



**UNIVERSITI KUALA LUMPUR**  
**Malaysian Institute of Marine Engineering Technology**

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**FINAL EXAMINATION**  
**JULY 2025 SEMESTER SESSION**

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**SUBJECT CODE** : LEB21802

**SUBJECT TITLE** : STATICS AND DYNAMICS

**PROGRAMME NAME** : BACHELOR OF ENGINEERING TECHNOLOGY IN  
(FOR MPU: PROGRAMME LEVEL) ELECTRICAL AND ELECTRONICS (MARINE)

**TIME / DURATION** : 9.00 AM - 12.00 PM  
(3 HOURS)

**DATE** : 22 DECEMBER 2025

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**INSTRUCTIONS TO CANDIDATES**

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1. Please read **CAREFULLY** the instructions given in the question paper.
  2. This question paper has information printed on both sides of the paper.
  3. This question paper consists of FIVE (5) questions.
  4. Answer **FOUR (4)** questions **ONLY**.
  5. Please write your answers on this answer booklet provided.
  6. Answer **ALL** questions in English language **ONLY**.
  7. Formula table has been appended for your reference.
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**THERE ARE 7 PAGES OF QUESTIONS, INCLUDING THIS PAGE.**

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**TOTAL 5 QUESTION: 100 marks**

**INSTRUCTION: Answer 4 questions ONLY.**  
**Please use the answer booklet provided.**

**Question 1**

With reference to the equilibrium of particles:

During a towing operation, a tugboat pulls the vessel via a towing pendant AB attached to a bridle at point B on the bow (Figure 1). The tug exerts a steady pull of 50 kN along the pendant AB. Two bridle legs, BC and BD, run from the junction at B to fairleads at C (forward) and D (aft), respectively. The bridle legs lie in the same vertical plane as the pendant.

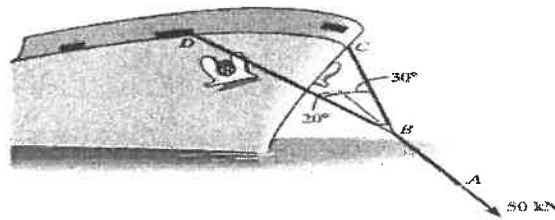


Figure 1

Geometry at B: Leg BC is inclined  $30^\circ$  above the pendant AB. Leg BD is inclined  $20^\circ$  above the pendant AB (to the opposite side of BC as shown). Assume the ship moves forward with constant velocity (quasi-static equilibrium). Neglect line weight, stretch and fairlead friction.

- Draw a clear free-body diagram (FBD) of the junction at B, showing the 50 kN pull in AB and the unknown tensions in BC and BD with correct directions/angles. (4 marks)
- Using equilibrium of forces at B, determine the tensions in bridle legs BC and BD. Show component resolution and all steps. (8 marks)
- Considering the 15% environmental degradation and the stated safety factor, assess whether each bridle leg is safe for continuous towing. State assumptions and show calculations (e.g., allowable working load vs. calculated tension). (4 marks)
- Identify two conflicting requirements a marine engineer must consider when selecting a towing bridle for this application (e.g., weight vs. strength/handling, cost vs. durability/UV resistance, low stretch vs. shock absorption). (4 marks)

## Question 2

With reference to static equilibrium and structural analysis:

On a vessel's deck, a bracket platform is supported at point A by a pin and braced by a tie-rod CD connected to the bracket at C and to the deck at D (see Figure 2). The platform beam AB carries a 4 kN equipment load acting vertically downward at B. Neglect the self-weight of members and friction in the joints.

Additional info:

- The tie-rod CD is made of stainless steel with a rated tensile capacity of 14 kN (ultimate). Marine environmental degradation (corrosion, UV, fatigue) reduces effective strength by up to 20% over service life.
- Minimum required Factor of Safety (FoS)  $\geq 2$  for continuous service on deck.

