UNIVERSITY OF BOLTON

OFF CAMPUS DIVISION

WESTERN INTERNATIONAL COLLEGE

BENG (HONS) MECHANICAL ENGINEERING

SEMESTER TWO EXAMINATION 2023/2024

ENGINEERING PRINCIPLES 2

MODULE NO: AME4063

Date: 9th May 2024 **Time: 10:00am-12:00**

INSTRUCTIONS TO CANDIDATES: **There are SIX questions.**

Answer TWO Questions from Part A and TWO 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)**

University of Bolton
Off Campus Division
Western International College
BEng (Hons) Mechanical Engineering
Semester 2 Examination 2023/24
Engineering Principles 2
Module No. AME 4063

PART A

Question 1

a) Differentiate the following given equations:

i. $y = 15 \ln (2t^2 + 8)$

(3 marks)

ii. $y = 2\sqrt{x}$

(2 marks)

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

(3 marks)

b) A particle moves in a straight line from a fixed point given by

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

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) An open rectangular container is to have a volume of 13.5m^3. Determine the least surface area of metal required for the manufacture of rectangular box.

(10 marks)

Total 25 marks

PLEASE TURN THE PAGE

University of Bolton
Off Campus Division
Western International College
BEng (Hons) Mechanical Engineering
Semester 2 Examination 2023/24
Engineering Principles 2
Module No. AME 4063

Question 2

a) A projectile fired from ground level rises x metres vertically upwards in t seconds and x = (100 * t) – [(25/2) * t^2].

Find

(i) the initial velocity of the projectile

(1 mark)

(ii) the time when the height of the projectile is maximum

(2 marks)

(iii) the maximum height reached

(2 marks)

(iv) the velocity with which the projectile hits the ground

(2 marks)

b) The average 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

PLEASE TURN THE PAGE

University of Bolton
Off Campus Division
Western International College
BEng (Hons) Mechanical Engineering
Semester 2 Examination 2023/24
Engineering Principles 2
Module No. AME 4063

Question 3

a) A differential equation relating the difference in tension T, 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. Also determine the value of θ when T is 300 N.

(13 marks)

b) The rate of cooling of a body is given by,

$$\frac{d\theta}{dt} = k\theta$$, where k is a constant.

When θ = 70^{0}C, at t = 3 minutes and θ = 60^{0}C, at t = 5 minutes.

i. Deduce a general solution for the above first order differential equation.

(8 marks)

ii. Determine the time taken to fall to 20^{0}C, correct to the nearest second.

(4 marks)

Total 25 marks

PLEASE TURN THE PAGE

University of Bolton
Off Campus Division
Western International College
BEng (Hons) Mechanical Engineering
Semester 2 Examination 2023/24
Engineering Principles 2
Module No. AME 4063

PART B

Question 4

Figure Q4 is a section with the dimensions in mms as shown. Determine the following:

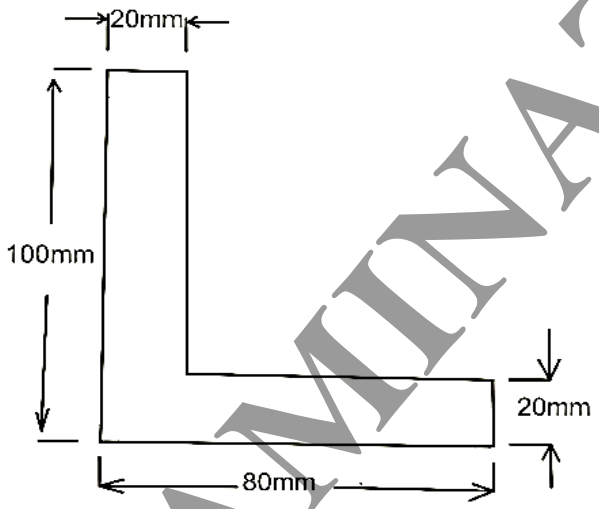

Figure Q4: L-Section

i. the centroid of the section

(9 marks)

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

(8 marks)

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

(8 marks)

Total 25 marks

PLEASE TURN THE PAGE

University of Bolton
Off Campus Division
Western International College
BEng (Hons) Mechanical Engineering
Semester 2 Examination 2023/24
Engineering Principles 2
Module No. AME 4063

Question 5

a) A solid cylindrical shaft is to transmit 300kW power at 100 rpm.

(i) If the shear stress is not to exceed 80N/mm^2, find the diameter.

(6 mark)

(ii) What percentage saving in weight would be obtained if the shaft is replaced by a hollow shaft whose internal diameter equals 0.6 of the external diameters, the length, the material and the shear stress being the same?

(7 mark)

b) A body, resting on a rough horizontal plane, required a pull of 180 N inclined at 30^0 to the plane just to move it. It was found that a push of 220N inclined at 30^0 to the plane just moved the body. Determine

(i) The weight of the body and

(6 mark)

(ii) The coefficient of friction

(6 mark)

Total 25 marks

Question 6

A square beam 20mmX20mm in section and 2m long is supported at the ends. The beam fails when a point load of 400N is applied at the centre of the beam. What uniformly distributed load per meter length will break a cantilever of the same material 40mm wide, 60mm deep and 3m long?

Total 25 marks

END OF QUESTIONS

PLEASE TURN THE PAGE

University of Bolton
Off Campus Division
Western International College
BEng (Hons) Mechanical Engineering
Semester 2 Examination 2023/24
Engineering Principles 2
Module No. AME 4063

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

Rectangle X = (b/2), Y= (d/2) , A=bd $\quad I_{XX} = \frac{bd^3}{12}$ $\quad I_{YY} = \frac{db^3}{12}$

Circle $I_{XX} = \frac{\pi R^4}{4}$ $\quad$ Polar $J_{solid} = \frac{\pi D^4}{32}$ $\quad J_{hollow} = \pi(D^4 - d^4)/32$

PLEASE TURN THE PAGE

University of Bolton
Off Campus Division
Western International College
BEng (Hons) Mechanical Engineering
Semester 2 Examination 2023/24
Engineering Principles 2
Module No. AME 4063

For composite sections

$$\bar{X} = \frac{\Sigma AiXi}{\Sigma Ai}$$

$$\bar{Y} = \frac{\Sigma AiYi}{\Sigma Ai}$$

Parallel Axis Theorem

$I_{xx} = I_{GG} + Ah^2$

$I_{XX} = (I_{XX})_I + \Sigma A_i(Y_i - \bar{Y})^2$

$I_{YY} = (I_{YY})_I + \Sigma A_i(X_i - \bar{X})^2$

Bending Equation

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

Power generated

$$P = 2\pi NT$$

Torsion Equation

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

Friction

$$F = \mu N$$

END OF FORMULA SHEET