OCD008

UNIVERSITY OF BOLTON

OFF CAMPUS DIVISION

WESTERN INTERNATIONAL COLLEGE

BENG (HONS) MECHANICAL ENGINEERING

SEMESTER ONE EXAMINATION 2022/2023

ENGINEERING PRINCIPLES 1

MODULE NO: AME4062

Date: Saturday, 07 January 2023 **Time: 10:00 – 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)**

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PART A

Q1.

a) In a system of forces, the relationship between two forces in Newton F_1 and F_2 is given by:

$$F_1 + 2F_2 + 4 = 0$$

$$5F_1 + 3F_2 - 1 = 0$$

Use '**Matrices Method**' to solve for F_1 and F_2

(10 marks)

b) Two alternating voltages are given by

$$V_1 = 10\ sin\ sin\ \omega t\ volts \quad ; \qquad V_2 = 14\ sin\ sin\left(\omega t + \frac{\pi}{3}\right)\ volts$$

Determine a sinusoidal expression for the resultant $\mathbf{V_R = V_1 + V_2}$, using sine and cosine rule and compare the results graphically.

(10 marks)

c) If $z = 7\left(cos\frac{\pi}{4} + j\ sin\frac{\pi}{4}\right)$, using ***De Moivre's*** theorem find z^5

(5 marks)

(Total 25 marks)

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Q2.

a) Use partial Fractions to expand:

$$Y(s) = \frac{x^2 + 7x + 3}{x^2(x+3)}$$

(10 marks)

b) The value of a lathe originally valued at AED 30000 depreciates 15% per annum.

i) Calculate its value after 4 years.

(5 marks)

ii) If the machine is sold when its value is less than AED 5400. After how many years is the lathe sold?

(5 marks)

c) Solve the logarithmic equation

$$\log x^4 - \log x^3 = \log 5x - \log 2x$$

(5 marks)
(Total 25 mark)

Q3.

a) The law connecting friction F and load L for an experiment is given by

F = aL- Mb,

Where, a, b & M are constants. Given that when F= 6.84N, L= 2.3N, M= 4.4 and when F= 1.23N, L=8.5N, M = 6.7. Find the following:

i) the value of a & b using ***determinant method***

(8 marks)

ii) find the value of F when L = 6.0 and M = 0

(2 marks)

b) Use partial fractions to expand

$$\frac{5x^2 - 17x + 15}{(x-1)(x-2)^2}$$

(10 marks)

c) Solve, correct to 4 significant figures:

$$e^{(x+1)} = 3e^{(2x-5))}$$

(5 marks)
Total 25 marks

END OF PART A – PLEASE TURN THE PAGE FOR PART B…..

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PART B

Q4.

A steel cube block of 50mm side is subjected to a force of 10kN (tension), 12.5kN (compression) and 7.5kN (tension) along x, y and z directions respectively as shown in **Figure Q4**.

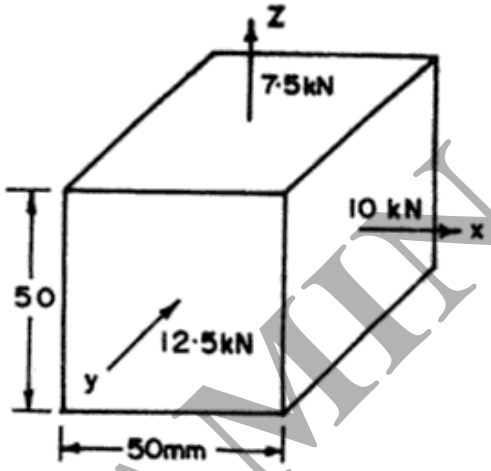

Figure Q4. Steel cube block

Determine the following:

a) Stresses in x,y and z directions

(6 marks)

b) Assuming Poisson's ratio as 0.3, find in terms of modulus of elasticity of the material E, the strains in the direction of each force.

(6 marks)

c) If modulus of elasticity E=200kN/mm^2, find the values of the modulus of rigidity and bulk modulus for the material of the block.

