UNIVERSITY OF GREATER MANCHESTER

OFF CAMPUS DIVISION

WESTERN INTERNATIONAL COLLEGE, RAS AL KHAIMAH

BENG (HONS) MECHANICAL ENGINEERING

SEMESTER ONE EXAMINATION 2025/2026

ENGINEERING PRINCIPLES 1

MODULE NO: AME4062

Date: Thursday, 22nd January 2026 **Time: 10:00 – 12:00**

INSTRUCTIONS TO CANDIDATES:

There are SIX (6) questions.

Answer TWO (2) Questions from Part A and TWO (2) 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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Engineering Principles 1
Module No. AME4062

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PART A

Q1. a) Solve the following

(i) Determine the inverse of $[3\ \ -1\ \ -4\ 7\ ]$

(4 marks)

(ii) Evaluate $\begin{vmatrix} 8 & -2 & -10 \\ 2 & -3 & -2 \\ 6 & 3 & 8 \end{vmatrix}$

(5 marks)

b) Forces of 15 N and 10 N are at an angle of 90° to each other as shown in Fig. Q1. Calculate the magnitude of the resultant of these two forces and its direction with respect to the 15 N force.

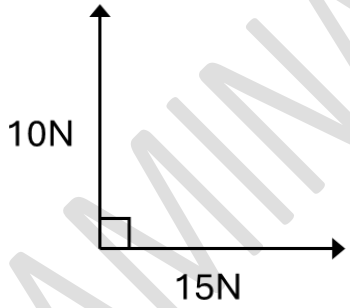

Figure Q1

(10 marks)

c) Solve the complex equations:

(i) $(2 + j\ )(3 - j2) = a + jb$

(i) $(x\ -\ j2y) - (\ y - \ j\ x) = 2 + j$

(6 marks)

(Total 25 marks)

Q2. a) Consider a system where the transfer function of a control system is given by:

$$\frac{x^2 - 3x + 6}{x(x-2)(x-1)}$$

To analyse the system response in the time domain, you need to decompose the transfer function $Y(s)$ into partial fractions. Find the partial fraction decomposition of the transfer function. (10 marks)

Question 2 continues over the page

Question 2 continues

b) On commencing employment, a man is paid a salary of AED 16000 per annum and receives annual increments of AED 480. Determine his salary in the 9th year and calculate the total he will have received in the first 12 years.

(4 marks)

c) The value of a lathe originally valued at $3000 depreciates 15% per annum. Calculate its value after 4 years. The machine is sold when its value is less than $550. After how many years is the lathe sold?

(5 marks)

d) Solve the logarithmic equations

(i) $log_3(x) = 2$
(ii) $log_5 125 = x$
(iii) $log\ x^4 - log\ x^3 = log\ 5x - log\ 2x$

(6 marks)

(Total 25 marks)

Q3. a) Kirchhoff's laws are used to determine the current equations in an electrical network and show that

$$I_1 + 8I_2 + 3I_3 = -31$$
$$3I_1 - 2I_2 + I_3 = -5$$
$$2I_1 - 3I_2 + 2I_3 = 6$$

Use determinants to find the values of I_1 , I_2 and I_3

(13 marks)

(b) Determine the partial fraction decomposition of the following expression.

$$\frac{3x^2 + 16x + 15}{(x+3)^3}$$

(8 marks)

Question 3 continued over the page

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Question 3 continues

(c) A jib crane is shown in Fig. Q3. If the tie rod PR is 8.0 long and PQ is 4.5 m long determine (a) the length of jib RQ, and (b) the angle between the jib and the tie rod.

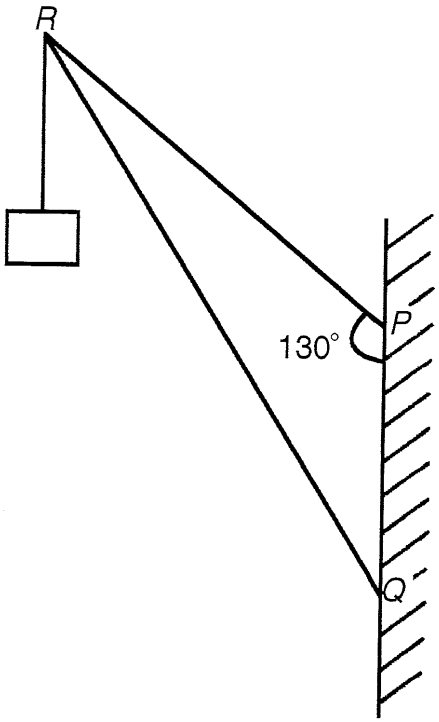

Figure Q3

(4 marks)

(**Total 25 marks)**

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PART B

Q4. a) An eye bolt is subjected to two applied forces of 5 kN and 8 kN, arranged as shown in **Figure Q4a**. The 5 kN force makes an angle of 60° with the vertical axis, while the 8 kN force is inclined at 45° below the horizontal axis. Determine:

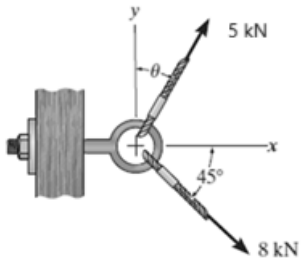

Figure Q4a: Forces acting on the eye bolt

i) The magnitude and direction of the resultant force acting on the eye bolt.

