THE OPEN UNIVERSITY OF SRI LANKA
BACHELOR OF TECHNOLOGY (ENGINEERING) - LEVEL 5
FINAL EXAMINATION - 2007/08

CEX 5230 - SURVEYING II

Time allowed: Three hours

Date: Wednesday, 21st May 2008 Time: 1330 - 1630 hours

Answer <u>any five</u> questions. All questions carry equal marks.

If you have attempted more than five questions, whether partly or in full, 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 super elevation to the surface. This super elevation could be introduced either wholly on the straight, or wholly on the curve, or partly on the straight and partly on the curve. Comment on these three arrangements as compared to the introduction of a transition curve.

   Two straights AI and BI have their intersection point lying on a river. Points P and Q on AI and BI respectively, and located on the river bank, were selected and their distance apart was measured as 72.56 m. Angles APQ and BQP were measured as 148° 40' and 160° 30' respectively. If the two straights are to be joined by a circular curve of radius 480 m, find the distances to the respective tangent points from P and Q. Also determine the length of the curve.

   It is later proposed to introduce cubic spiral transitions of length 120 m at each end of the circular arc. Find the distance by which the tangent point on the straight AI will be displaced. The "shift" is given by $L^2/24R$, where L and R have their usual meanings.

2. Briefly describe the design criteria for a summit vertical parabolic curve.

   A road has a rising grade of 3.6 % connected to a falling grade of 2.4 % by a parabolic vertical curve, 100 m long. Find the visibility distance measured between approaching vehicles at a height of 1.05 m above the road surface.

   It is proposed to double the visibility distance on the curve by increasing its length. Find,
   (a) the length of the new parabolic curve,
   (b) the horizontal distance between old and new tangent points on the 3.6 % grade, and,
   (c) the horizontal distance between the summits of the old and new curves.

   The following mathematical relationships (with the usual notation) between visibility distance (S) and length of curve (L) may be used.

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

3. Describe the survey operations that you would carry out in order to set out the centre line of a straight tunnel to be drilled through a hill. Show how the positions of shafts along the tunnel are fixed. Illustrate your answer with clear diagrams.

4. A round of angles A, B and C, closing at a station was observed with a theodolite, and was recorded as follows.

A = 127° 40' 50" B = 93° 50' 56" C = 138° 28' 20"

The composite angles (A + B), (B + C) and (C + A) were also measured, to a greater degree of precision of three times as compared to that of the individual angles. The values recorded were,

(A + B) = 221° 31' 43" (B + C) = 232° 19' 21" (C + A) = 266° 09' 05"

Using the method of correlates, determine the most probable values of the three angles A, B and C.

5. Earthwork is to be balanced on a 1500 m long stretch of a road project, without reference to adjoining lengths on either side of it. The formation level of the road centre line descends at a uniform rate of 2.0 per cent, and the reduced level at chainage 1500 m is to be 92.00 m. The volumes of earthwork between cross sections at 100 m intervals are given in Table 1, along with the existing ground levels on the proposed centre line.

Table 1

Chainage, m	**1500**		**1600**		**1700**		**1800**		**1900**		**2000**
Ground level, m	*98.0*		*99.8*		*97.9*		*96.1*		*88.6*		*80.7*
Volume, m^3		948		1182		1200		878		198	
Chainage, m	**2000**		**2100**		**2200**		**2300**		**2400**		**2500**
Ground level, m	*80.7*		*74.4*		*67.8*		*62.8*		*59.7*		*50.5*
Volume, m^3		- 573		- 1302		- 1928		- 2277		- 3023	
Chainage, m	**2500**		**2600**		**2700**		**2800**		**2900**		**3000**
Ground level, m	*50.5*		*62.3*		*74.5*		*77.9*		*86.4*		*89.3*
Volume, m^3		- 2490		- 99		1103		2048		3010	

(a) Draw the profile of the proposed road on the longitudinal section of the existing ground
(b) Draw the mass haul curve using a bulking factor of 1.1
(c) Find the haul limits and the total volume of excavation
(d) Calculate the total haul in this 1500 m length, and the over haul if the free haul distance is specified as 300 m.

6. Describe in detail how you would conduct a contour survey using tacheometry in a hilly residential area, and produce a contour plan. Your answer must cover all aspects from the selection of instruments, selection of stations, selection of contour interval, all field measurements and office work. Also comment on any problems that you may anticipate, and how you propose to overcome them.

7. Photographs were taken from two stations A and B using a phototheodolite of focal length 175 mm. The camera axis was normal to the line AB at both stations. A control point P, having coordinates of 380.2 m North and 201.4 m East in relation to station A, was imaged on the photograph from A at 12.0 mm to the right of the principal line and 11.0 mm above the horizon line. The corresponding coordinates of the image of P on the photograph taken from B were 18.5 mm to the left of the principal line and 5.0 mm above the horizon line.

Find the inclination of the camera axis at B to the horizontal, given that the camera level at B was 4.16 m higher than that at A, where the axis was truly horizontal.