(8 marks)

d) The change in volume of the block due to loading specified above.

(5 marks)

Total 25 marks

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Q5. a) A steel rod of 3cm diameter is enclosed centrally in hollow copper tube of external diameter 5cm and internal diameter of 4cm. The composite bar is then subjected to an axial pull of 45000 N as shown in Figure Q5a. If the length of each bar is 15cm, determine

i. Stress developed in steel rod

(5 marks)

ii. Stress developed in copper tube

(5 marks)

Take modulus of elasticity, E of steel as 2.1 X 10^5MPa and E of copper as 1.1 X 10^5MPa

iii. Define compound bar and its rules of calculation

(5 marks)

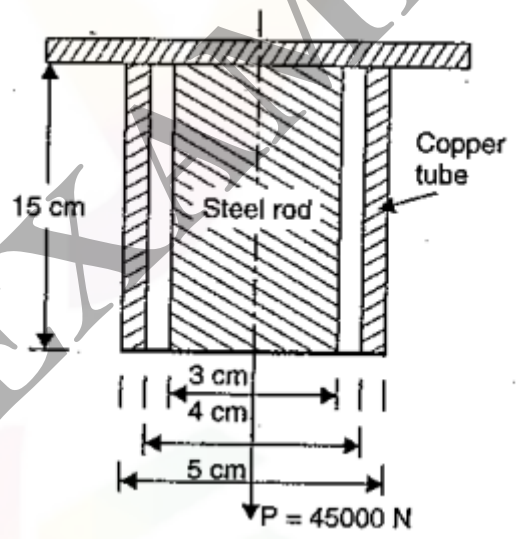

Figure Q5a. A Compound bar

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Q5 continued…

b) The following forces act at a point as shown in Figure Q5b:

(i) 20 N inclined at 30° towards North of East,

(ii) 25 N towards North,

(iii) 30 N towards North-West, and

(iv) 35 N inclined at 40° towards the South of West.

Find the magnitude and direction of the resultant force.

(10 marks)

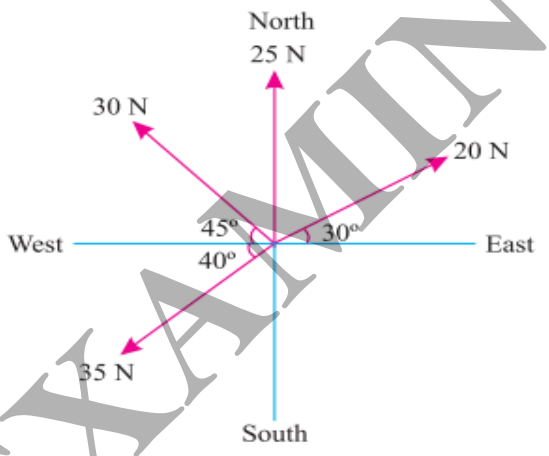

Figure Q5b. Concurrent force system

Total 25 marks

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Q6. A simply supported beam carries concentrated lateral loads at C and D, and a uniformly distributed lateral load over the length DF as shown in Figure Q6. Determine:

i. Reaction loads at the support (5 marks)

ii. Construct the shear force diagram for the beam (8 marks)

iii. Construct the bending moment diagram for the beam (8 marks)

iv. Find the position of maximum bending moment. (4 marks)

