Loughborough University

Site Surveying and Measurement (CEM)
23CVA128

Semester 2 2024 Online Short-window Exam paper

This is an online short-window examination, meaning you have a total of **2 hours plus an additional 30 minutes** to complete and submit this paper. The additional 30 minutes are for downloading the paper and uploading your answers when you have finished. If you have extra time or rest breaks as part of a Reasonable Adjustment, you will have further additional time as indicated on your exam timetable.

It is your responsibility to submit your work by the deadline for this examination. You must make sure you leave yourself enough time to do so.

It is also your responsibility to check that you have submitted the correct file.

Exam Help

If you are experiencing difficulties in accessing or uploading files during the exam period, you should contact the Exam Helpline. For urgent queries please call **01509 222900**.

For other queries email examhelp@lboro.ac.uk

You may handwrite and/or word process your answers, as you see fit.

You may use a calculator for this exam, but candidates must write sufficient information to show the method used in deriving the answers.

Answer **THREE** questions.

All questions carry equal marks.

A formula sheet is provided.

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1. The following sequence of staff readings in metres were observed using an automatic level, in good weather conditions.

   BS: 0.644, ISs: 1.857 at Peg A, 1.658 at Peg B, FS: 2.521
   BS: 0.595, ISs: 1.174 at Peg C, 0.483 at Peg D, FS: 0.672
   BS: 0.858, ISs: 1.836 at Ground Level Below Bridge, (4.052) at Bridge Soffit Level , FS: 2.612
   BS: 1.564, FS: 1.279

   Where the readings in brackets denote a location where the levelling staff was inverted.

   The first backsight was taken to a staff positioned on a Benchmark with a reduced level of 84.510m AOD. The final foresight was observed to a staff situated at a TBM at a reduced level of 81.470m AOD.

   a) Draft a levelling table and set out, reduce and check the level readings using either the Rise and Fall or the Height of Collimation method. Ensure that you show all appropriate checks and establish the misclosure of the levelling.

   [21 marks]

   b) Determine the allowable misclosure and comment on whether the levelling should be accepted or rejected.

   [2 marks]

   c) List the sources of error in levelling and explain how these errors can be reduced when carrying out levelling.

   [10 marks]

2. Write short notes on the following topics:

   a) Identify and describe the function of the various components and features of a Total Station ensuring that you discuss the role of a Dual Axis Compensator.

   [17 marks]

   b) Methods used to measure volumes by computation ensuring you provide appropriate neat sketches where appropriate.

   [16 marks]

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3. The four corners of a building marked as W, X, Y, Z are to be set out from a baseline between two control stations: STN A and STN B.

   The coordinates of the points are given in table 1 below.

Table 1

Point Identity (PID)	Eastings (m)	Northings (m)
STN A	250.000	360.000
STN B	250.000	260.000
W	230.000	370.000
X	275.000	370.000
Y	275.000	310.000
Z	230.000	310.000

   a) Draw a neat, annotated plan sketch of the relative position of all the points ensuring the eastings and northings axis are labelled correctly.

   [6 marks]

   b) Calculate the required bearing and distance from STN A to set out pegs at each of the four points WXYZ.

   [23 marks]

   c) Draft a table with the following data: Point Identity, Easting, Northing, difference in Eastings, difference in Northings, Distance from A, Whole Circle Bearing from STN A.

   [4 marks]

4. A circular curve is to connect two straight roads with an intersection angle of 48-07-46. The radius of the curve is 100m and the chainage of the intersection point is 871.627m.

   a) Determine the tangent length, length of curve, chainage at T1 and T2, the first arc length and last arc length.

   [12 marks]

   b) Calculate and tabulate the data necessary to set out the required curve using a Theodolite and steel band, ensuring that the running chainage is maintained at intervals of10m. Ensure you carry out the necessary checks for arc lengths and deflection angles.

   [18 marks]

   c) Describe how this setting out could be checked for errors.

