Universiti Tun Hussein Onn Malaysia

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER II
SESSION 2023/2024

COURSE NAME	:	STATICS
COURSE CODE	:	DAM13403
PROGRAMME CODE	:	DAM
EXAMINATION DATE	:	JULY 2024
DURATION	:	3 HOURS
INSTRUCTIONS	:	1. ANSWER **FIVE (5)** QUESTIONS **ONLY** 2. THIS FINAL EXAMINATION IS CONDUCTED VIA ☐ Open book ☒ Closed book 3. STUDENTS ARE **PROHIBITED** TO CONSULT THEIR OWN MATERIAL OR ANY EXTERNAL RESOURCES DURING THE EXAMINATION

THIS QUESTION PAPER CONSISTS OF **SEVEN (7)** PAGES

Q1 In physics, force is a vector quantity that describes the interaction between two objects or systems, resulting in a change in their motion or state of rest. Force is characterized by its magnitude, direction, and point of application.

(a) Describe magnitude and direction in relation to the reaction of forces.

(4 marks)

(b) In **Figure Q1.1,** two forces are shown acting on the eyebolt. Given $\theta = 30°$ and T= 6 kN, use Parallelogram Law and Trigonometry to determine the magnitude of the resultant force acting on the eyebolt and its direction, measured clockwise from the positive x axis.

(6 marks)

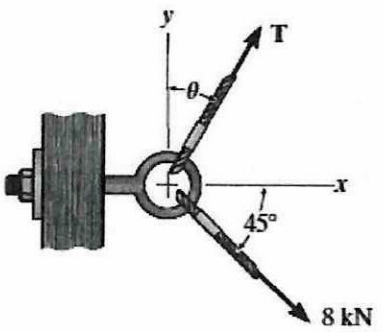


Figure Q1.1

(c) The magnitude and direction of the three forces applied to the eyebolt are shown in **Figure Q1.2**. Replace these forces with a single equivalent force F_R. Show the result on a sketch of the eyebolt.

(10 marks)

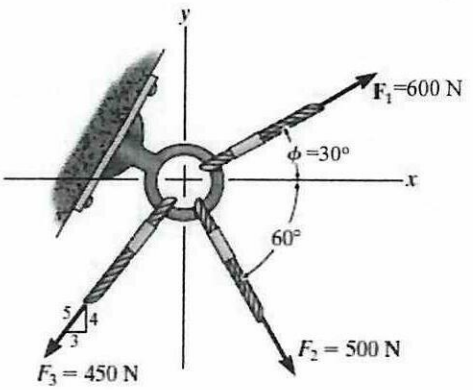


Figure Q1.2

Q2 In statics, the equilibrium of a particle is governed by Newton's first law of motion, which states that an object will remain at rest or in uniform motion in a straight line unless acted upon by a net external force. Therefore, for a particle to be in equilibrium, the vector sum of all the forces acting on it must be zero.

(a) The equilibrium of a particle can be analyzed by drawing a free-body diagram (FBD). Describe the free-body diagram.

(4 marks)

(b) **Figure Q2.1** shows the 50 N bucket is supported at D by a system of 4 wires and a spring BC. Determine the force in each wire and a spring for equilibrium.

(12 marks)

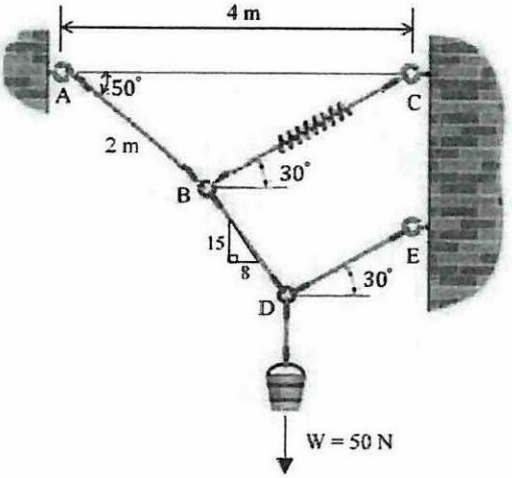


Figure Q2.1

(c) In the context of static equilibrium, the sum of the moments (or torques) acting on an object is indeed zero. This is a fundamental condition for rotational equilibrium. **Figure Q2.2** shows two forces of magnitude P each act on the beam. Determine the angle θ for which the combined moment of the forces about A is zero.

