UNIVERSITY OF GREATER MANCHESTER

OFF CAMPUS DIVISION

WESTERN INTERNATIONAL COLLEGE

BENG (HONS) MECHANICAL ENGINEERING

SEMESTER TWO EXAMINATION 2024/2025

ENGINEERING PRINCIPLES 2

MODULE NO: AME4063

Date: Saturday, 17 May 2025 **Time: 10:00 am – 12:00 pm**

INSTRUCTIONS TO CANDIDATES:

There are SIX (6) questions.

Answer TWO (2) Questions from Part A and TWO (2) Questions from Part B.

All questions carry equal marks.

Marks for parts of questions are shown in brackets.

Electronic calculators may be used provided the data and program storage memory is cleaned prior to the examination.

CANDIDATES REQUIRE: **Formula Sheet (attached)**

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PART A

QUESTION 1

a) Differentiate the following given equations:

(i) $y = xsinx$

(3 marks)

(ii) $y = 2\sqrt{x}$

(2 marks)

(iii) $y = \frac{2x}{x^2-1}$

(3 marks)

b) An object moves in a straight line from a fixed point described by the equation

$$x = 7t + ln\,(2 - t),$$

where 'x' is the distance travelled in meters and 't' is the time taken in seconds. Determine,

(i) The initial velocity and acceleration

(3 marks)

(ii) The velocity and acceleration after 3 s

(4 marks)

c) The distance '**s**' metres travelled by car in 't' seconds after the brakes are applied is given by **$s = 25t - 2.5t^2$.**

Determine:

(i) the speed of the car (in km/h) when the brakes are applied,

(ii) the distance the car travels before it stops.

(10 marks)

[TOTAL 25 MARKS]

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QUESTION 2

a) At any time 't' seconds, the distance x metres of a particle moving in a straight line from a fixed point is given by **x = 4t + ln (1 - t).** Determine (a) the initial velocity and acceleration (b) the velocity and acceleration after 1.5 s (c) the time when the velocity is zero.

(7 marks)

b) The value of a complex voltage waveform is given by:

$$V_{AV} = \frac{1}{\pi}\int_0^{\pi} (20\ sin\ \omega t\ + 5\ sin\ 3\omega t\ +\ 5\ sin\ 5\omega t\ )d(\omega t)$$

Evaluate VAV correct to 2 decimal places.

(8 marks)

c) Evaluate the following given equations:

(i) $\int_0^1 7e^{5t}dt$

(3 marks)

(ii) $\int_{\frac{\pi}{4}}^{\frac{\pi}{2}}(3\ sin2x - 2\ cos3x)dx$

(**4 marks)**

(iii) $\int \frac{2x^2+1}{x}dx$

(3 marks)

[TOTAL 25 MARKS]

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QUESTION 3

a) The difference in tension T is related by differential equation where, pulley contact angle θ and coefficient of friction μ is $\frac{dT}{d\theta} = \mu T$. When $\theta = 0$, T=150N, and $\mu = 0.30$. Determine the tension at the point of slipping when θ = 2 radians. Determine also the value of θ when T is 300 N.

(13 marks)

b) The velocity of a chemical reaction is given by $\frac{dx}{dt} = k(a - x)$, where x is the amount transferred in time t, k is a constant and a is the concentration at time t = 0 when x = 0. Solve the equation and determine x in terms of t.

(12 marks)

[TOTAL 25 MARKS]

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PART B

QUESTION 4

a) **Figure 1** is a I - section with the dimensions in mms as shown. Determine the following:

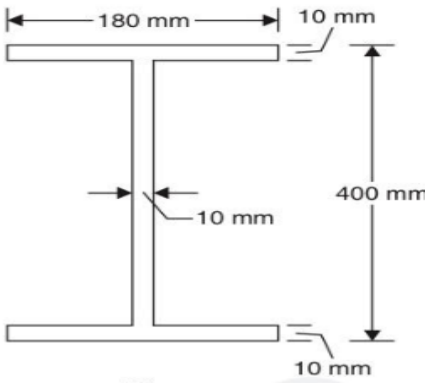

Figure 1: I-Section

(i) The centroid of the I section

(**2 marks)**

(ii) The moment of inertia of the section about the 'xx' axis through the centroid.

(5 marks)

(iii) The moment of inertia of the section about the 'yy' axis through the centroid.

(5 marks)

b) A steel I-beam used in the construction of a bridge, designed to span 10 m. This beam, with the given dimensions shown in the figure 1, supports a uniformly distributed load (UDL) of 2kN/m across the length. The beam is simply supported. Determine

(i) The maximum stress produced due to bending

(8 marks)

(ii) Stress at 150 mm from the neutral axis.

(5 marks)

[TOTAL 25 MARKS]

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QUESTION 5

a) Briefly answer the following questions on Torque.

(i) What is Torque?

(ii) What is the difference between Torque and Moment?

(iii) What is meant by Torsional Rigidity?

(5 marks)

b) A hollow shaft, having an internal diameter 40% of its external diameter, transmits 562.5kW power at 100rpm. Determine the external diameter of the shaft if the shear stress is not to exceed 60N/mm^2 and the twist in a length of 2.5 m should not exceed 1.3 degrees. Assume maximum torque = 1.25 mean torque and modulus of rigidity = 9 x 10^4 N/mm^2. Compare the weight of the hollow shaft with a solid shaft of the same material and external diameter. Calculate the percentage weight saved.

