OCD003

UNIVERSITY OF BOLTON

OFF CAMPUS DIVISION

WESTERN INTERNATIONAL COLLEGE FZE

BENG(HONS) MECHANICAL ENGINEERING

TRIMESTER TWO EXAMINATION 2021/2022

ENGINEERING PRINCIPLES 1

MODULE NO: AME4062

Date: Saturday 30th April 2022 **Time: 2:00pm – 4:00pm**

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.

Graph paper will be provided

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

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Engineering Principles I
Module No. AME4062

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

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

Where ω represents angular frequency in rad/sec.

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

(10 marks)

c) Use De Moivre's Theorem to find the 5th power of the complex number z = 2(cos 24° + i sin 24°). Express the answer in the rectangular form a + bi

(5 marks)

(Total 25 marks)

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)**

Q2 continued next page…….

Q2 continued…

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 frictional force, 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. determine 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) Determine the partial fraction decomposition of each of the following expression.

$$\frac{4x^2 - 22x + 7}{(2x+3)(x-2)^2}$$

(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 block of 300mm X 100mm X 40mm side is subjected to a force of 5kN (tension), 6kN (tension) and 4kN (tension) along x, y and z directions respectively as shown in **Figure Q4**.

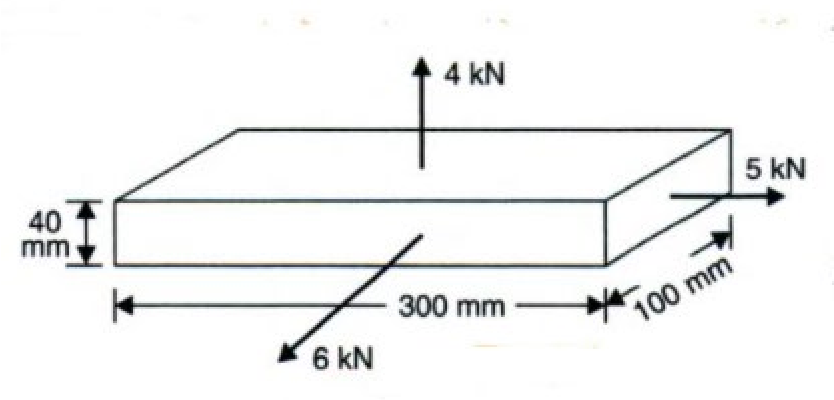

Figure Q4. Steel cube block

Determine the following:

a) Stresses in x,y and z directions **(6 marks)**

b) Assuming Poisson's ratio as 0.25, 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 compound bar shown in **Figure Q5a**.consists of three bars made of copper, zinc and aluminium having cross section 500,750 and 1000 square mm respectively. They are rigid connected at their ends. If this compound member is subjected to a longitudinal pull of 250kN, determine the following:

I. Stress developed in copper bar **(5 marks)**

II. Stress developed in zinc bar **(5 marks)**

III. Stresses developed in aluminium bar **(5 marks)**

Take modulus of elasticity, E of copper as $1.3x10^5$ N/mm ^{2}, E of zinc 1 $x10^5$ N/mm ^{2} and E of aluminium as $0.8x10^5$ N/mm ^{2}

IV. Define compound bar and its rules of calculation **(3 marks)**

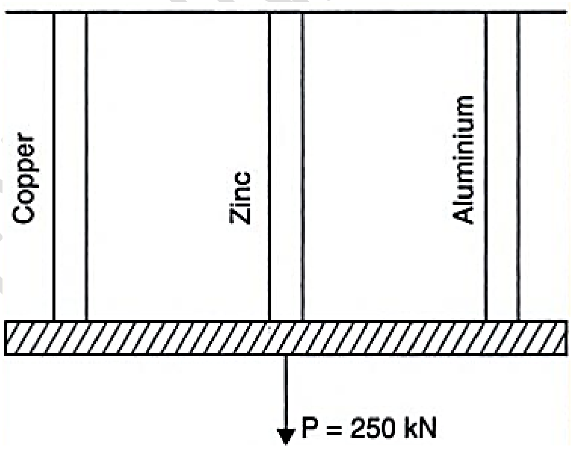

Figure Q5a. A Compound bar

Q5 continued over the page…

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Q5 continued….

b) If five forces act on a particle as shown in **Figure Q5b** and the algebraic sum of horizontal components of all these forces is -324.904kN. Calculate the following:

I. magnitude of 'P' **(4marks)**

II. the resultant of all the forces **(3marks)**

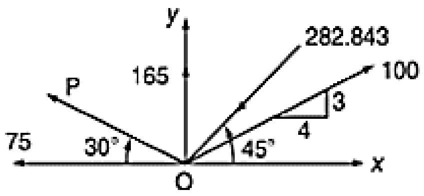

Figure Q5b. Force Diagram

Total 25 marks

Q6. A simply supported beam carries concentrated lateral loads at C and D, and a uniformly distributed lateral load over the length CD 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)**

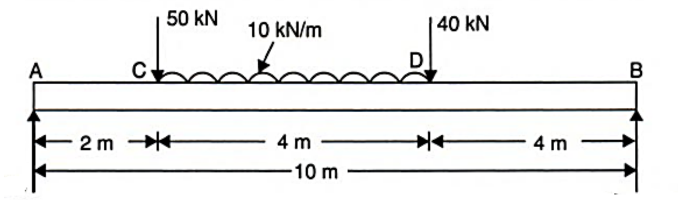

Figure Q6. Simply supported beam

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

$P = P_1 + P_2$

$P = \sigma_1 A_1 + \sigma_2 A_2$

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

Elastic Constants

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

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

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

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

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

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

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

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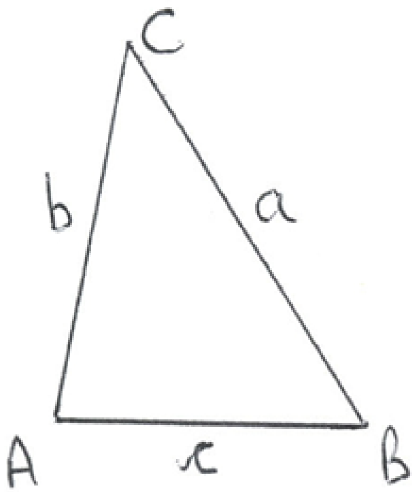

Compressibility

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

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

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

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

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

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 SHEETS

END OF PAPER