   [3 marks]

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5. The following angles within a triangular shape, figure 1 below, were measured:

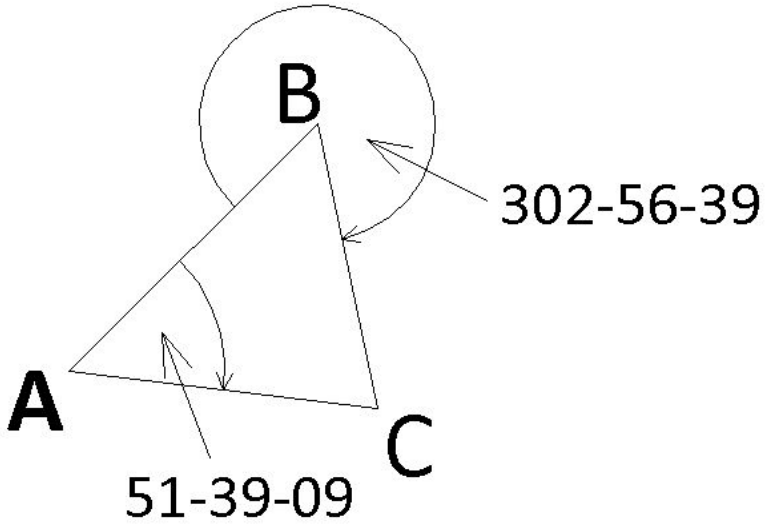

Figure 1

From-At-To	Clockwise angle
STN A - STN B - C	302-56-39
STN A - STN B - C	51-39-09

Assuming that the coordinates of points STN A and STN B are:

Point	Easting (m)	Northing (m)
STN A	408.592	1176.929
STN B	470.916	1239.197

a) Determine, by calculation, the accepted coordinates of point C.

[27 marks]

b) Calculate the coordinates of the mid-point P of the line STN B − C.

[6 marks]

R N Stanley

Formula Sheet on next page

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FORMULA SHEET

Coordinates

$$\Delta E_{AB} = D_{AB}.\sin\theta_{AB} \qquad \Delta N_{AB} = D_{AB}.\cos\theta_{AB}$$

$$\theta_{AB} = \tan^{-1}\left(\frac{\Delta E_{AB}}{\Delta N_{AB}}\right) \qquad D_{AB} = \sqrt{\Delta E_{AB}^2 + \Delta N_{AB}^2}$$

Tape Corrections

$$C_{\text{Standard}} = \frac{D(L - L_s)}{L_s} \qquad C_{\text{Temperature}} = D\alpha(t - t_s)$$

$$C_{\text{Tension}} = \frac{D(T - T_s)}{EA} \qquad C_{\text{Catenary}} = -\frac{w^2 D^3(\cos^2\theta)}{24T^2}$$

$$C_{\text{Slope}} = -D(1 - \cos\theta) \qquad C_{\text{Slope}} = \sqrt{(D^2 - \Delta H^2)} - D \qquad C_{\text{Slope}} \approx -\frac{\Delta H^2}{2D}$$

Areas

Coordinates: $2.Area = (N_1E_2 + N_2E_3 + .. + N_nE_1) - (E_1N_2 + E_2N_3 + .. + E_nN_1)$

Trapezoidal: $Area = \frac{L}{2}\left(O_1 + O_n + 2.\sum \text{remaining offsets}\right)$

Simpsons: $Area = \frac{L}{3}\left(O_1 + O_n + 4.\sum \text{even offsets} + 2.\sum \text{remaining odd offsets}\right)$

Volumes

Trapezoidal: $Volume = \frac{L}{2}\left(A_1 + A_n + 2.\sum \text{remaining Areas}\right)$

Simpsons: $Volume = \frac{L}{3}\left(A_1 + A_n + 4.\sum \text{even Areas} + 2.\sum \text{remaining odd Areas}\right)$

Triang. grid: $Volume = A.\frac{(h_1 + h_2 + h_3)}{3}$ Rect. Grid: $Volume = \frac{A}{4}.\sum(h_i.t_i)$

Circular Curves

$$\text{TL} = R\tan\theta/2 \qquad L = R\theta$$

Deflection Angles

$$\delta\text{rad} = \text{arc}/2R \qquad \text{chord} = 2R\sin\delta$$