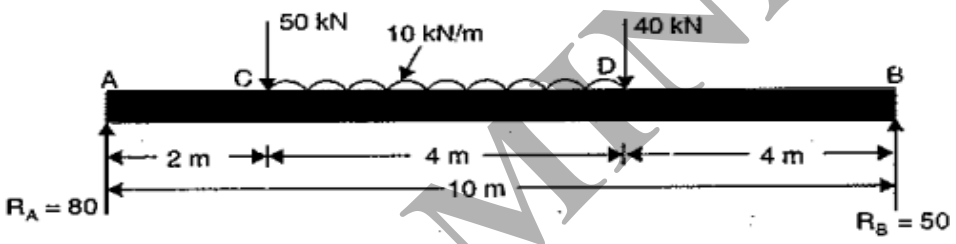

Figure Q6. Simply supported beam

Total 25 marks

END OF QUESTIONS

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FORMULA SHEET

Determinants

$$\frac{x}{D_x} = \frac{-y}{D_y} = \frac{z}{D_z} = \frac{-1}{D}$$

Matrices

$$A^{-1} = \frac{adjA}{D}$$

$$X = A^{-1}B$$

Series

$U_n = a + (n-1)\,d$

$S_n = \frac{n}{2}[2a + (n-1)\,d]$

$U_n = ar^{n-1}$

$S_n = \frac{a(1-r^n)}{1-r}$

$$S_\infty = \frac{a}{1-r}$$

$U_n = a + (n-1)d + \frac{1}{2}(n-1)(n-2)C$

Binomial

$(1+x)^n = 1 + nx + \frac{n(n-1)}{2!}x^2 + \ldots\ldots\ldots\ldots$

Validity $|x| < 1$

Partial Fractions

$$\frac{F(x)}{(x+a)(x+b)} = \frac{A}{(x+a)} + \frac{B}{(x+b)}$$

$$\frac{F(x)}{(x+a)(x+b)(x+c)} = \frac{A}{(x+a)} + \frac{B}{(x+b)} + \frac{C}{(x+c)}$$

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Stress

Normal $\sigma = \frac{P}{A}$ A = x-sectional area

Shear $\tau = \frac{P}{A}$ A = shear area

Strain

Normal $\varepsilon = \frac{\delta \ell}{\ell}$

Shear $\gamma = \frac{x}{y}$ (Angular Displacement in rads in direction of F)

Compound Bars

$P = P_1 + P_2$

$P = \int_1 A_1 + \int_2 A_2$

$$\frac{\sigma_1}{E_1} = \frac{\sigma_2}{E_2},$$

Elastic Constants

$$E = \frac{\sigma}{\varepsilon}, \qquad G = \frac{\tau}{\gamma}$$

$$\varepsilon_x = \frac{\sigma_x}{E} - \upsilon\frac{\sigma_y}{E} - \upsilon\frac{\sigma_z}{E}$$

$$\varepsilon_y = \frac{\sigma_y}{E} - \upsilon\frac{\sigma_x}{E} - \upsilon\frac{\sigma_z}{E}$$

$$\varepsilon_z = \frac{\sigma_z}{E} - \upsilon\frac{\sigma_x}{E} - \upsilon\frac{\sigma_y}{E}$$

$$\varepsilon_v = \varepsilon_x + \varepsilon_y + \varepsilon_z$$

$$\varepsilon_v = \frac{1-2\upsilon}{E}\left(\sigma_x + \sigma_y + \sigma_z\right)$$

$$\varepsilon_v = \frac{\delta V}{V}$$

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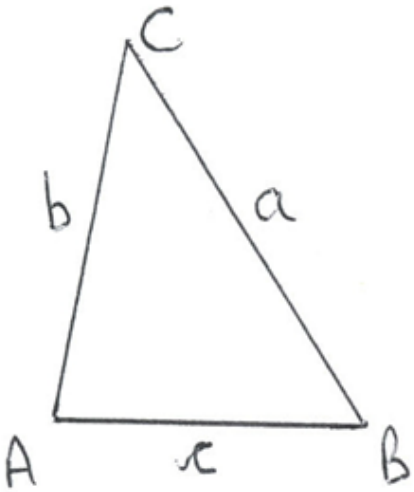

Compressibility

$$K = \frac{\sigma}{\varepsilon_V}$$

$$\varepsilon_V = \frac{3\sigma(1-2\upsilon)}{E}$$

$$E = 3K(1-2\upsilon)$$

$$E = 2G(1+\upsilon)$$

$$e_v = \frac{\delta L}{L}(1-2\mu)$$

Trigonometry

Sine Rule: $\frac{a}{\sin A} = \frac{b}{\sin B} = \frac{c}{\sin C}$

Cosine Rule: $a^2 = b^2 + c^2 - 2bc \cos A$

END OF FORMULA SHEET

END OF PAPER