Loughborough University

Professional Practice in Engineering
22CVA102

Semester 2 2023 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: 1.624, ISs: 2.125 at Peg A, 2.010 at Peg B, 1.905 at Peg C, FS: 1.852
   BS: 0.624, ISs: 1.412 at Peg D, 0.325 at Peg E, FS: 0.595
   BS: 1.610, ISs: 1.458 at Ground Level Below Bridge, (3.351) at Bridge Soffit Level, FS: 0.487
   BS: 1.336, FS: 1.006

   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 104.320m AOD. The final foresight was observed to a staff situated at a TBM at a reduced level of 105.570m 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. a) Describe the workflow for surveying three-dimensional detail using a total station.

   [21 marks]

   b) State which information should be normally included on the completed survey plan in addition to the actual surveyed area.

   [12 marks]

Continues/…

3. a) Outline the responsibilities of a setting out engineer, paying particular attention to the good working practises that should be adopted.

[17 marks]

Four sight rails are to be set out to control the excavation required for a drainage run. The horizontal length of the drainage run is 42.60m and it has a design gradient of 1:35.
The drainage run starts at 0.00m chainage at an inspection chamber with an invert level of 24.279 mAOD.

The reduced levels of four pegs located at the base of the sight rails are:

Chainage (m) from inspection chamber at start of drainage run	**Reduced Level (m AOD) Pegs at base of sight rails**
0.00	25.281
14.20	24.931
28.40	25.129
42.60	25.015

b) Calculate the reduced levels of formation at each of the inspection chambers at the chainages 14.20m, 28.40m, 42.60m.

[5 marks]

c) Determine the length of the traveller to be used (as a multiple of 0.5m) if the top of each sight rail is to be set at a minimum of 0.5m above each of the pegs at the base of the sight rails.

[6 marks]

d) Calculate the vertical distances that the tops of the sight rails must be set relative to the reduced levels of the pegs at the following chainages: 0.00m, 14.20m, 28.40m, 42.60m.

[5 marks]

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4. There are five systematic errors which may need to be corrected when using a steel band (steel tape).

   Describe and account for each systematic error listed below (a -e). All answers should include description of relevant functional models used for each correction and identification of all terms used.

   Indicate, where applicable, how simple surveying methods can simplify or even avoid the use of the correction.

   a) Standardisation

   [6 marks]

   b) Temperature

   [7 marks]

   c) Tension

   [7 marks]

   d) Sag (or Catenary)

   [7 marks]

   e) Slope

   [6 marks]

Continues/…

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

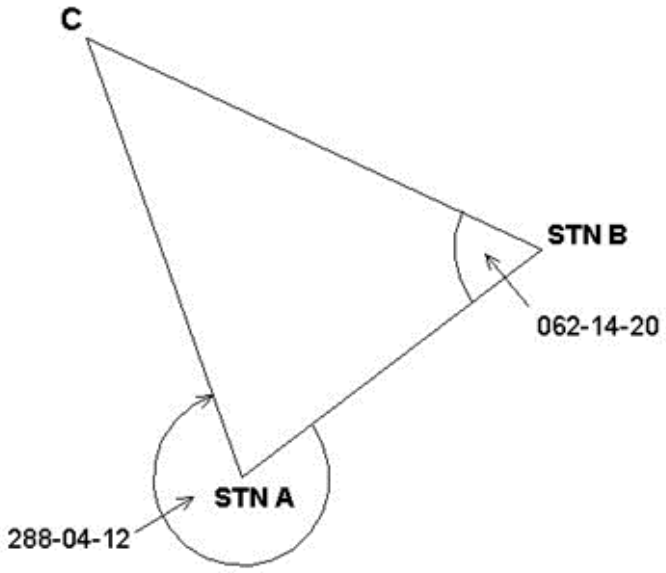

Figure 1

From-At-To	Clockwise angle
STN B - STN A - C	288-04-12
STN A - STN B - C	062-14-20

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

Point	Easting (m)	Northing (m)
STN A	286.061	181.050
STN B	332.367	216.393

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 A − 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

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