(6 marks)

ii) A graphical representation of the resultant force and the corresponding equilibrant for this coplanar force system.

(4 marks)

b) The members of a truss are pin-connected at joint *O* as in **Figure Q4b**.

i) What are the conditions necessary for a body to be in static equilibrium under the action of a coplanar force system?

(4 marks)

ii) What are the resultant and equilibrant of a coplanar force system? Explain with an example.

(6 marks)

iii) Determine the magnitude of F1 and F2 if all forces at point O are at equilibrium

(5 marks)

Question 4 continued over the page

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Question 4 continues

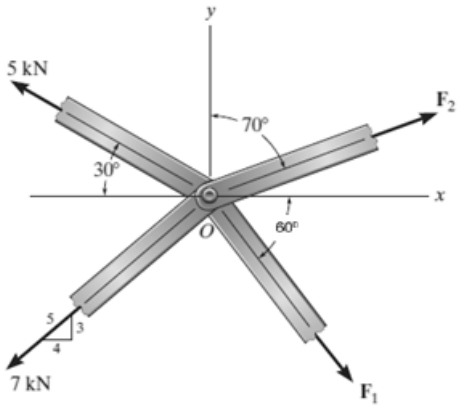

Figure Q4b: Forces acting on the pin-joint

Total 25 marks

Q5. 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 Q5. Determine:

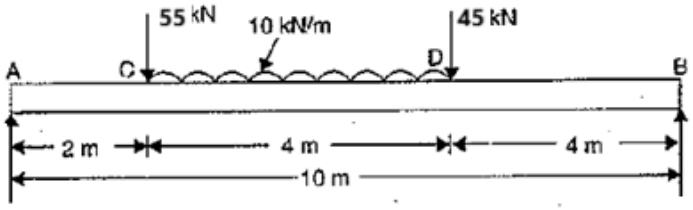

Figure Q5: Simply supported beam

i. Reaction loads at the support

(6 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.

(3 marks)

Total 25 marks
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Q6. B) A metallic rectangular block of dimensions 300 mm × 100 mm × 40 mm is subjected to forces of 5 kN (tension), 6 kN (tension) and 4 kN (tension) along the x, y and z directions, respectively as shown in **Figure Q6**.

Determine the following:

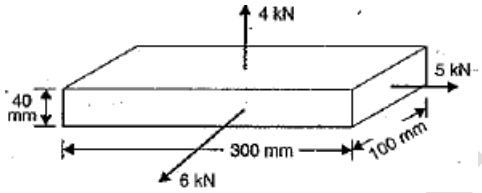

Figure Q6: Rectangular block subject to load

i) Stresses in x, y and z directions

(6 marks)

ii) Assuming Poisson's ratio as 0.25, find in terms of modulus of elasticity E, the strains in the direction of each force

(6 marks)

iii) If modulus of elasticity E = 2 × 10^5 N/mm^2, find the values of the modulus of rigidity and bulk modulus for the material of the block

(8 marks)

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

(5 marks)

Total 25 marks

END OF QUESTIONS

Please turn the page for formula sheet

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FORMULA SHEET

Matrices

$$A^{-1} = \frac{adj\ A}{|A|}$$

Cramer's rule:

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

Series

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

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

$$U_n = ar^{n-1}$$

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

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

Binomial

$$\frac{n(n-1)}{2!}x^2 + \cdots\cdots\cdots\cdots\cdots$$

$(1 + x)^n = 1 + nx +$

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Validity $|x| < 1$ Partial Fractions

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

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

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

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

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

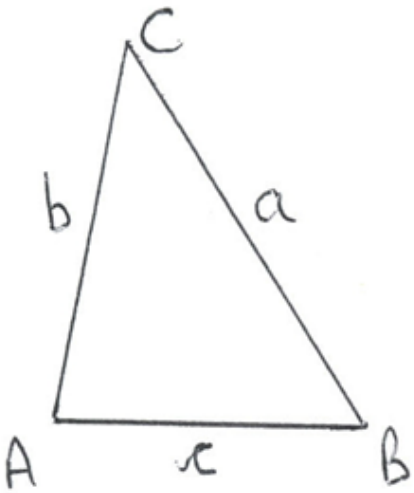
$$\varepsilon_y = \frac{\sigma_y}{E} - \upsilon\frac{\sigma_x}{E} - \upsilon\frac{\sigma_z}{E}$$

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

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

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

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



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 PAPER