UNIVERSITY OF BOLTON

SCHOOL OF THE BUILT ENVIRONMENT & ENGINEERING

BSc (HONS) CIVIL ENGINEERING

SEMESTER ONE EXAMINATION 2010/2011

STRUCTURES

MODULE NO: BLT2018

Date: Wednesday 19 January 2011 **Time: 2.00 pm – 4.00 pm**

INSTRUCTIONS TO CANDIDATES:

There are FOUR questions.

Answer ANY THREE questions.

All questions carry equal marks.

Marks for parts of questions are shown in brackets.

This examination paper carries a total of 75 marks.

Tables of fixed-end moments are provided.

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Question 1

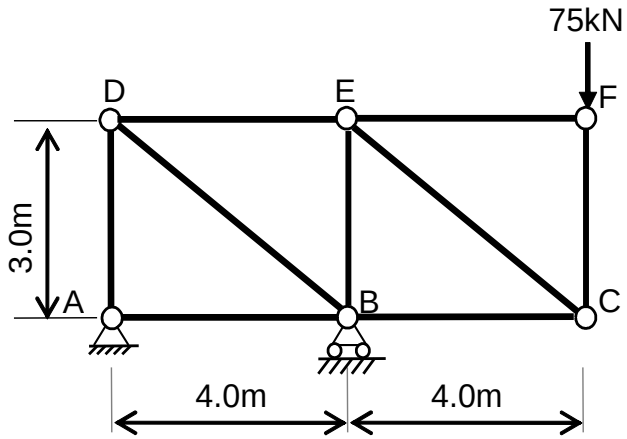

Figure Q1

Figure Q1 shows a pin-jointed frame ABCDEF which has a pinned support at A and a horizontal roller support at B. The frame carries a vertical point load of 75kN at F. The members are steel, E = 210 kN/mm^2, and all have a cross-section area of 1000 mm^2.
The member axial forces, P_0, due to the load shown in Figure Q1 are shown in Table 1 provided separately.

a) Use the principle of virtual work to find the horizontal displacement of joint C and the vertical displacement of joint F.

   Use the blank columns of Table 1 provided separately to record the results of your calculations.

   (19 marks)

b) Without a complete re-analysis of the structure, determine how the results of part (a) would change if joint A was on a horizontal roller support and joint B was a pinned support.

   (6 marks)

Formula for the deflection of a joint in a pin-jointed truss: $\delta = \sum \frac{P_o P_1 L}{EA}$

Total 25 marks

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Question 2

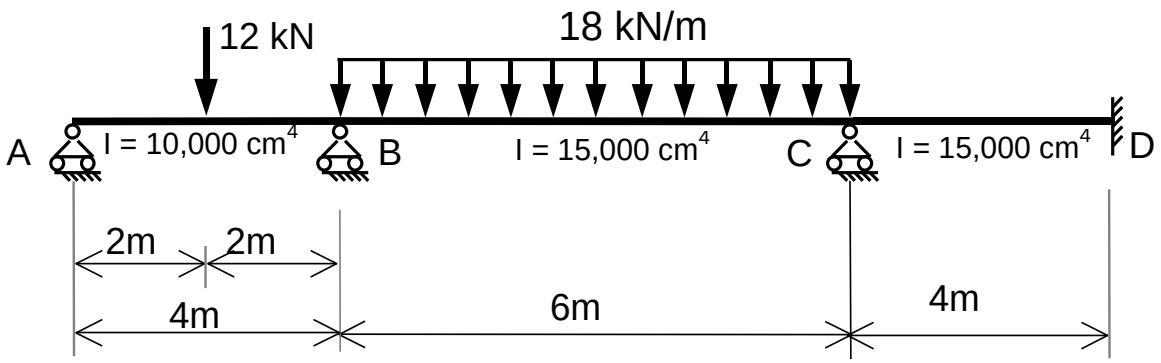

Figure Q2

Figure Q2 shows a 3-span continuous beam ABCD which is simply supported at A, B and C and fixed to a support at D. The members are steel (E = 205 kN/mm^2) as follows:

Spans AB	I = 10,000 cm^4
Span BC and CD	I = 15,000 cm^4

a. Using Moment Distribution method, calculate the bending moments at A, B, C and D.

