Universiti Tun Hussein Onn Malaysia

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER I
SESSION 2019/2020

COURSE NAME	:	ENGINEERING MECHANICS
COURSE CODE	:	BDU 10503
PROGRAMME CODE	:	BDC/ BDM
EXAMINATION DATE	:	DECEMBER 2019/ JANUARY 2020
DURATION	:	3 HOURS
INSTRUCTION	:	ANSWER **FOUR (4)** QUESTIONS ONLY 1. ANSWER **TWO (2)** QUESTIONS FROM **PART A** 2. ANSWER **TWO (2)** QUESTIONS FROM **PART B**

THIS PAPER CONSISTS OF **ELEVEN (11)** PAGES

PART A

Q1 (a) Given a bracket as shown in the **Figure Q1(a)**. Two forces, F_A and F_B are acting through point O. If force F_A = 700 N, F_B = 600 N and $\theta = 20°$, determine the magnitude and angle measured clockwise from the positive x-axis of the resultant force acting on the bracket.

(7 marks)

(b) **Figure Q1(b)** shows the forces acting on the plate. If the magnitude for the resultant force acting on the plate is required to be 6 kN and its direction measured clockwise from the positive x axis is $\theta = 30°$, determine the magnitude of F_2 and its direction angle, ϕ.

(9 marks)

(c) A box hanged out by three ropes as depicted in **Figure Q1(c)**. Determine the magnitude and direction θ of force F_1 so that the resultant force is directed vertically upward and has a magnitude of 800 N.

(9 marks)

Q2 (a) The ball D in **Figure Q2(a)** has a mass of 20 kg. If a force of F = 100 N is applied horizontally to the ring at A, compute dimension, d so that the force in cable AC is zero.

(6 marks)

(b) **Figure Q2(b)** shows a chandelier with mass M is supported by four wires, AB, BC, BD and CD.

(i) Determine the tension developed in each four wires as the function of M.

(7 marks)

(ii) The tension developed in each of the four wires in is not allowed to exceed 600 N, determine the maximum mass of the chandelier that can be supported.

(3 marks)

(c) A cable connection system with a spring is shown in **Figure Q2(c)**. The spring has a stiffness of k = 800 N/m and an unstretched length of 200 mm. Determine force in cables BC and BD when the spring is held in the position is shown in the figure.

(9 marks)

Q3 (a) A simple truss shown in **Figure Q3(a)** is subjected to load $P_1 = 240$ N and $P_2 = 100$ N at pin D.

(i) Which members in the truss shown in the figure that can be considered as zero-force members? Explain the reasons.

(4 marks)

(ii) Calculate the force in all the truss members and state if the members are in tension or compression.

(6 marks)

(b) A truss is subjected to a load P at the pin A as shown in **Figure Q3(b)**.

(i) Calculate the force in each member of the truss as the function of P and state if the members are in tension or compression.

(11 marks)

(ii) Determine the maximum force P that can be applied to the truss so that none of the members are subjected to a force exceeding either 2.5 kN in tension or 2 kN in compression.

(4 marks)

PART B

Q4 (a) Describe briefly the following terms.

(i) Kinematic.

(ii) Kinetic.

(4 marks)

(b) A light aircraft is on climbing to certain altitude after takeoff from an airport with its position vector as:

$$\boldsymbol{r} = (3t^2 + 6t)\boldsymbol{i} + (3t - t^2)\boldsymbol{j} + 3t^2\boldsymbol{k} \quad [\text{m}]$$

where t is in seconds and $(\boldsymbol{i}, \boldsymbol{j}, \boldsymbol{k})$ are unit vectors along xyz coordinate axes. $\boldsymbol{r}$ is measured from the origin of the coordinate system, with the z-axis directed vertically upward. Determine:

(i) the x, y, z projections of the velocity, $\boldsymbol{v}$ and the acceleration, $\boldsymbol{a}$ of the light aircraft at $t = 3$ seconds.

(10 marks)

(ii) the speed v of the light aircraft at $t = 5$ seconds.

(5 marks)

(iii) the distance traveled by the light aircraft in the interval from $t = 0$ to $t = 3$ seconds.

(6 marks)

Q5 In **Figure Q5(a),** the weights of A and B are 200 kg and 400 kg, respectively. The weight and friction of pulleys and cables are negligible. The coefficient of frictions between A, B and the planes is $\mu = 0.2$.