(20 marks)

[TOTAL 25 MARKS]

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QUESTION 6

a) The **Figure 2** shows a 700 kg car on a theme park ride. The car is at point A and travels at velocity of 20 m/s.

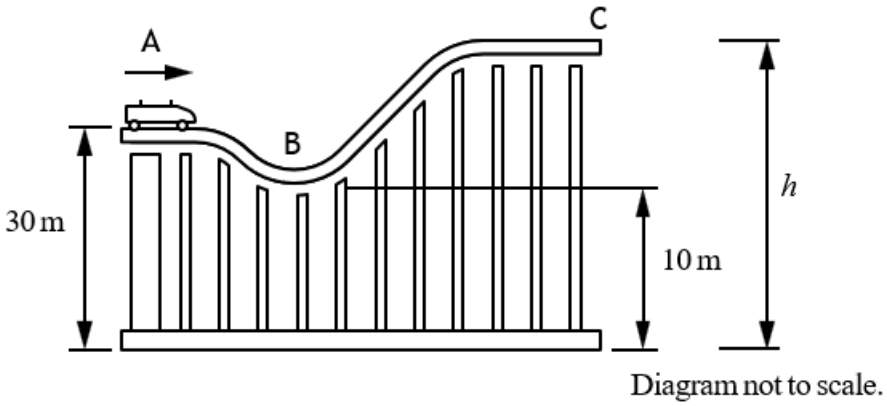

Figure 2: Motion of Car

Assume the track is frictionless and there is no wind resistance.

(i) Calculate the kinetic energy of the car at point A.

(2 mark)

(ii) Calculate the gravitational potential energy of the of the car at point A.

(2 mark)

The car continues along the track

(iii) Calculate the velocity of the car at point B.

(4 mark)

The car then continues along the track to point C where its velocity is 0m/s

(iv) Calculate the height “h” of the track at point C.

(4 mark)

Question 6 continued over the page…

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Question 6 continued…

b) A car is traveling along a straight road with an initial velocity of u = 15m/s. The driver applies the brakes, causing the car to decelerate uniformly at a rate of a = −2m/s^2.

(i)Calculate the time it takes for the car to come to rest.

(3 marks)

(ii)Determine the distance travelled by car before it comes to rest.

(3 marks)

(iii)After coming to rest, the car is then accelerated uniformly at a=1.5m/s^2 for t=8s. Calculate the final velocity of the car after this time.

(3 marks)

(iv)Find the total distance travelled by car during the entire motion (both the deceleration and acceleration phases). **(4 marks)**

[TOTAL 25 MARKS]

END OF QUESTIONS

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FORMULA SHEET

Differentiation

y = uv $\quad \frac{dy}{dx} = u\frac{dv}{dx} + v\frac{du}{dx}$ (Product Rule)

y = $\frac{u}{v}$ $\quad \frac{dy}{dx} = \frac{v\frac{du}{dx} - u\frac{dv}{dx}}{v^2}$ (Quotient Rule)

$\frac{dy}{dx} = \frac{dy}{dt} x \frac{dt}{dx}$ (Chain Rule)

Integration

$\int u\frac{dv}{dx}dx = uv - \int v\frac{du}{dx}dx$ (By parts)

$\int \frac{f^1(x)}{f(x)}dx = \ln|f(x)| + c$

Differential equations

Linear differential equation

dy/dx + Py = Q

Integrating factor is $e^{\int Pdx}$

Solution is $y \times IF = \int Q \times IF dx$

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Part B

Centroid Coordinates & Area

Shape	Centroid (X, Y)	Area (A)	Moment of Inertia
Rectangle	X = b/2, Y = d/2	A = bd	$I_{XX} = \frac{bd^3}{12}$ $I_{yy} = \frac{db^3}{12}$
Circle	X = D/2, Y = D/2	A = $\frac{\pi D^2}{4}$	$I_{xx} = I_{yy} = \frac{\Pi D^4}{64}$

Polar Moment of Inertia (J)

Solid Shaft: J_solid = $\frac{\pi D^4}{32}$

Hollow Shaft: J_hollow = $\frac{\pi(D^4-d^4)}{32}$

Composite Sections

Centroid Coordinates: X = (Σ Ai Xi) / (Σ Ai) = $\frac{A_1x_1+A_2x_2+\cdots}{A_1+A_2+\cdots}$, Y = (Σ Ai Yi) / (Σ Ai)=$\frac{A_1y_1+A_2y_2+\cdots}{A_2+A_2+\cdots}$

Parallel Axis Theorem: $I_{xx} = I_G + Ah^2$

Bending Equation

$$M/I = \sigma/y = E/R$$

Power Transmission

$$P = (2\pi NT)/60$$

Torsion Equation

$$T/J = G\theta/L = \tau/r$$

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Kinematics (SUVAT Equations)

$$v = u + at$$

$$s = ut + 1/2\ at^2$$

$$v^2 = u^2 + 2as$$

Energy Equations

Kinetic Energy: $KE = 1/2\ mv^2$

Gravitational Potential Energy: $GPE = mgh$

END OF PAPER