(17 marks)

b. Sketch the bending moment diagram for the whole beam, showing values at supports and mid-spans.

(8 marks)

Flexural stiffnesses of beams:

Opposite end fixed	K = EI / L
Opposite end pinned	K = 0.75EI / L

Tables of Fixed-End Moments are provided in Table 2.

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Total 25 marks

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Question 3

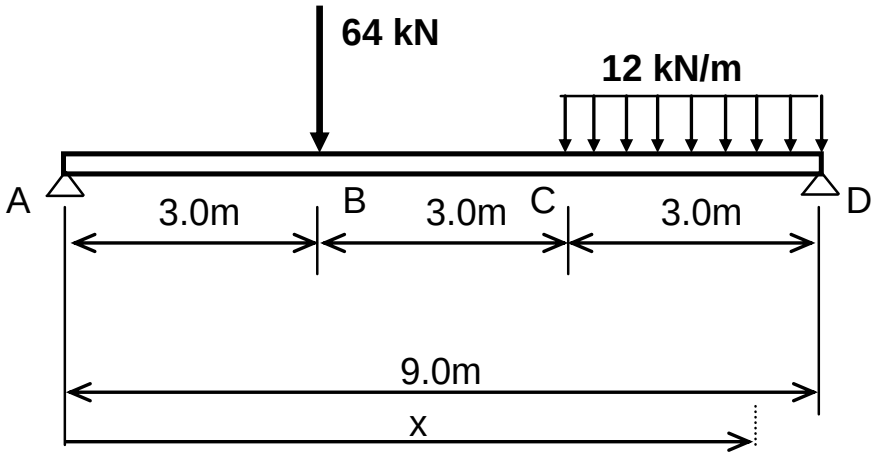

Figure Q3

Figure Q3 shows a beam ABCD which is simply supported with a span of 9.0 metres. The beam carries a point load and a distributed load as shown. The beam has uniform rigidity EI.

a Use Macaulay's method to calculate, in terms of EI, the slope of the beam at x = 4m and the slope of the beam at x = 5m

(20 marks)

b Estimate the value of x at which the slope will be zero, and hence find the maximum deflection of the beam in terms of EI

(3 marks)

c If E = 210 kN/mm^2 and I = 10,000 cm^4, find the maximum deflection of the beam in mm.

(2 marks)

Formula for the deflection of a beam: $\mathbf{M = -EI\frac{d^2v}{dx^2}}$

Total 25 marks

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Question 4

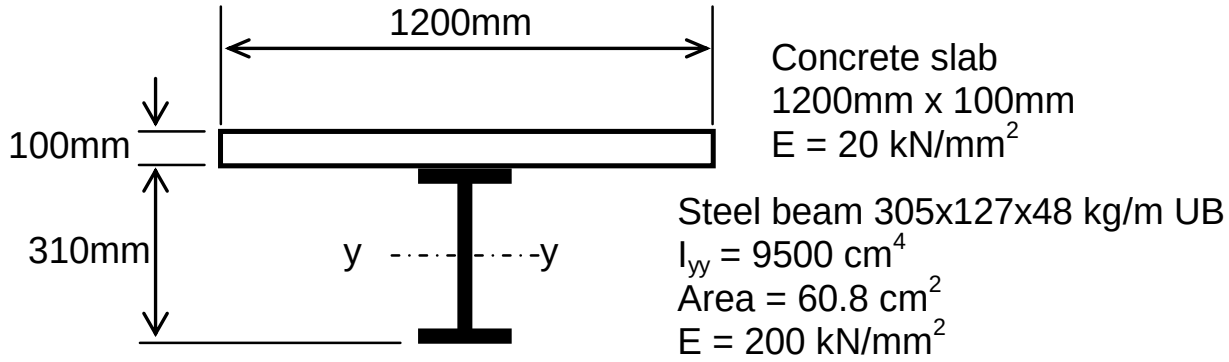

Figure Q4

Figure Q4 shows the section of a composite steel/concrete beam. The E value of the steel is 200 kN/mm^2 and the E value of the concrete is 20 kN/mm^2.