(a) Draw the free body diagram of the system.

(5 marks)

(b) If A and B are released from rest, explain whether the A and B will slide or not. If the system slides, in which direction?

(10 marks)

(c) Determine the acceleration of the sliding.

(3 marks)

(d) Determine the velocity of the system 5 seconds after it started to slide.

(2 marks)

(e) If B is being replaced by an electrical motor, determine the power needed by the motor to maintain a constant velocity (as obtained in Q5(d)) of A.

(5 marks)

Q6 (a) Describe briefly the following terms.
(i) Impulse.
(ii) Conservation of momentum.
(iii) Conservation of energy.

(6 marks)

(b) A 0.5 kg drone shown in **Figure Q6(b)** is taking off from ground vertically by exerting a constant vertical force 6 N from all its propellers to the ground. After 5 s, determine:
(i) its velocity.
(ii) how high it goes in 5 s.

(9 marks)

(c) The 10 kg block shown in **Figure Q6(c)** rests on the smooth incline. If the spring is originally stretched 0.5 m. Determine the total work done by all the forces acting on the block when a horizontal force P = 400 N pushes the block up the plane s = 2 m.

(10 marks)

- END OF QUESTIONS –

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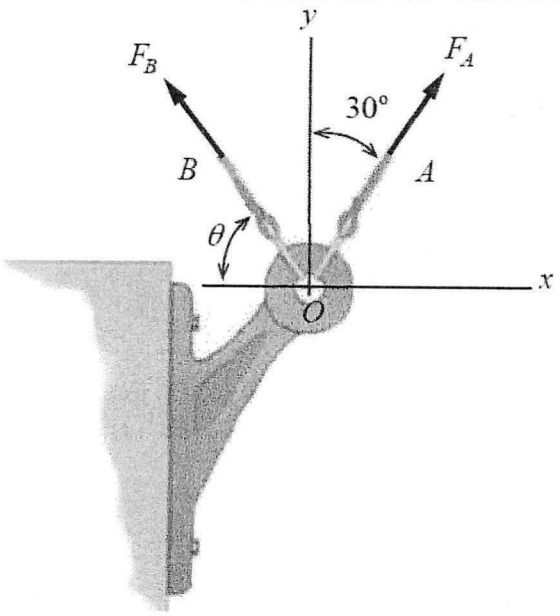

Figure Q1(a)

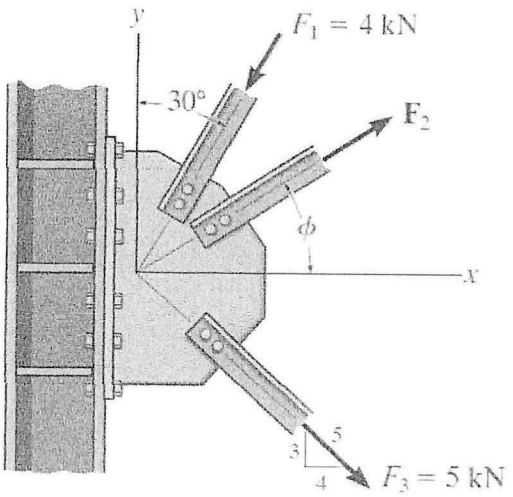

Figure Q1(b)

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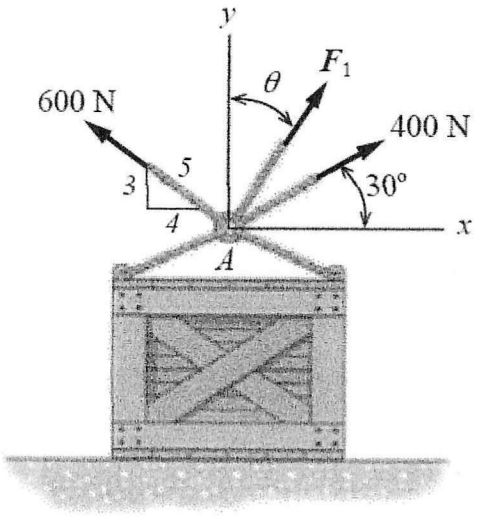

Figure Q1(c)

