UNIVERSITY OF BOLTON

WESTERN INTERNATIONAL COLLEGE FZE

BENG (HONS) MECHANICAL ENGINEERING

SEMESTER TWO EXAMINATION 2018/2019

ENGINEERING PRINCIPLES 1

MODULE NO: AME4062

Date: Thursday 30th May 2019 **Time: 10:00 AM – 12:00 PM**

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
Western International College FZE
BEng (Hons) Mechanical Engineering
Semester 2 Examination 2018/2019
Engineering Principles I
Module No. AME 4062

PART A

Q1.

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)

b) Use Partial fractions to expand:

$$\frac{2x^2 + 7x - 17}{(x-1)(x-2)(x+3)}$$

(10 marks)

(Total 25 marks)

Q2.

a) Use partial fractions to expand: $\frac{8x - 28}{x^2 - 6x + 8}$ (6 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 (1 marks)

Question 2 continued over the page

Please turn the page

Q2 Continued.

b) Forces of $F_1 = 40N$ at 45^0 and $F_2 = 30N$ at 125^0 acting at one starting point. Determine the vector sum **'$F_1 + F_2$'**and vector difference '**$F_1 – F_2$'**. Use appropriate figures to represent your answers.

(10 marks)

(Total 25 mark)

Q3.

a) If $x= 3 (\cos \pi/4 + j \sin \pi/4)$ find the value of x^5 (5 marks)

b) A drilling machine is to have 6 speeds ranging from 50 rev/min to750 rev/min. If the speeds form a geometric progression, determine their values, each correct to the nearest whole number. (10 marks)

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

$$3F_1 + 2F_2 + 6 = 0$$

$$2F_1 + 4F_2 + 12 = 0$$

Use determinants to solve for F_1 and F_2

(10 marks)

(**Total 25 marks)**

University of Bolton
Western International College FZE
BEng (Hons) Mechanical Engineering
Semester 2 Examination 2018/2019
Engineering Principles I
Module No. AME 4062

PART B

Q4.

A rectangular block 250mm x 100mmx 80mm shown in Figure Q4 is subjected to axial loads as follows:

480kN tensile in the direction of its length

100kN compressive on the 250mmx 100mm faces

900kN tensile on 250mm x 80mm faces.

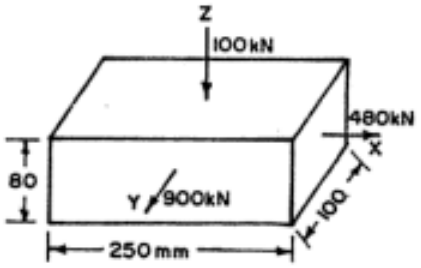


Figure Q4. rectangular block

Determine the following:

a) 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.
(12 marks)

b) If modulus of elasticity E= 2x 10^5N/mm^2, find the values of the modulus of rigidity and bulk modulus for the material of the block.
(8marks)

c) Calculate the change in volume of the block due to loading specified above. (5 marks)

Total 25 marks

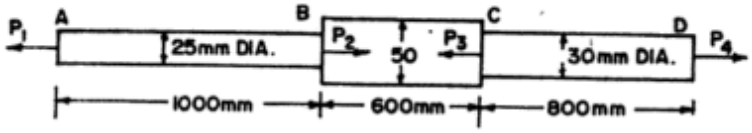
Please turn the page

University of Bolton
Western International College FZE
BEng (Hons) Mechanical Engineering
Semester 2 Examination 2018/2019
Engineering Principles I
Module No. AME 4062

Q5.

a) A stepped member ABCD is subjected to point loads P_1,P_2,P_3 and P_4 as shown in **Figure Q5a**.

Calculate the force P_2 necessary for equilibrium if P_1= 10kN, P_3=40kN and P_4=16kN.Taking modulus of elasticity as 2.05x 10^5N/mm^2, determine the total elongation of the member.



(15 marks)

Figure Q5a. stepped member

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)

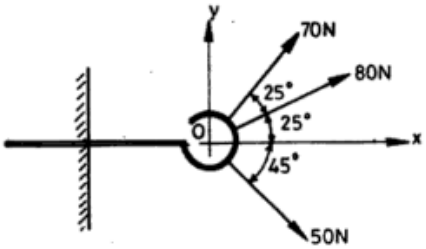


Figure Q5b. Forces on a hook

Total 25 marks

Please turn the page

University of Bolton
Western International College FZE
BEng (Hons) Mechanical Engineering
Semester 2 Examination 2018/2019
Engineering Principles I
Module No. AME 4062

Q6.

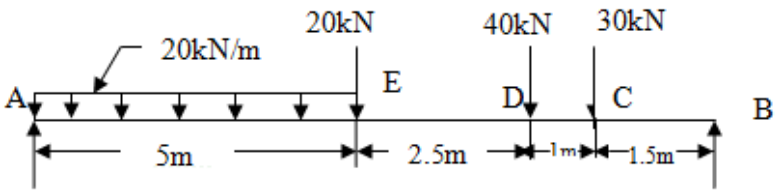
A simply supported beam carries concentrated lateral loads at C, D, E and a uniformly distributed lateral load over the length AE as shown in Figure Q6. Determine:

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)



FigQ6.

Figure Q6. Simply supported beam

Total 25 marks

END OF QUESTIONS

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Please turn the page

University of Bolton
Western International College FZE
BEng (Hons) Mechanical Engineering
Semester 2 Examination 2018/2019
Engineering Principles I
Module No. AME 4062

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 $|x| < 1$

Please turn the page

University of Bolton
Western International College FZE
BEng (Hons) Mechanical Engineering
Semester 2 Examination 2018/2019
Engineering Principles I
Module No. AME 4062

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

$P = P_1 + P_2$

$P = \sigma_1 A_1 + \sigma_2 A_2$

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

University of Bolton
Western International College FZE
BEng (Hons) Mechanical Engineering
Semester 2 Examination 2018/2019
Engineering Principles I
Module No. AME 4062

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

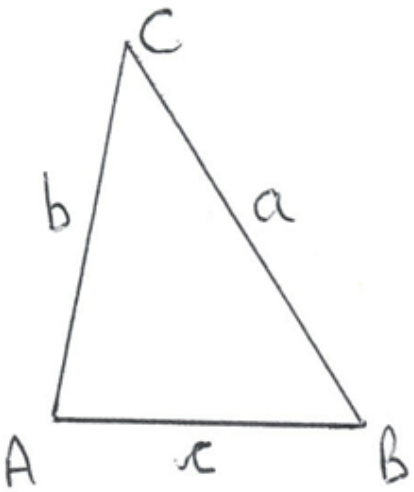
$$K = \frac{\sigma}{\varepsilon_V}$$

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

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

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

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



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 FORMULA SHEET