The beam is simply supported over a span of 6.0m and carries a total working load of 40 kN/m

a If the UB section carried the load without composite action, find the maximum stress and maximum deflection of the beam.

(6 marks)

b Transform the composite section to an equivalent steel beam. Find the position of the neutral axis, the value of the second moment of inertia, I_y , and the values of elastic section modulus, $W_{el,y}$, for the transformed beam

(12 marks)

c Find the maximum stress in the steel, the maximum stress in the concrete and the maximum deflection of the composite beam

(4 marks)

d The calculations in part (b) show that the neutral axis in the steel section. Explain how your calculation method would change if the neutral axis was in the concrete slab

(3 marks)

DATA
The central deflection of a simply supported beam carrying a uniformly distributed load w per unit length is given by**:**

Total 25 marks

END OF QUESTIONS

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Student Number: .....

Table 1: Worksheet for Question Q1

P_0 are the truss member axial forced due to the loads shown in Figure Q1

Use the blank columns to record the results of other calculations.

	P_0 kN	P_1 kN	P_2 kN	L mm	E kN/mm^2	A mm^2	P_0P_1L/EA mm	P_0P_2L/EA mm
AB	0							
AD	+75							
BC	-100							
BD	-125							
BE	-75							
CE	+125							
CF	-75							
DE	+100							
EF	0							

PLEASE ENSURE THAT THIS WORKSHEET IS SECURELY ATTACHED TO YOUR ANSWER BOOK WITH YOUR STUDENT NUMBER WRITTEN ON TOP LEFT HAND SIDE.

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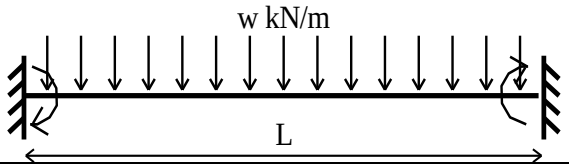
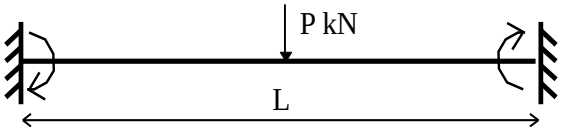
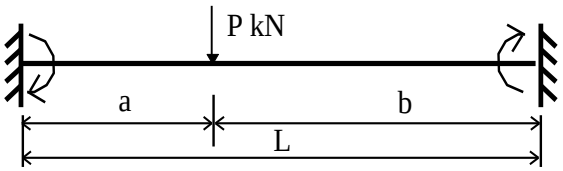
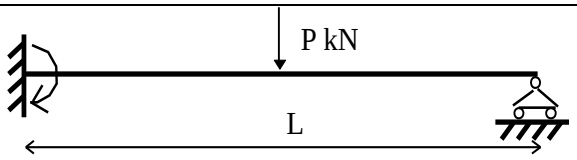
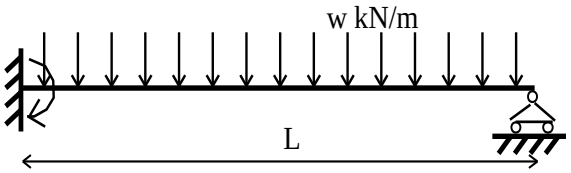
Table 2: Fixed-End Moments for Question 2

FIXED-END MOMENTS		
FEM_{AB}	**A** **B**	FEM_{BA}
$-\frac{wL^2}{12}$		$\frac{wL^2}{12}$
$-\frac{PL}{8}$		$\frac{PL}{8}$
$-\frac{Pab^2}{L^2}$		$\frac{Pa^2b}{L^2}$
$-\frac{3PL}{16}$ $\text{Reaction} = \frac{11P}{16}$		0 $\text{Reaction} = \frac{5P}{16}$
$-\frac{wL^2}{8}$ $\text{Reaction} = \frac{5wL}{8}$		0 $\text{Reaction} = \frac{3wL}{8}$

END OF PAPER