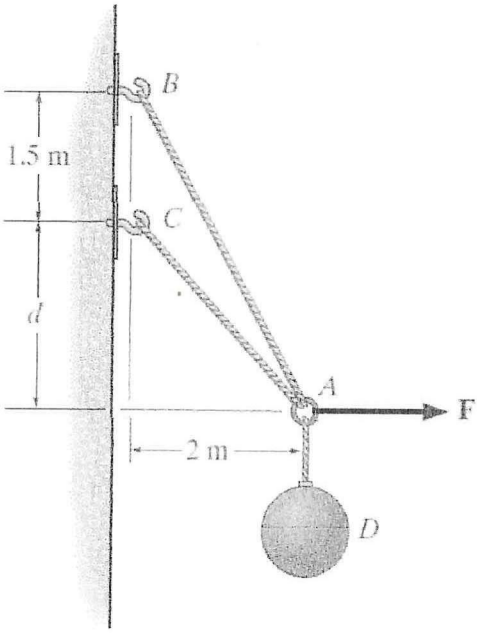

Figure Q2(a)

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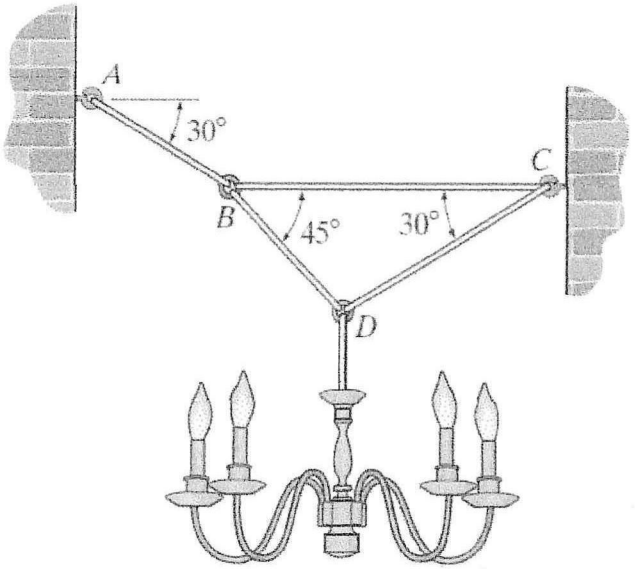

Figure Q2(b)

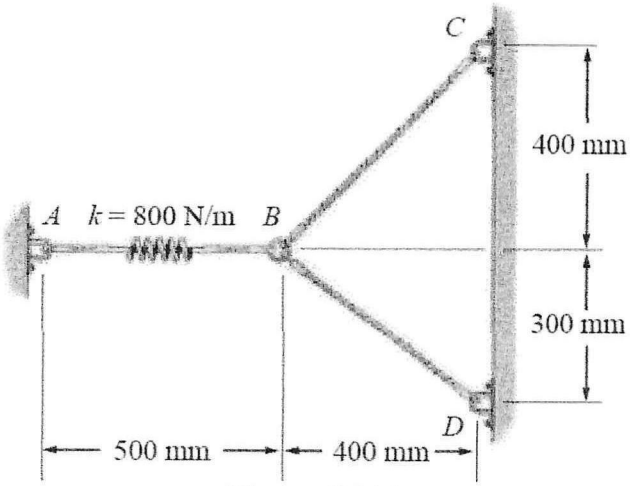

Figure Q2(c)

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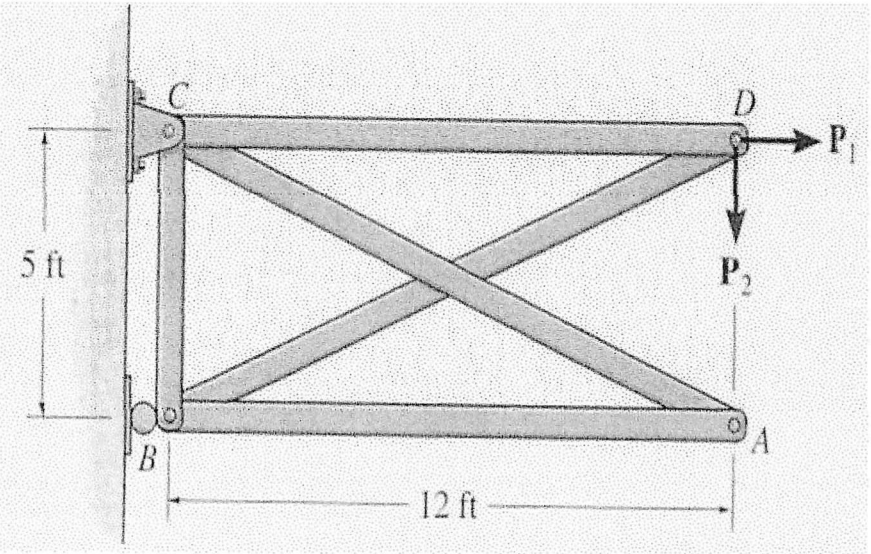

