.9951	0.9952
2.6	0.9953	0.9955	0.9956	0.9957	0.9959	0.9960	0.9961	0.9962	0.9963	0.9964
2.7	0.9965	0.9966	0.9967	0.9968	0.9969	0.9970	0.9971	0.9972	0.9973	0.9974
2.8	0.9974	0.9975	0.9976	0.9977	0.9977	0.9978	0.9979	0.9979	0.9980	0.9981
2.9	0.9981	0.9982	0.9982	0.9983	0.9984	0.9984	0.9985	0.9985	0.9986	0.9986
3.0	0.9987	0.9987	0.9987	0.9988	0.9988	0.9989	0.9989	0.9989	0.9990	0.9990

How to use the table: If $(x - \mu)/\sigma = 1.75$ look down the left column to 1.7 and across the row to the element in the column headed 0.05; the value for the probability is 0.9599, i.e. the probability is 95.99%.

Table Q1-2

Bay	*Measured length (m)*	*Temperature (°C)*	*Difference in level between ends (m)*	*Tension (N)*
1	*29.899*	*18.0*	*+0.064*	*178*
2	*29.901*	*18.0*	*+0.374*	*178*
3	*29.882*	*18.1*	*-0.232*	*178*
4	*29.950*	*17.9*	*+0.238*	*178*

Table Q2-1

Survey line	CD	DE	EF	FG	GC
Length (m)	78.82	93.50	a	b	122.70

Table Q2-2

Angle	GCD	CDE	DEF	EFG	FGC
Value	110° 47′ 40″	90° 30′ 00″	132° 49′20″	125° 54′ 40″	80° 00′ 00″

Table Q4-1: The measured coordinates for traverse ABCDEF

Station	N (m)	E (m)
A	300	200
B	300	310
C	180	400
D	90	310
E	90	200
F	180	100

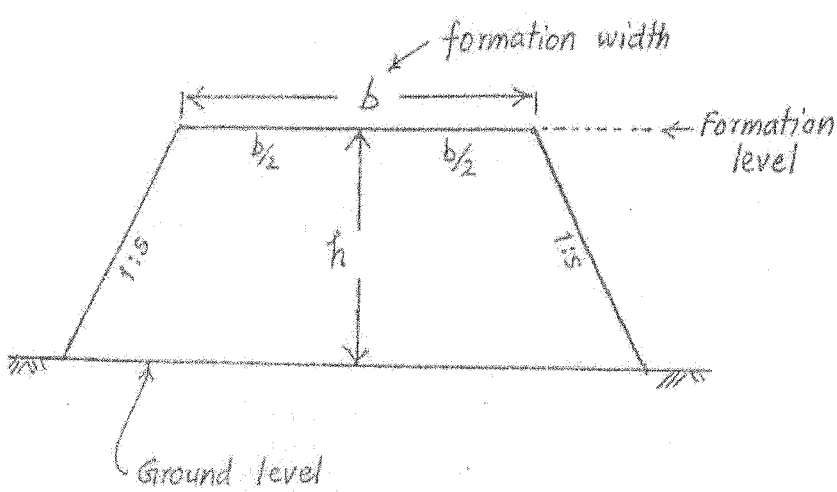

Fig Q6-1: Cross section (Not to scale)

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

Table Q5-1: The level sheet

Back-sight	Interm ediate sight	Fore-sight		Uncorrected Reduced Level (m)	Corrected Reduced Level (m)	Remarks
1.512						BM 1
	1.625					A
	2.452					B
	2.685					C
	3.225					D
1.335		3.568				E
	1.153					F
	0.945					G
1.458		1.223				H
	1.895					I
	2.105					J
	2.458					K
2.458		2.995				L
	2.558					M
	2.887					N
	2.842					O
2.785		2.775				P
		3.887				BM 2

(NOTE: Detach Table Q6-1 and attach it to answer script)

Table Q6-1

Chainage (m)	Existing RL (m)	Formation level (m)	
0	203.55	206.00	
40	204.94		
80	205.22		
120	204.61		
160	205.09		
210	205.92		
260	206.17		
310	207.16		
360	207.98		
460	207.52		
560	209.56		

Equations to be used in the calculations

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

$$C_t = KL\Delta t$$

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

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

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

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

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

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