



**CEX 5230 – SURVEYING II**

Time allowed: Three hours

Date: Sunday, 8th April 2007

Time: 0930 – 1230 hours

Answer **any five** 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. Show that the gradient of a parabolic vertical curve varies uniformly along its length. Explain how this property enables you to locate the highest point of a crest curve or the lowest point of a sag curve easily.

A parabolic vertical curve is used to join a falling grade of 4.4 % to a rising grade of 3.6 %. The point of intersection of the two grades has a chainage of 4430 m and a reduced level of 63.42 m above mean sea level (MSL). The curve is required to have a reduced level of 64.40 m above MSL at the chainage of 4455 m in order to allow for adequate headroom. Determine the length of the curve, and the chainage and reduced level of its lowest point.

The headlamp beams of a vehicle, when standing on flat ground, make an angle of  $+ 2^\circ$  with the horizontal. Find the headlamp visibility distance if the headlamps are located 700 mm above road surface.

*The following relationships for visibility, where  $h$  is the height of headlamp above road surface, may be used.*

$$L = S^2A / (140 + 7.0 S) \text{ when } S \leq L, \text{ and } L = 2S - (140 + 7.0 S) / A \text{ when } S \geq L.$$

2. A circular curve of radius 900 m joins a straight with a bearing of  $125^\circ 00'$  on a road to another with a bearing of  $190^\circ 30'$ . Later, as part of a road improvement, it was decided to change the curve to allow cubic spiral transition curves of length 120 m each to be inserted at either end, but keeping the total length of the route unchanged. Determine the distance between the new and existing tangent points.

Also, compute the data necessary for setting out the transition curve using 20 m chords, if the intersection point has a chainage of 4455.47 m.

3. (a) Underground surveys are conducted in more adverse working conditions when compared to surface surveys. Therefore, the former calls for special requirements in the instruments used and the procedures adopted. How would you select or modify the instruments and the procedures to satisfy these requirements?
- (b) Derive expressions for the corrections (if, any) to be applied to horizontal and vertical angles measured using a theodolite fitted with a side mounted auxiliary telescope.
4. Explain the meanings of the terms 'most probable value', 'residual error', and 'true error' of a quantity.

Levelling was carried out between each pair of stations in the network PQRS, and the results obtained are given below, along with the relative weight assigned to each measurement.

From stn.	To stn.	Level diff. (m)	Weight
P	Q	4.68	2
P	R	7.52	2
P	S	3.65	2
Q	R	2.82	1
Q	S	-1.00	1
R	S	-3.83	2

If the reduced level of station P is 621.020 m, find the most probable values of the reduced levels at stations Q, R and S.

5. Explain the terms 'free haul', 'over haul', 'free haul volume' and 'over haul volume' in relation to a mass haul curve.

The volumes of excavation (+) and fill (-) between successive cross sections at 100 m intervals along a proposed road alignment are given in the table below.

From Chainage	To Chainage	Volume (m <sup>3</sup> )	From Chainage	To Chainage	Volume (m <sup>3</sup> )
0	100	+ 614	800	900	- 1426
100	200	+ 779	900	1000	- 1934
200	300	+ 798	1000	1100	- 403
300	400	+ 554	1100	1200	- 92
400	500	+ 165	1200	1300	+ 238
500	600	- 370	1300	1400	+ 1267
600	700	- 780	1400	1500	+ 1683
700	800	-1254	1500	1600	+ 1386

Draw the mass haul curve if the material encountered throughout the length has a shrinkage factor of 0.95. If you are given the choice to waste excess earth at either end, which alternative would you suggest for minimising the haul? Give reasons.

Calculate the over haul for the selected alternative if the free haul distance is 400 m.

6. It is required to make a deep excavation for the construction of a high rise building which incorporates three levels for basement parking of vehicles. Describe all the surveys that you would carry out in order to compute the amount of earthwork involved.

Using a set of hypothetical values, show how you would calculate the volume of excavation.

7. Photographs were taken from two stations P and Q (Q being 1300 m to the south of P) using a photo-theodolite with a focal length of 250 mm. A certain length AB of a pipeline, which runs along a hillside to the east of PQ, appears on the photographs as follows.

Point on Pipeline	Coordinates on Photograph at P		Coordinates on Photograph at Q	
	x (mm)	y (mm)	x (mm)	y (mm)
Northern end A	0	2.0	-25.0	—
Southern end B	27.5	2.5	-6.0	0

The camera axis was horizontal at each station, and had whole circle bearings of  $100^{\circ} 00'$  at P and  $90^{\circ} 00'$  at Q. Find the horizontal distance and level difference between the two ends A and B of the pipeline.

If the camera axis was 1.60 m and 1.68 m above ground level respectively at P and Q, find the difference in elevation between the two camera stations.

What would be the y-coordinate of A in the photograph taken at Q?

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