Figure Q3(a)

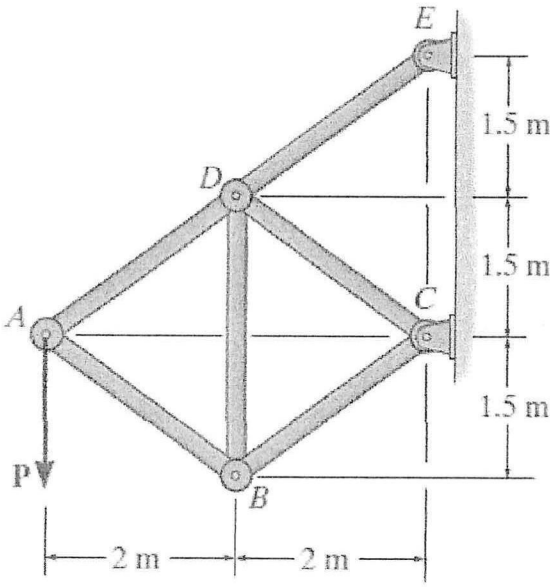

Figure Q3(b)

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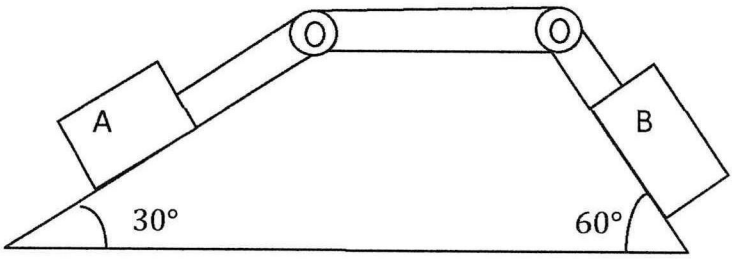

Figure Q5(a)

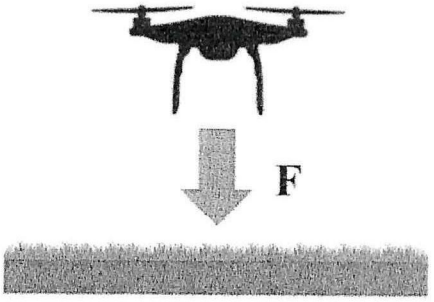

Figure Q6(a)

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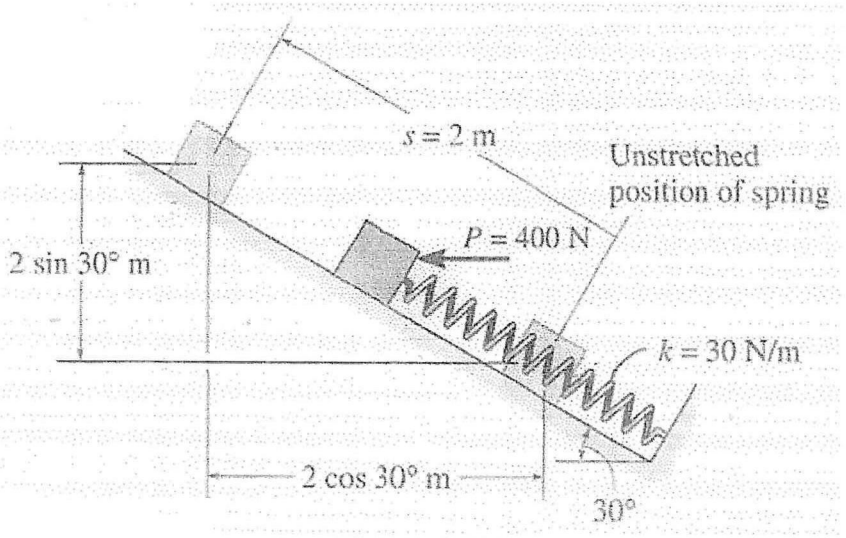

Figure Q6(b)