[OCD001]

UNIVERSITY OF BOLTON

OFF CAMPUS DIVISION

WESTERN INTERNATIONAL COLLEGE

BENG(HONS) MECHANICAL ENGINEERING

TRIMESTER ONE EXAMINATION 2021/2022

ENGINEERING PRINCIPLES 1

MODULE NO: AME4062

Date: Saturday 8th January 2022 **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

$$V_1 = 10\sin\omega t\ volts$$

$$V_2 = 14\sin\left(\omega t + \frac{\pi}{3}\right) volts$$

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 marks

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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

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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**.

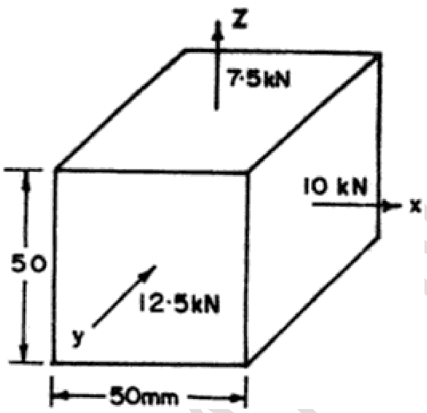

Figure Q4. Steel cube block

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.

(8marks)

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 consists of a circular rod of steel of diameter 20mm rigidly fitted into a copper tube of internal diameter 20mm and thickness 5mm as shown in FigureQ5a.If the bar is subjected to a load of 100kN,determine the following:

i. Stress developed in steel rod

(5 marks)

ii. Stress developed in copper tube

(5 marks)

Take modulus of elasticity, E of steel as 200GPa and E of copper as 120GPa

iii. Define compound bar and its rules of calculation

(5 marks)

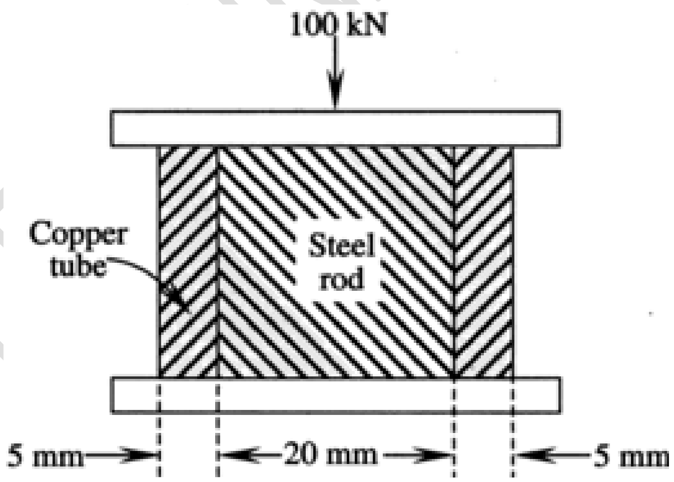

Figure Q5a. A Compound bar

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Q5 continued…

b) The resultant of four concurrent forces which are acting at a point O as shown in figure Q5b is along Y-axis. The magnitude of forces F1, F3 and F4 are 10kN,20kN and 40kN respectively. The angles made by 10kN,20kN and 40kN with X-axis are 30^0,90^0 and 120^0 respectively.

Determine the magnitude and direction of F2 if the resultant is 72kN.

(10 marks)

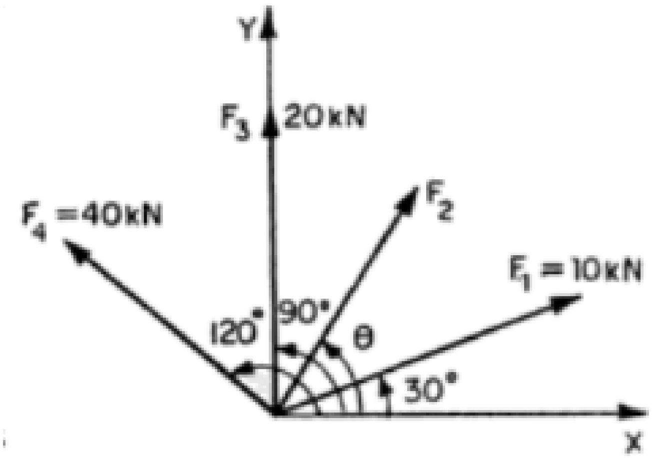

Figure Q5b. Concurrent force system

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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)**

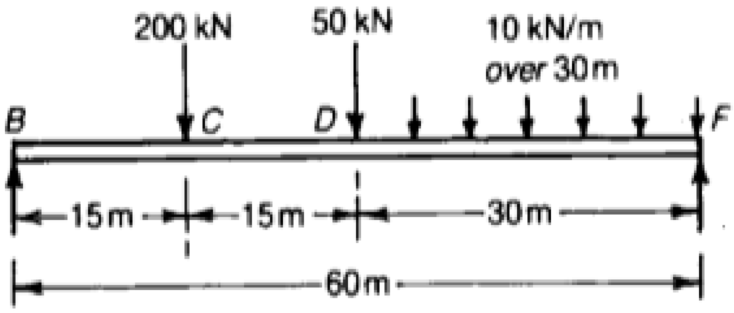

Figure Q6. Simply supported beam

Total 25 marks

END OF PART B

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

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

Validity $|x| < 1$

Partial Fractions

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

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

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

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

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

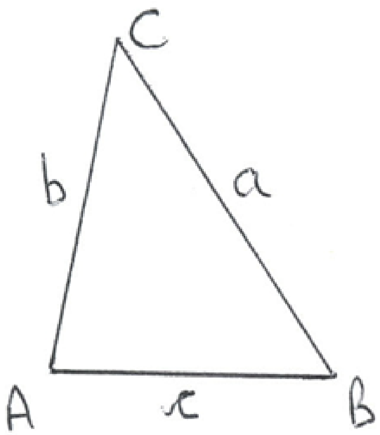
$$\varepsilon_y = \frac{\sigma_y}{E} - \upsilon\frac{\sigma_x}{E} - \upsilon\frac{\sigma_z}{E}$$

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

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

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

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



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