Loughborough University

Geomatics Engineering Surveying 1
24CVA135

Semester 2 2025 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.

Section A, question 1 is compulsory – you **MUST** answer this question.

Answer **TWO** questions from Section B.

A formula sheet is provided.

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SECTION A
(Answer **THIS** question)

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

   BS: 0.814, ISs: 1.348 at Peg A, 1.164 at Peg B, FS: 2.701
   BS: 0.795, ISs: 0.995 at Peg C, 0.628 at Peg D, FS: 1.077
   BS: 1.005, ISs: 1.158 at Ground Level Below Bridge, (2.105) at Bridge Soffit Level , FS: 2.352
   BS: 4.779, FS: 4.686

   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 24.879m AOD. The final foresight was observed to a staff situated at a TBM at a reduced level of 21.461m 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.

   [11 marks]

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SECTION B
(Answer **TWO** questions)

2. Write short notes on the following topics:

   a) Methods used to set out a large horizontal curve.

   [17 marks]

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

   [16 marks]

3. The four corners of a building marked as A, B, C, D are to be set out from a baseline between two control stations: STN 1 and STN 2.

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

Table 1

Point Identity (PID)	Eastings (m)	Northings (m)
STN 1	675.000	430.100
STN 2	760.500	430.100
A	665.000	460.000
B	695.000	460.000
C	695.000	420.000
D	665.000	420.000

   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 1 to set out pegs at each of the four points ABCD.

   [23 marks]

   c) Draft a table with the following data: Point Identity, Easting, Northing, difference in Eastings, difference in Northings, Distance from STN 1, Whole Circle Bearing (WCB) from STN 1.

   [4 marks]

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4. Linear measurements between points A and B and between points B and C were recorded.

   Reduced levels of the points are: A=143.896 m AOD; B=139.838 m AOD and C=145.244 m AOD.

   A steel band was used to measure the slope distances, in metres, along the ground between the points.

   The measurements were repeated three times and the steel band graduation readings, in metres, at each point were recorded as below:

   A-B = 43.643-1.0; 43.423-0.782; 42.885-0.247

   B-C = 35.621-1.0; 35.044-0.426; 34.834-0.215

   Band Temperature: 9°C; Applied Tension: 75N

   Note: For the band standardised at 50N and 20°C, the coefficient of thermal expansion is 0.0000122 per °C; Young's modulus is 200N/mm2 x103 (200kN/mm2) and the cross-sectional area of the band is 2.5mm2.

   The actual length of the band when compared to an unused reference band was 49.987m when measured over a standard length of 50m under standard conditions (50N applied tension; 20°C band temperature).

   a) Explain, giving reasons, which systematic errors would need to be accounted for to reduce the above measured slope distances AB and BC to horizontal distances.

   [11 marks]

   b) Reduce the measured slope distances AB and BC, measured with the steel band, to the horizontal distances.

      Note: Determine the mean horizontal distance AB and the mean horizontal distance BC and ensure that you apply all appropriate corrections.

   [22 marks]

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5. The following angles within a triangular shape ABC, (figure 1), were measured:

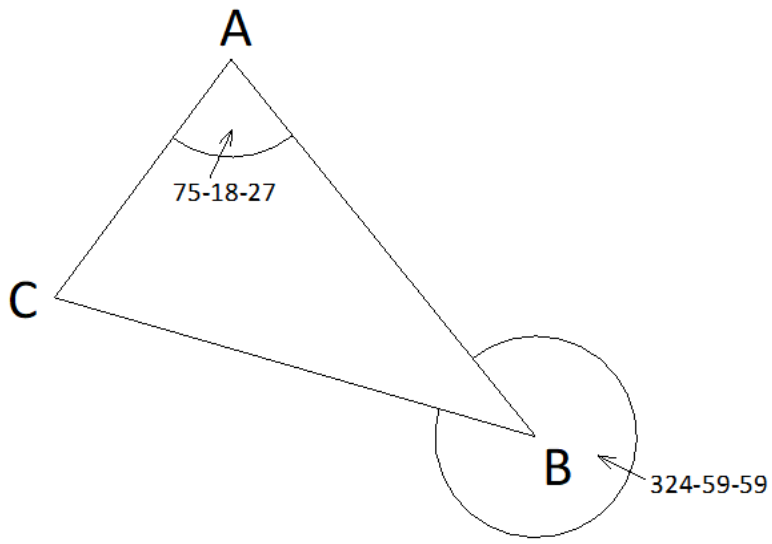

Figure 1

From-At-To	Clockwise angle
B-A-C	75-18-27
A-B-C	324-59-59

Assuming that the coordinates of points A and B are

Point	Easting (m)	Northing (m)
A	654.768	598.267
B	907.088	284.974

a) Determine, by calculation, the accepted coordinates of point C. [27 marks]

b) Calculate the coordinates of the mid-point of the line BC. [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

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