UNIVERSITY OF BOLTON

WESTERN INTERNATIONAL COLLEGE FZE

BENG (HONS) CIVIL ENGINEERING

SEMESTER TWO EXAMINATION 2018/2019

MATHEMATICS AND STRUCTURAL DESIGN

MODULE NO: CIE4012

Date: Wednesday 29th May 2019 **Time: 10.00am - 1.00pm**

INSTRUCTIONS TO CANDIDATES:

There are FIVE questions on this paper.

Answer ALL questions.

Answer Section A and Section B questions in separate answer books.

Marks for parts of questions are shown in the brackets.

This examination paper carries a total of 100 marks.

Formula sheet for Section B is attached on Page 6 of this paper.

The necessary design aid data for and formula sheet for Section A will be provided at the examination hall.

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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SECTION A: STRUCTURAL DESIGN

Question 1: Steel Beam Design
(General Aid for Design provided on Page 3)

Figure 1 shows a plan view of the first floor of an office building. The office building has a ground floor and first floor with identical layouts. For the steel beam **CD** along the **grid line 3**,

a. Prepare a set of manual design calculations to choose a beam size of minimum weight and most economical. (9 marks)

b. Sketch the cross-section of the chosen steel beam section (5 marks)

c. Show the suitability of the chosen beam for bending, compression, shear strength, web shear buckling and combined bending and shear check. (13 marks)

d. Assume beam **CD** to be simply supported and calculate the vertical deflection at mid-span of the beam **CD** to check whether it is satisfactory. (3 marks)

Total 30 marks

Question 2: Steel Column Design
(General Aid for Design provided on Page 3)

For the plan view shown in **Figure 1** provided on **page 3,** Prepare a set of manual design calculations for the steel column **D** along the **grid line 2** at the ground floor if the floor to floor height is 3.2m.

a. Calculate the load acting on Column D. Ignore the self-weight of columns. (10 marks)

b. Choose a suitable steel section for the column D which must be economical. (4 marks)

c. Design the column for buckling and compression resistance (6marks)

Total 20 marks

Please turn the page for Figure 1 and the General Aid for Design

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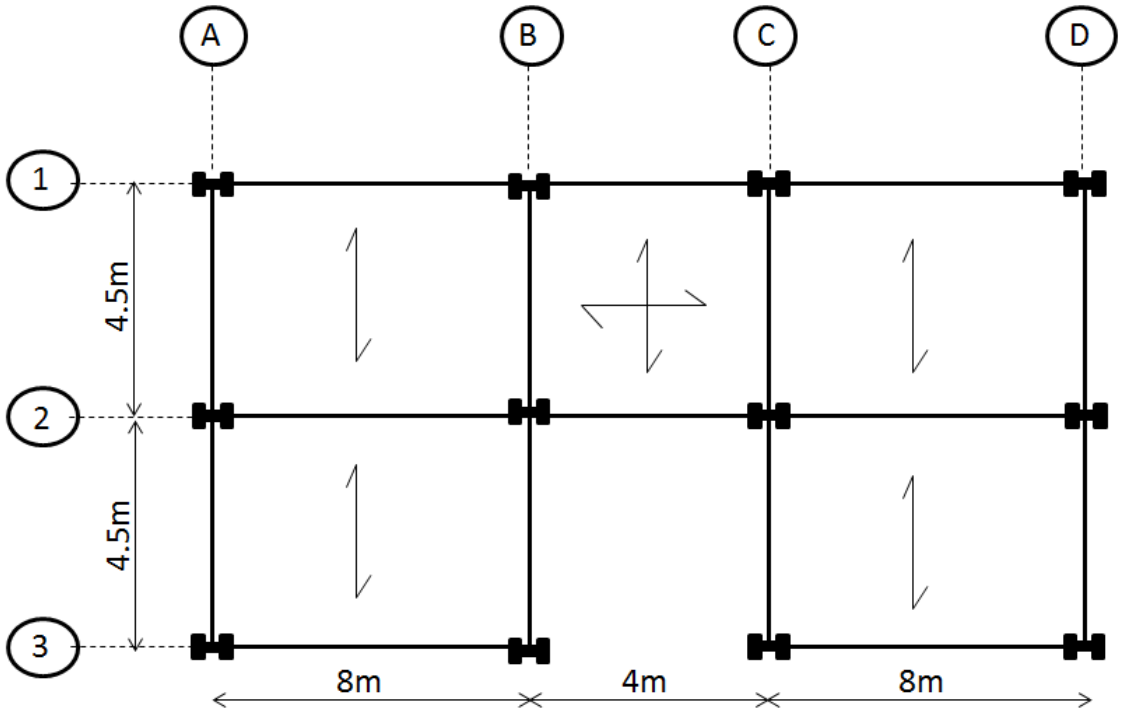