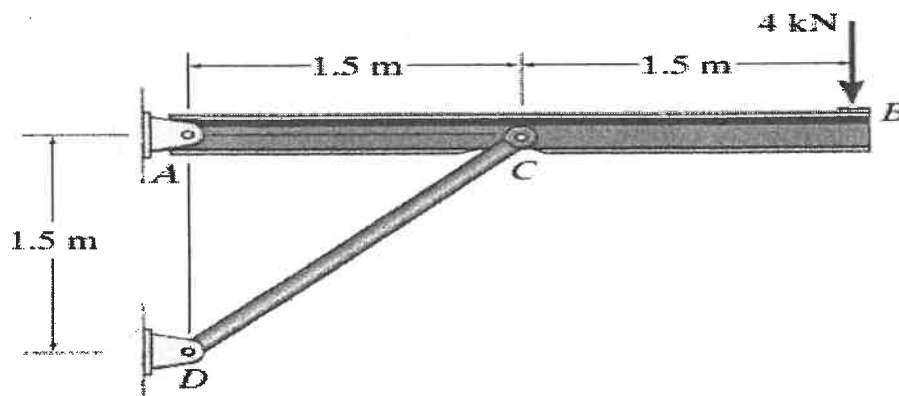


Figure 2

- Draw the free-body diagram (FBD) of beam AB (replace CD with its force acting at C).  
(5 marks)
- Determine the horizontal and vertical reaction components at pin A ( $A_x$ ,  $A_y$ ) and the force in member CD as it acts on the beam at C. Indicate the directions. (10 marks)  
(10 marks)
- Evaluate the safety adequacy of the tie-rod considering marine degradation and the FoS requirement.  
(5 marks)
- Discussing two conflicting requirements, a marine engineer must consider when selecting a tie-rod for this application (e.g., weight vs. strength, cost vs. durability, stiffness vs. ease of installation).  
(5 marks)

**Question 3**

With reference to statics, center of gravity and centroids:

(a) Locate the centroid ( $\bar{x}$ ,  $\bar{y}$ ) of the cross-sectional area in Figure 3.

(10 marks)

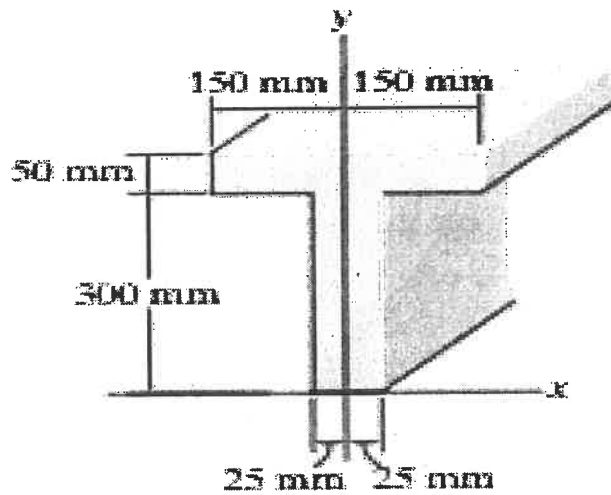


Figure 3

(b) Determine the center of mass ( $\bar{x}$ ,  $\bar{y}$ ,  $\bar{z}$ ) of the homogeneous solid block in Figure 4.

(15 marks)

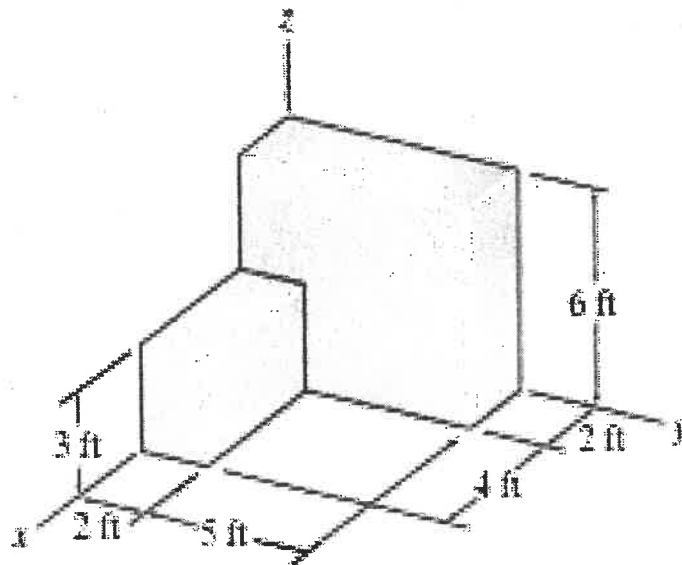


Figure 4

**Question 4**

With reference to dynamics, Force and accelerations:

Determine the horizontal and vertical components of reaction at the supports. Neglect the thickness of the beam. A prismatic beam AB of negligible thickness is supported by a pin at A and a roller at B. The span AB is 10 ft. A further 5 ft overhang extends beyond B to the right end of the beam (total length A to right end = 15 ft). See schematic below.

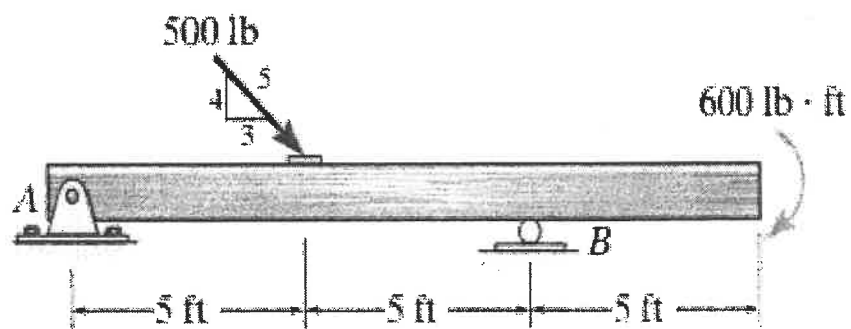


Figure 5

- (a) Draw a clear free-body diagram (FBD) of the entire beam, showing all applied loads and the reaction components at the supports. Label distances. (5 marks)
- (b) Determine the reaction components at the supports:  $A_x$ ,  $A_y$  at the pin and  $B_y$  at the roller. State directions with signs. (15 marks)
- (c) Find the shear force and bending moment at a section just to the left of B (i.e., at  $x=10$  ft measured from A). Indicate positive sign convention used. (5 marks)

