UNIVERSITY OF BOLTON

WESTERN INTERNATIONAL COLLEGE FZE

BEng (Hons) MECHANICAL ENGINEERING

SEMESTER ONE EXAMINATION 2018/2019

ENGINEERING PRINCIPLES 1

MODULE NO: AME4062

Date: Tuesday 15th January 2019 **Time: 10:00am – 12:00pm**

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.

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

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PART A

Q1.

a) Use Partial fractions to expand:

$$Y(s) = \frac{s^2 + 4s + 5}{(s^2 + 2s + 4)(s + 3)}$$

(10 marks)

b) Solve the following Logarithmic Equations

i) $\log(x^2 + 2) = 2.6$ (2 marks)

ii) $3(10^{0.5x-2})$ = 96 (3 marks)

c) A machine has seven speeds ranging from 25rev/min to 500 rev/min. If the speeds form a geometric progression, determine their value, each correct to nearest whole number. (10 marks)

(Total 25 marks)

Q2.

a) In a mechanical system, deceleration '**a**' in m/s^2, velocity '**v**' in m/s and distance '**x**' in m, are related by simultaneous equation given below:

$$x + 2v + 3a = -7.8$$

$$2x + 5v - a = 1.4$$

$$5x - v + 7a = 3.5$$

Solve using ***determinant method*** to find the acceleration, velocity, and distance.

(15 marks)

Q2 continued over the page

Please turn the page

Q2 continued.

b) Two vehicles are accelerating with a_1 = 1.5m/s^2 at 90^0 and a_2 = 2.6 m/s^2 at 145^0 from one starting point. Determine the vector sum **'a_1 + a_2'**and vector difference '**a_1 – a_2'**. Use appropriate figures to represent your answers. (10 marks)

(Total 25 mark)

Q3.

a) If $= 7\left(cos\frac{\pi}{4} + j\ sin\frac{\pi}{4}\right)$, using ***De Moivre's*** theorem find **z^2** (5 marks)

b) The 1st, 10th and the last terms of an arithmetic progression are 9, 40.5 and 425.5 respectively. Find

i) the number of terms (5 marks)
ii) sum of all terms (3 marks)
iii) the 75th term in the series (2 marks)

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

F = aL+b,

where a & b are constants. Given that when F=5.6, L=8.0 and when F=4.4,L=2.0. Find the following:

i) the value of a & b using ***matrices method*** (8 marks)
ii) the value of F when L = 6.5 (2 marks)

(**Total 25 marks)**

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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**.

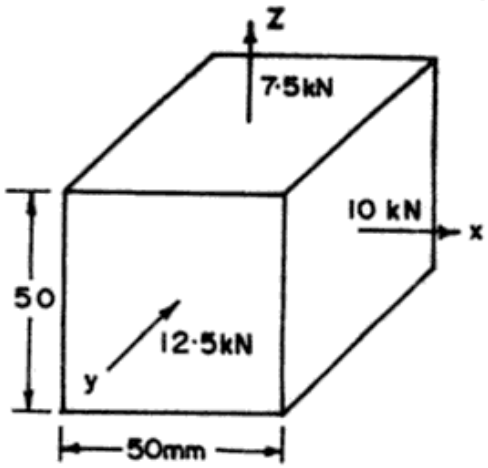

Figure Q4. Steel cube block

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 brass bar, having cross sectional area of 1000mm^2, is subjected to axial forces as shown in **Figure Q5a**.

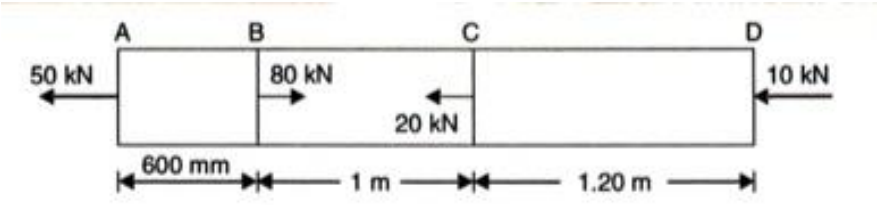

Figure Q5a.

Determine the following:

i. Change in length of part AB,BC and CD (12 marks)
ii. Total elongation of the bar (3 marks)

Take young's modulus of brass, E = 1.05 x 10^5 N/mm^2

b) Three forces are acting on a hook as shown in Figure Q5b.Determine the following:

i. The resultant force in magnitude (7 marks)
ii. The resultant force in direction (3 marks)

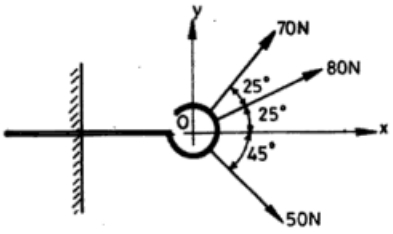

Figure Q5b. Forces on a hook

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)

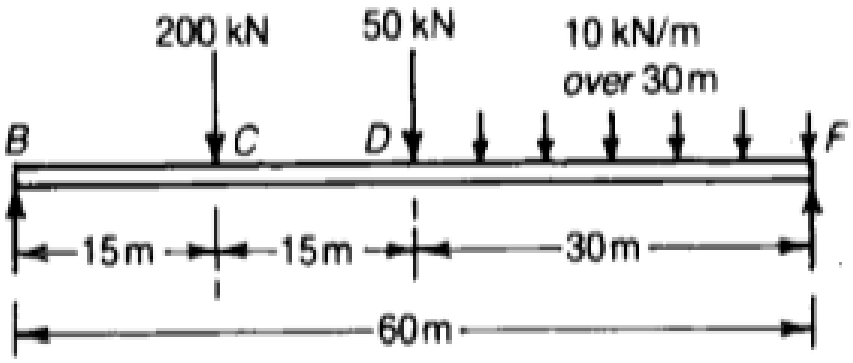

Figure Q6. Simply supported beam

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 $|x| < 1$

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Partial Fractions

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

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

$$\frac{F(x)}{(x+a)(x^2+b)} = \frac{A}{(x+a)} + \frac{Bx+C}{(x^2+b)}$$

De Moivre's Theorem

$(\cos\theta + j\ \sin\theta)^n = \cos n\theta + j \sin n\theta$

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

$P = P_1 + P_2$

$P = \sigma_1 A_1 + \sigma_2 A_2$

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

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Elastic Constants

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

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

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

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

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

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

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

Compressibility

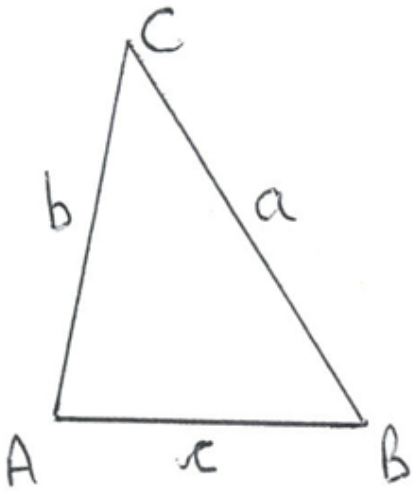
$$K = \frac{\sigma}{\varepsilon_V}$$

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

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

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

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



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 PAPER