[ENG32]

UNIVERSITY OF BOLTON

SCHOOL OF ENGINEERING

BENG (HONS) CIVIL ENGINEERING

SEMESTER 1 EXAM 2021/2022

MATHEMATICAL METHODS FOR CIVIL ENGINEERING

MODULE NO: CIE4022

Date: Monday 17th January 2022 **Time: 10:00 – 13:00**

INSTRUCTIONS TO CANDIDATES:

This is an OPEN book examination

There are FOUR questions

Answer ALL Questions

All questions carry equal marks.

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.

CANDIDATES REQUIRE: **Formula Sheets (attached following questions).**

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Question 1

(a) Differentiate the following

(i) $y = 3x^3 + 7x - \frac{2}{x^2}$ (3 marks)

(ii) $y = \sqrt[3]{x^7} - \frac{1}{\sqrt[3]{x^7}}$ (4 marks)

(iii) $y = (3x^2 + 7)^{11}$ (4 marks)

(iv) $y = \ln(6x^3 + 2x - 3)$ (4 marks)

(v) $y = 5\sin(3x)\cos(4x)$ (5 marks)

(vi) $y = \frac{e^{5x}}{7x-2}$ (5 marks)

Total Marks 25 Marks

Question 2

(a) (i) Sketch the graph $y = (x + 7)(x + 1)(x - 3)$ indicating where it crosses the x axis.

(ii) Determine the gradient function of the equation from part (a)

(6 marks)

(iii) Find the gradient where $x = 1$

(iv) Find the x co-ordinates where $\frac{dy}{dx} = 8$. (6 marks)

(v) Find the x co-ordinates of the stationary points to two decimal places.

(vi) indicate, with justification, whether each stationary point is a local maxima or local minimum.

(6 marks)

(b) If $h = 7e^{3r^2}$

Show that: $\frac{d^2h}{dr^2} = 42e^{3r^2}(1 + 6r^2)$

(7 marks)

Total Marks 25 Marks

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Question 3

(a) Integrate each of the following

(i) $\int 3x^3 + 7x - \frac{2}{x^2}\, dx$ (3 marks)

(ii) $\int \frac{8}{\sqrt[3]{x^7}}\, dx$ (3 marks)

(iii) $\int 2x\cos(x^2)\, dx$ (4 marks)

(iv) $\int \frac{60x^3+18x-21}{5x^4+3x^2-7x+9}\, dx$ (5 marks)

(v) $\int 2x\cos(7x)\, dx$ (5 marks)

(vi) $\int 7x^2\ln(x)\ dx$ (5 marks)

Total Marks 25 Marks

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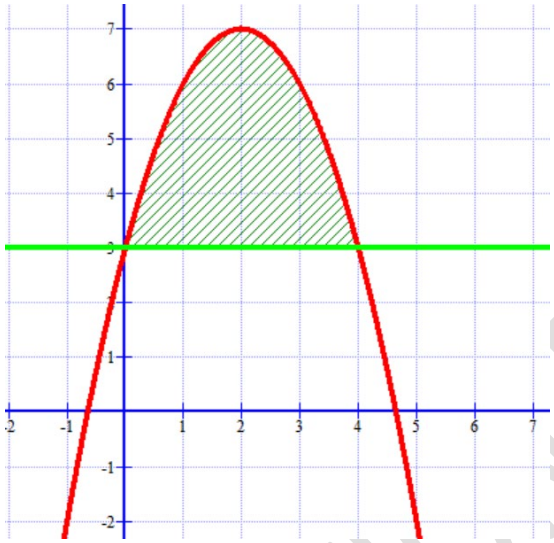
Question 4

(a) The curve below is represented by the equation $y = 3 + 4x - x^2$. Find the area of the shaded region.



(6 marks)

(b) (i) Sketch the graph of $y = \cos(\theta)$ $0 \leq \theta \leq 2\pi$

(1 marks)

(ii) Evaluate $\int_0^{\pi/2} \cos(\theta)\, d\theta$

(3 marks)

iii) Evaluate $\int_0^{3\pi/2} \cos(\theta)\, d\theta$

(4 marks)

(c) A function that passes through the point (0,10) is differentiated to produce $\frac{dy}{dx} = 3e^{3x} + 7$. Find the original function.

(6 marks)

(d) Integrate the following,

$$\int 6x^2\ (x^3 - 3)^{-2/3}\, dx$$

(5 marks)

Total Marks 25 Marks

END OF QUESTIONS

FORMULA SHEET FOLLOWS OVER THE PAGE….

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FORMULA SHEET

Function f(x) or y	Differentiation f '(x) or $\frac{dy}{dx}$
x^n	nx^{n-1}
e^x	e^x
e^{ax}	ae^{ax}
ln (x)	$\frac{1}{x}$
sin (x)	cos (x)
sin (ax)	a cos (ax)
cos (ax)	-a sin (ax)

	Chain rule	**Product rule**	**Quotient rule**
Differentiation	$y = f(g(x))$ $\quad u = g(x)$ $\frac{dy}{dx} = \frac{dy}{du} \cdot \frac{du}{dx}$	$y = u\,v$ $\frac{dy}{dx} = u\frac{dv}{dx} + v\frac{du}{dx}$	$y = \frac{u}{v}$ $\frac{dy}{dx} = \frac{v\frac{du}{dx} - u\frac{dv}{dx}}{v^2}$
	By parts		
Integration	$y = u\,\frac{dv}{dx}$ $\int u\,\frac{dv}{dx} = uv - \int v\,\frac{du}{dx}$		

END OF PAPER