**Question 5**

With reference to dynamics, work, energy and momentum:

A tugboat (mass 55 Mg) tows a barge (mass 80 Mg) using a straight towline. Starting from rest, the tug increases speed uniformly to 30 km/h in 35 s. Neglect hydrodynamic resistance and towline mass. The tug's propeller produces a forward thrust  $F$ . The towline exerts a horizontal force  $T$  on the barge (forward) and on the tug (backward).

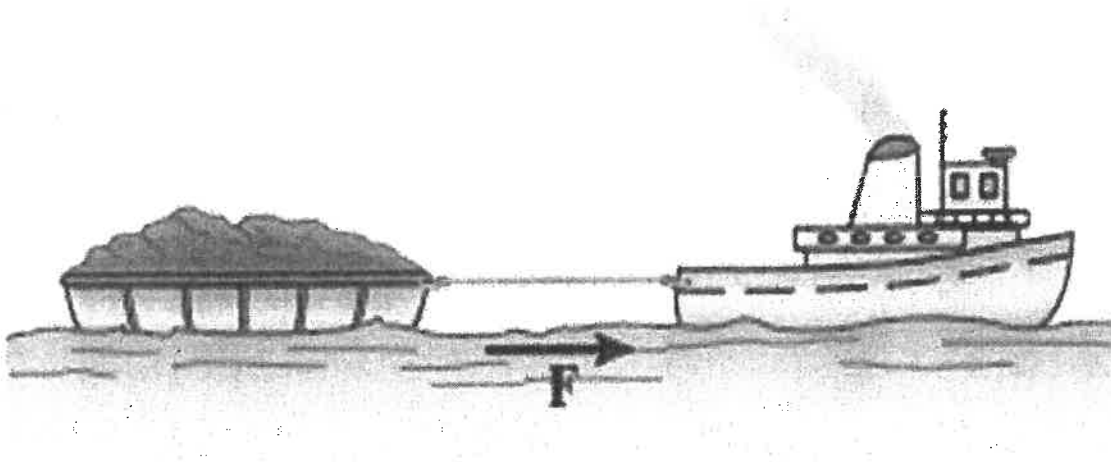
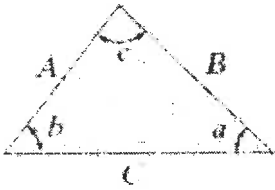


Figure 6

- (a) Determine the acceleration of the system. (4 marks)
- (b) Calculate the towline force on the tug,  $T$  (its magnitude and direction on the tug). (8 marks)
- (c) Determine the propeller thrust  $F$  acting on the tug. (8 marks)
- (d) Identify **TWO (2)** conflicting requirements a marine engineer must consider when specifying towing speed and thrust for harbour operations (e.g., fuel use vs. schedule, wake/wash vs. productivity). (5 marks)

**END OF QUESTION PAPER**

## Appendix 1 Formulae

$F_s = ks$ $v = v_o + a_c t$ $s = s_o + v_o t + (1/2) a_c t^2$ $v^2 = (v_o)^2 + 2a_c(s - s_o)$	$\sum mv_1 = \sum mv_2$ $T_1 + \sum U_{1-2} = T_2$ $e = \frac{(v_B)_2 - (v_A)_2}{(v_A)_1 - (v_B)_1}$
$\bar{x} = \frac{\sum \bar{x}A}{\sum A}$ $\bar{y} = \frac{\sum \bar{y}A}{\sum A}$	$\bar{x} = \frac{\sum \bar{x}V}{\sum V}$ $\bar{y} = \frac{\sum \bar{y}V}{\sum V}$
$a_n = \frac{v^2}{\rho}$ $a_t = v = \frac{dv}{dt}$ $a = \sqrt{a_t^2 + a_n^2}$	$I_x = I_x + A(d_y)^2$ $x_B = x_A + (v_A)_x t$ $y_B = y_A + (v_A)_y t + \frac{1}{2} a_y t^2$
	<div style="border: 1px solid black; padding: 5px;"> <p>Cosine law:</p> <math display="block">C = \sqrt{A^2 + B^2 - 2AB \cos c}</math> <p>Sine law:</p> <math display="block">\frac{A}{\sin a} = \frac{B}{\sin b} = \frac{C}{\sin c}</math> </div>
$F_{Rx} = \sum F_x$ $F_{Ry} = \sum F_y$	$F_R = \sqrt{F_{Rx}^2 + F_{Ry}^2} \quad \text{and} \quad \theta = \tan^{-1} \left  \frac{F_{Ry}}{F_{Rx}} \right $
$FoS = \frac{F_{MAX}}{T}$	