[ENG01]

UNIVERSITY OF BOLTON

SCHOOL OF ENGINEERING

BEng (HONS) CIVIL ENGINEERING

SEMESTER ONE EXAMINATION 2021/2022

MATHEMATICS & STRUCTURAL ANALYSIS

MODULE NO: CIE4011

Date: Wednesday 12th January 2022 **Time: 10:00 – 13:00**

INSTRUCTIONS TO CANDIDATES:

There are THREE questions.

Answer ALL questions.

Marks for parts of questions are shown in brackets.

This examination paper carries a total of 100 marks.

All working must be shown.

A numerical solution to a question obtained by programming an electronic calculator will not be accepted.

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Question 1

Figure Q1 shows a simply supported beam with a pin support at A, and a roller support at D. The beam is carrying one vertical point load at B, and a uniform distributed load (UDL) between C and D.

i) Calculate and state the support reactions at A and D **(5 marks)**

ii) Draw the Shear Force Diagram (SFD), showing the values along the beam. **(7 marks)**

iii) Find the distance from C where the shear force is zero. **(3 marks)**

iv) Draw the Bending Moment Diagram (BMD, showing important values along the beam. **(10 marks)**

v) Calculate the value of the maximum bending moment and its position along the beam **(5 marks)**

Total 30 marks

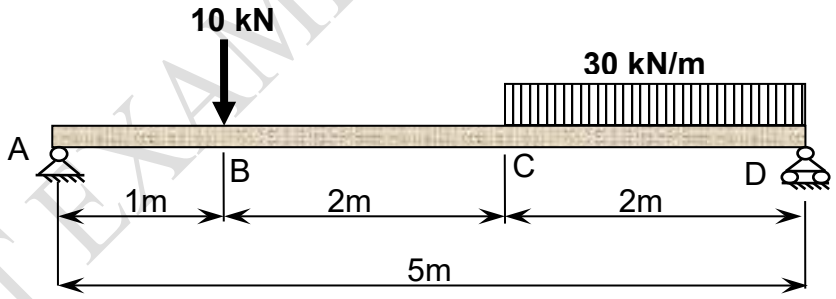

Figure Q1

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Question 2

For the pin jointed truss shown in Figure Q2:

i) Use the formula (B + R = 2J) to show that the truss is statically determinate. **(2 marks)**

ii) Calculate and state the support reactions at A and E **(3 marks)**

iii) Calculate the axial forces in all members of the truss, state whether each axial force is in tension or compression. **(20 marks)**

iv) Show the system of axial forces in the truss as a graphical presentation. **(5 marks)**

Total 30 marks

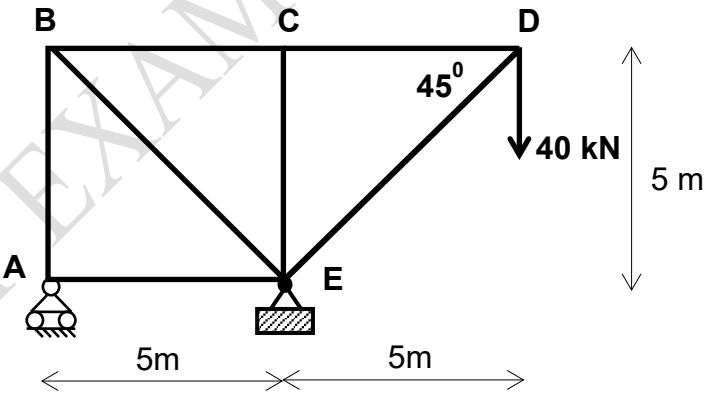

Figure Q2

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Question 3

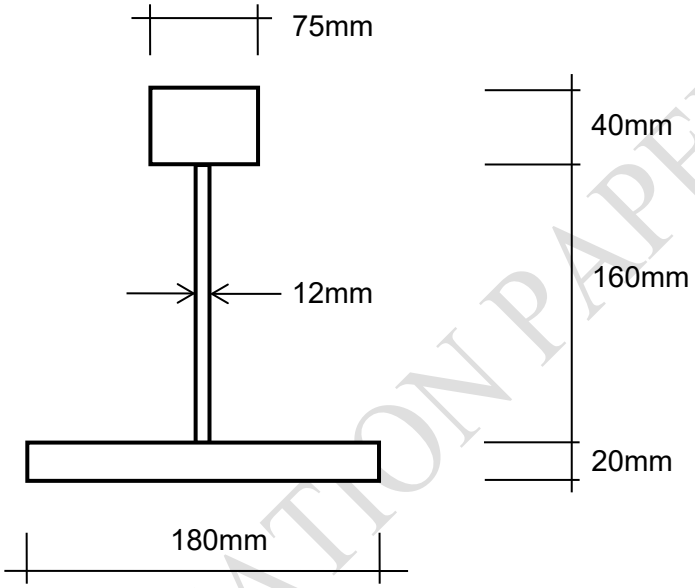

Figure Q3 (i)

Figure Q3 (i) shows a cross-section of an asymmetrical steel beam.

i) Determine the position of the horizontal neutral axis of the beam.

(10 marks)

ii) What is the value of the second moment of area I about the horizontal neutral axis of the beam section?

(10 marks)

Question 3 continues over the page….

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Question 3 Continued…..

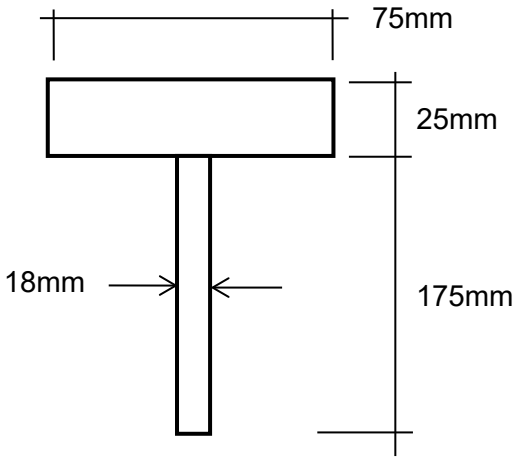

Figure Q3 (ii)
Section through cantilever tee beam

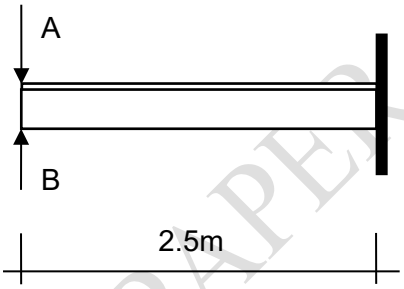

Figure Q3 (iii)
Elevation on cantilever tee beam

Figure Q3 (ii) shows a cross-section of a different asymmetrical cast iron tee beam with a cantilever span of 2.5m; also see elevation in Figure Q3 (iii). The allowable bending stresses in the tee beam are shown the table below:

	Maximum stress (N/mm^2)
Tension	18.5
Compression	98.8

The geometrical properties of the tee beam are shown in the table below:

Distance of the horizontal neutral axis of the tee beam above the bottom of the section	124.8mm
Second moment of area (I)	1989 cm^4

iii) What is the maximum force A that can be applied vertically downward to the cantilever tee beam without exceeding the allowable bending stress in the tee beam (ignore force B)? **(10 marks)**

iv) What is the maximum force B that can be applied vertically upward to the cantilever tee beam without exceeding the allowable bending stress in the tee beam (ignore force A)?

(10 marks)

Total 40 marks

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END OF QUESTIONS