THE OPEN UNIVERSITY OF SRI LANKA
BACHELOR OF TECHNOLOGY (ENGINEERING) - LEVEL 5
FINAL EXAMINATION - 2009/10

CEX5230 - SURVEYING II

Time allowed: Three hours

Date: Thursday, 1st April 2010 Time: 1400 - 1700 hours

Answer any five questions. All questions carry equal marks.

If you have answered more than five questions (either partly or in full), cross out the extra answers. Otherwise, only the first five answers appearing in the answer book will be evaluated.

1. A circular curve of radius 800 m joins a straight with a bearing of 72° 40' on a road to another with a bearing of 133° 00'. As part of road improvement, it has been decided to change the curve to allow cubic spiral transition curves of length 144 m each to be inserted at either end of the circular arc, thus allowing the total length of the route to be increased by 50 m. Find the new radius of the circular arc, and the distance between the new and existing tangent points.

   If the intersection point has a chainage of 3247.50 m, compute the data necessary for setting out the transition curve using 24 m chords.

2. A descending grade of 3.6 % meets an ascending grade of 4.8 % at a point having a chainage of 4170 m, and a reduced level of 56.40 m. There is an overhead bridge at chainage 4075 m, with the bottom of its beams having a reduced level of 66.60 m. It is proposed to join the two grades by a parabolic vertical curve allowing a clearance of 6.0 m under the bridge. Find the length of the curve, and the chainage and reduced level of its lowest point.

   The headlamp beams of a vehicle, when standing on level ground, make an angle of + 2° with the horizontal. Find the headlamp visibility distance if the headlamps are positioned 650 mm above road surface.

   The following relationships for visibility, where h is the height of headlamp (in metres) above road surface and α (in degrees) is the inclination of the light beam from the level road surface, may be used.

   $L = S^2A / 200(h + S \tan \alpha)$ *when* $S \leq L$, *and,* $L = 2S - 200(h + S \tan \alpha) / A$ *when* $S \geq L$.

3. Describe how you would conduct a contour survey in a hilly area using tacheometry, and produce a contour plan. Your answer must cover all aspects from the selection of instruments, selection of stations, selection of a suitable contour interval, field measurements and office work. Comment on the suitability of tacheometry for the job.

4. (a) Briefly describe the survey operations carried out to transfer the surface bearings and levels to a tunnel when access to it is provided through an inclined tunnel.

   (b) In setting out a tunnel its centre line was marked by two wires X and Y, suspended down a vertical shaft from its collar. The spacing between wires was 3.640 m. A theodolite was set up at a ground station P, close to the extended line YX. The whole circle bearings of PX and PY measured with the theodolite, were recorded as 124° 44' 10.3" and 124° 41' 55.5" respectively. The lengths PX and PY were measured as 3.108 and 6.748 m respectively.

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A theodolite was then set up at a station U inside the tunnel, close to the extended line XY. Clockwise angles of 185° 36' 20.8" and 185° 34' 20.0" respectively were measured to wires X and Y from a reference mark V. Lengths UX and UY were found to be 6.630 and 2.990 m respectively.

If the centre line of the tunnel is required to follow the direction S 50° 00' E, what should be the angle to be set out with respect to reference line UV?

5. Explain the meaning of *random error*, and state the principle of least squares as applicable to a set of normally distributed random errors.

The clockwise horizontal angles observed round a point P are given in the table below, along with their relative weights.

Angle	Observed Value	Weight
APB	62° 24' 25"	1
BPC	112° 25' 20"	1
CPD	96° 28' 20"	1
DPA	88° 42' 00"	1
APC	174° 49' 43"	2
BPD	208° 53' 39"	2
CPA	185° 10' 18"	2

Find the most probable values of the angles at the station P using the method of correlates. Check the accuracy of the computed angles.

6. Define the terms *free haul distance*, *free haul* and *over haul*, as applicable to movement of earth in civil engineering projects that extend over a considerable length. Show these quantities in a diagram.

Describe how the mass haul diagram could be used to economise the movement of earth within the project. Illustrate your answer with diagrams, where necessary.

7. A photo theodolite with a focal length of 200 mm was used to take photographs of a 50 m high communication tower lying to the north of a base line AB. The station B lies 120 m to the north and 480 m to the east of A. The camera axis was maintained horizontal at both stations.

On the photograph taken at A the image of the tower appears 12.0 mm to the right of the principal line, with the top and bottom ends at 30.0 and 2.0 mm respectively above the horizon line. The image of the tower on the photograph taken at B appears 10.6 mm to the left of the principal line. On this image the top of the tower is 24.5 mm above the horizon line, and the base is 5.0 mm below it.

Find the coordinates of the tower with respect to station A. If the camera heights at A and B are 1.64 and 1.60 m respectively, and the reduced level of station A is 64.36 m, find the reduced levels of the base of tower and station B.