(4 marks)

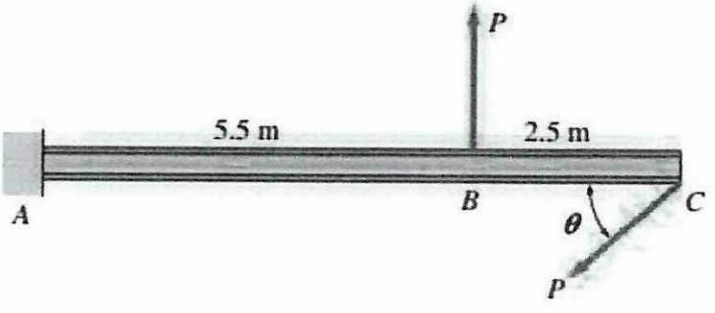


Figure Q2.2

Q3 Distributed and concentrated loads are two common types of loads encountered in engineering and structural analysis.

(a) Explain the differences between distributed and concentrated loads.

(4marks)

(b) The bent beam ABC shown in **Figure Q3.1** is supported by a pin at B and a roller at C. Neglecting the weight of the beam,

(i) draw the Free Body Diagram (FBD).

(2 marks)

(ii) find the magnitudes of the reactions at B and C caused by the uniformly distributed load.

(8 marks)

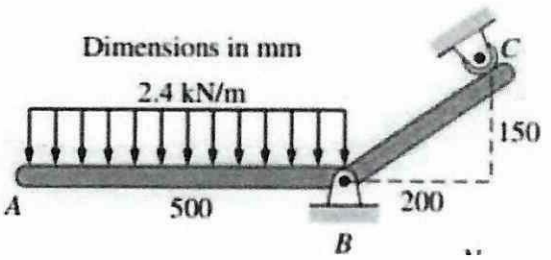


Figure Q3.1

(c) **Figure Q3.2** shows the two couples act on the cantilever beam. Determine the required magnitude of force F, if the resultant couple on the beam is to be zero.

(6 marks)

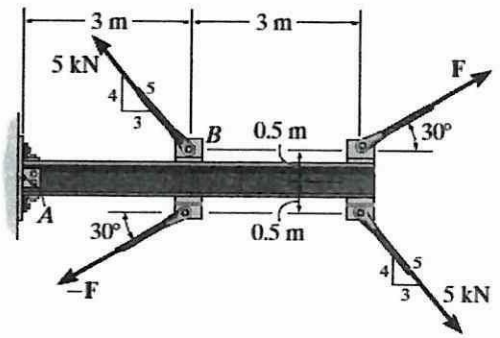


Figure Q3.2

Q4 Static structure analysis is a branch of engineering mechanics that deals with the study of structures under static loading conditions. It involves analyzing how structures behave when subjected to external forces, moments, and constraints without considering the effects of dynamic loads or motion.

(a) In the analysis of truss structures, it is essential to determine the forces in each truss member. This process, known as force analysis, relies on two key assumptions regarding member behaviour. Explain the **two (2)** key assumptions made in truss analysis.

(4 marks)

(b) The trusses frame shown in **Figure Q4.1** is supported by a pin at D and a roller at C.

(i) Draw the Free Body Diagram.

(2 marks)

(ii) Find the magnitudes of the reactions at D and C.

(3 marks)

(iii) Determine the force in each member of the truss, and state if the members are in tension or compression.