Figure 1: Plan of the first floor of an office building

General Aid for Design

i. The thickness of each slab is 200mm(with a unit weight of 25 kN/m^3) with 50mm thick screed(with a unit weight of 24kN/m^3) over it

ii. The slabs are subjected to a live load of 6.0kN/m^2 each

iii. Consider the loadings on the slabs to be the same on each floor

iv. The self-weight of the steel beams are 1.5kN/m each

v. Assume the column is carrying axial force only and pinned at both ends.

vi. The Young's modulus of steel should be taken as 210000N/mm^2

vii. Steel grade of S275 is considered for the whole structure

viii. Suggested limit for vertical deflection in steel beams here is L/200

END OF SECTION A

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Please turn the page for SECTION B

SECTION B: MATHEMATICS

Question 3

Using suitable integration techniques, determine the following indefinite integrals, simplifying all the solutions.

a. $y = \int \frac{9}{(x-1)(x+2)^2} dx$ (8 marks)

b. $y = \int e^{5x} \sin 3x.dx$ (6 marks)

c. $y = \int x^2 \sin x.dx$ (6 marks)

d. $y = \int \frac{(x^2-1)(x-1)}{x(x-1)}.dx$ (5 marks)

Total 25 marks

Question 4

a. The bending moment 'M' of a beam is given by

$$\frac{dM}{dx} = -w(l-x)$$

Where $'w'$ the uniformly distributed load in kN/m of the beam, $'x'$ is the distance of the support from a section X-X as shown in Figure 4.a. Determine $'M'$ in terms of 'x' if $M = \frac{1}{2}wl^2$ when 'x'=0.

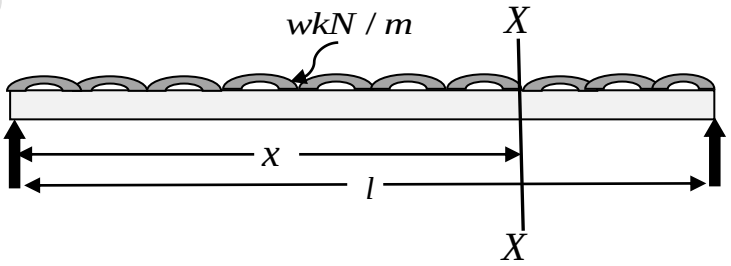

Figure 4.a- Simply Supported beam carrying UDL

(5 marks)

Question 4 continued over the page

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Please Turn the Page

b. A differential equation relating the difference in tension 'T', pulley contact angle 'θ' and coefficient of friction 'μ' is given as $\frac{dT}{d\theta} = \mu T$. Coefficient of friction is given as $\mu = 0.30$. Slipping starts when $\theta = 0$ and T=150N.

i. Determine the tension at the point of slipping when $\theta = 2 radians$

ii. Determine the value of θ when T is 300N

(7 marks)

c. Find the partial derivatives of $f(x, y, z) = xyz^2 + 3xy - z$ with respect to x, y and z

(6 marks)

d. Sketch the curves y= x^2 + 3 and y = 7- 3x and determine the area enclosed by them.

(7 marks)

Total 25 marks

END OF SECTION B

END OF QUESTIONS

Formula sheet over the page

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Formula Sheet

f(x)	**$\int$f(x) *dx* all '+c'**
2x	x^2
x	½ x^2
k (constant)	k x
x^n	$\frac{1}{n+1} x^{n+1}$
$\frac{1}{x}$	ln x
e^x	e^x
e^{kx}	$\frac{e^{kx}}{k}$
sin x	- cos x
cos x	sin x
sin kx	$-\frac{\cos kx}{k}$
cos kx	$\frac{\sin kx}{k}$

END OF PAPER