THE OPEN UNIVERSITY OF SRI LANKA
BACHELOR OF TECHNOLOGY – LEVEL 5
FINAL EXAMINATION – 2005/06

0066

CEX 5230 – SURVEYING II (New Curriculum)
CEU 3105 – SURVEYING (Old Curriculum)

Time allowed: Three hours

Date: Tuesday, 18th April 2006 Time: 0930 – 1230 hours

Answer **any five** questions. All questions carry equal marks. *If you have answered more than five questions (either partly or fully), cross out the extra answers. Otherwise, only the first five answers appearing in the answer book will be evaluated.*

1. When the horizontal alignment of a road changes from a straight to a circular curve it becomes necessary to introduce a super-elevation to the surface. This super-elevation could be introduced either, (a) completely on the straight, or, (b) completely on the curve, or, (c) partly on the straight and partly on the curve. Compare these three arrangements with the insertion of a transition curve.

   Explain what is meant by a wholly transitional curve.

   Two straights having whole circle bearings of 87° 30' and 102° 00' are to be joined by means of a wholly transitional curve. If the road is designed for a speed of 100 km/h, and the rate of change of radial acceleration is to be restricted to 0.3 m/s^3, find the minimum radius of the curve, and the total length of the curve.

   If the coordinates of the intersection point are 2056.6 m North and 1609.5 m East, find the coordinates of the two tangent points.

   The length of a transition curve, L can be expressed as L = V^3/46.66 cR, with the usual notation.

2. Briefly describe the differences in design methods used for summit curves and valley curves.

   A road has a rising gradient of 4.0 % connected to a falling gradient of 2.0 % by a parabolic vertical curve, 120 m long. Find the visibility distance measured at a height of 1.05 m on the approaching vehicles.

   This summit curve was later improved to increase the visibility distance to 200 m. Determine,
   (a) the length of the new curve,
   (b) the horizontal distance between the old and the new tangent points on the 4.0 % grade, and,
   (c) the horizontal distance between the summits of the old and new curves.

   The following relationships (with the usual notation) between visibility distance (S) and length of curve (L) may be used without proof.

   $S^2 = 200L\,(\sqrt{h_1} + \sqrt{h_2})^2/A$ *for* $S \leq L$, *and*
   $2S = L + 200\,(\sqrt{h_1} + \sqrt{h_2})^2/A$ *for* $S \geq L$.

3. (a) The lighting conditions inside a tunnel is usually poor. Explain how you would overcome this shortcoming when making observations with a theodolite inside a tunnel. 6

(b) Derive a mathematical expression for the correction to be applied to a horizontal angle measured with a theodolite using a side-mounted auxiliary telescope.

(c) Briefly describe the survey operations made to transfer surface bearings through a single vertical shaft during the construction of a tunnel. Include all the important steps, and give diagrams where appropriate. 7

4. Define the terms 'free haul distance', 'free haul volume' and 'free haul' and show them graphically on a sketch of a mass haul diagram.

The information given in Table 1 refers to a 1.2 km length of road to be developed. The levels given are for the existing ground, and the volumes are the excavation (+) or fill (-) involved in making a formation that is rising at the rate of 1.2 % from a level of 20.0 m at the chainage of 1000 m.

Table 1

Chainage (m)	1000		1100		1200		1300		1400		1500		1600
Ground level on Centre line (m)	29.3		33.8		29.9		23.6		21.2		16.2		14.0
Volume (m^3)		(+) 2344		(+) 1922		(+) 689		(-) 300		(-) 1361		(-) 2552	
Chainage (m)		1700		1800		1900		2000		2100		2200	
Ground level on Centre line (m)		18.0		26.0		30.8		37.4		38.6		42.0	
Volume (m^3)	(-) 2659		(-) 1411		(-) 298		(+) 456		(+) 912		(+) 542		

(a) Draw the longitudinal section of the existing ground, and mark the new formation
(b) Construct the mass haul diagram, assuming a bulking factor of 1.25
(c) Calculate the total haul within the 1.2 km length. If the free haul distance is 350 m, find the over haul volume and the over haul.

5. Explain the meanings of random error, and the most probable value of a quantity.

Horizontal clockwise angles were measured between targets as indicated in Table 2, using a theodolite set up at a station P.

Table 2

From target	To target	Observed Clockwise Angle ° ' "	Weight
A	B	35 35 35	2
B	C	60 30 32	2
C	D	35 43 48	2
A	C	96 06 04	1
B	D	96 14 22	1
A	D	131 49 52	1

Using residuals and normal equations find the most probable values of the angles between targets A and B, B and C, and C and D.

6. A deep excavation is to be made for the construction of a tall building, which includes two levels for basement parking of vehicles. Describe the survey(s) that you would carry out to enable the calculation of the amount of earthwork involved. Using a set of fictitious values, show how you would calculate the volume of excavation.

7. (a) State the differences between aerial and terrestrial photogrammetry, considering the manner in which photography is obtained. List the relative advantages and disadvantages of taking photographs from the air with the camera axis at an oblique angle as compared to vertical.

   (b) A photo theodolite having a focal length of 280 mm was used at two stations P and Q (Q lying 1.92 km to the south of P) to take photographs of three objects A, B and C. The coordinates measured on the two photographs are given in Table 3. The horizontal camera axis was pointing in the directions of S 60° 00' E and N 55° 00' E respectively at P and Q.

Table 3

Object	Photograph at P		Photograph at Q	
	x (mm)	y (mm)	x (mm)	y (mm)
A	- 42.0	+ 10.0	- 58.0	
B	+ 37.0	- 20.0	- 32.0	
C	+ 26.0	+ 40.0	+ 32.0	

Find the coordinates of A, B and C, and their elevations with respect to P if the instrument height at P was 1.60 m.