(11 marks)

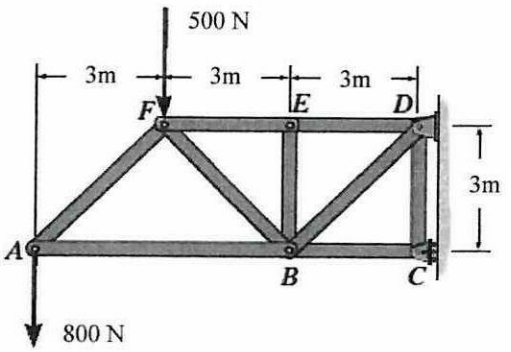


Figure Q4.1

Q5 Centroid and center of gravity are two concepts related to the distribution of mass in a body or object.

(a) What is the difference between the center of gravity and the centroid.

(2 marks)

(b) Briefly explain under what conditions the centroid coincides with the center of gravity.

(3 marks)

(c) Determine the coordinates of the centroid of the area that enclosed by the straight line $x = \frac{2}{3}y$ and the parabola $x^2 = 4y$, where x and y are measured in millimeters. Refer to **Figure Q5.1.**

(7 marks)

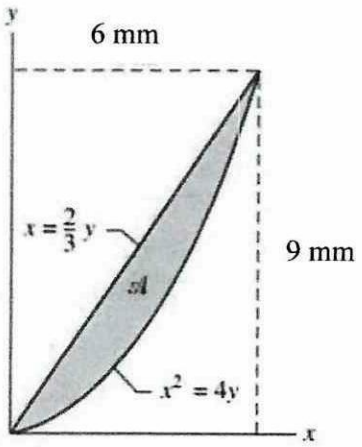
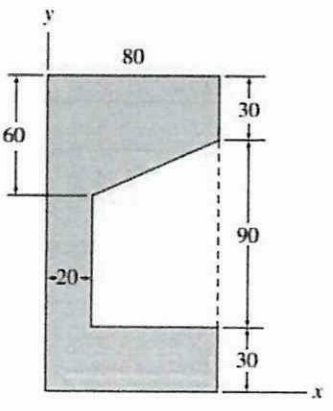


Figure Q5.1

(d) Use the method of composite areas to calculate the centroidal coordinates of the plane regions shown in **Figure Q5.2.**

(8 marks)



Dimensions in mm

Figure Q5.2

Q6 Friction is a fundamental force that opposes the relative motion or tendency of motion between two surfaces in contact. It arises due to the interactions between the microscopic irregularities on the surfaces, which resist the motion of one surface over the other. Friction occurs whenever there is contact between two surfaces, regardless of whether the surfaces are stationary or in motion.

(a) Friction, as a fundamental force in nature, has both advantages and disadvantages depending on the context. Explain five advantages and five disadvantages of friction.

(5 marks)

(b) Block A, weighing 1000 N, rests on top of block B, which weighs 2000 N, as shown in **Figure Q6.1.** Block A is connected to a wall with a horizontal string. If the coefficient of friction between A and B is ¼, and that between B and the floor is 1/3, what force value P is required to start motion if P is applied horizontally.

(7 marks)

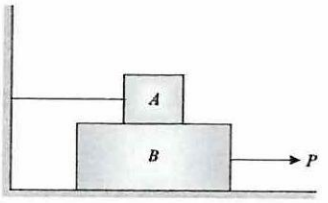


Figure Q6.1

(c) Wedge A is being used to lift a block B, as shown in **Figure Q6.2**. Calculate the force F_{push} required to push wedge A to lift Block B, which weighs 0.2kN.

(8 marks)

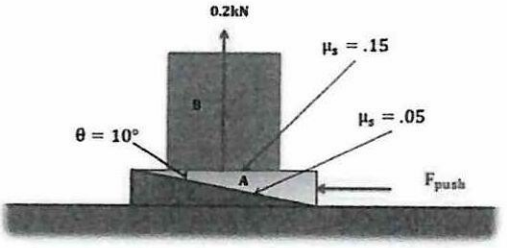


Figure Q6.2

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