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UNIVERSITI TUN HUSSEIN ONN MALAYSIA

**FINAL EXAMINATION
(ONLINE)
SEMESTER I
SESSION 2020/2021**

COURSE NAME : ENGINEERING MECHANICS
COURSE CODE : BDU 10503
PROGRAMME CODE : BDC / BDM
EXAMINATION DATE : JANUARY/FEBRUARY 2021
DURATION : 3 HOURS
INSTRUCTION : ANSWER ONLY FOUR (4) QUESTIONS
1. ANSWER TWO (2) QUESTIONS FROM SECTION A
2. ANSWER TWO (2) QUESTIONS FROM SECTION B

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THIS QUESTION PAPER CONSISTS OF SEVEN (7) PAGES

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SECTION A: STATICS

- Q1** (a) By using an appropriate example, explain the difference between ‘mass’ and ‘weight’.
(3 marks)
- (b) The rod assembly shown in **Figure Q1(b)** is subjected to F_1 applied at point D. Given $F_1 = 840$ N, point A is a ball and socket joint, point B is a smooth journal bearing and point C is the roller support. Examine the assembly using scalar analysis and then:
(i) sketch the free-body diagram
(ii) determine the components of reaction exerted on the rod assembly
(14 marks)
- (c) **Figure Q1(c)** shows that the aircraft measures the distance between its current position to airport A and airport B. The coordinates of airport A and airport B have been established from the measurement and given as A (4, 0, 3.5) km and B(7, 4, -3) km. Examine the figure and determine:
(i) the position vector of airports A and B
(ii) the angle θ between the lines of sight CA and CB.
(8 marks)
- Q2** In order to keep a hot air balloon from flying away during a tethered ride, the balloon is tied to the ground with three strong ropes as shown in **Figure Q2**. The tension in cable AC is found to be 500 N. A vertical force **Q** is exerted by the balloon at A. Examine the figure and determine:
(a) the unit vector for ropes AB, AC and AD
(12 marks)
(b) the magnitude of **Q**
(13 marks)
- Q3** A roof truss shown in **Figure Q3** is subjected to three loads. Given $P_1 = 10$ kN, $P_2 = 20$ kN and $P_3 = 10$ kN. Examine the truss and then:
(a) sketch the free-body diagram of each joint and include appropriate labels
(5 marks)
(b) determine the support reactions
(5 marks)
(c) determine the force in each member of the truss and evaluate whether it acts in tension or compression
(15 marks)

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SECTION B: DYNAMICS

- Q4** (a) Describe the following terms.
- (i) Kinematic
 - (ii) Kinetic

(4 marks)

- (b) Falcon 9 rocket is launched from Kennedy Space Center as shown in **Figure Q4(b)**. The acceleration of a rocket traveling upward is given by $a = (6 + 0.02s) \text{ ms}^{-2}$ where altitude, s is in meter. If the velocity, $v = 0$ and altitude, $s = 0$ when launching time, $t = 0$, determine the time needed for the rocket to reach an altitude of $s = 100 \text{ m}$.

(10 marks)

- (c) Two airplanes are heading to takeoff point as shown in **Figure Q4(c)**. Airplane A has a speed of 20 km/h, which is being increased at the rate of 300 km/h² as it reaches point X. At the same instant, airplane B is decelerating at 250 km/h² while traveling forward at 100 km/h. Determine the velocity and acceleration of airplane A with respect to airplane B.

(11 marks)

- Q5** (a) Define the following terms:
- (i) Power
 - (ii) Work
 - (iii) Energy

(6 marks)

- (b) The Jet A-1 tank shown in **Figure Q5(b)** is filled with 3 m³ of water for cleaning purpose. The velocity of the water jet discharging from the orifice can be determined from $v_A = \sqrt{2gh}$, where h is the depth of the orifice from the free water surface. Determine:

- (i) The time for a particle of water leaving the orifice to reach point B
- (ii) The horizontal distance x where it hits the surface

(7 marks)

- (c) The Boeing 737 engine assembly has a mass of 8 Mg and is hoisted using the boom and pulley system shown in **Figure Q5(c)**. If the winch at B draws in the cable with an acceleration of 2 ms⁻², and the boom has a mass of 2 Mg (mass center at G). Determine the compressive force in the hydraulic cylinder needed to support the boom. Provide the free body diagrams of the boom, pulley system and engine

(12 marks)

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- Q6** (a) Describe the following terms.
- (i) Conservation of energy
 - (ii) Conservation of momentum
 - (iii) Impulse
- (6 marks)
- (b) The Mikoyan MiG-29 jet has a mass of 7 Mg is traveling at a speed of 720 km/h as shown in **Figure Q6(b)**. At this instant, fuel burns at the rate of 0.8 kg/s, the engine takes in air at 200 kg/s, and the exhaust gas (air and fuel) has a relative speed of 12 000 m/s. The drag resistance of the air is $F_D = (55 v^2)$, where the speed is measured in m/s. Provide a free body diagram of the jet and determine the acceleration of the plane at this instant.
- (9 marks)
- (c) The 10 kg Learjet 29 engine block model shown in **Figure Q6(c)** rests on the smooth incline. If the spring is originally 0.5m stretched. Determine the total work done by all 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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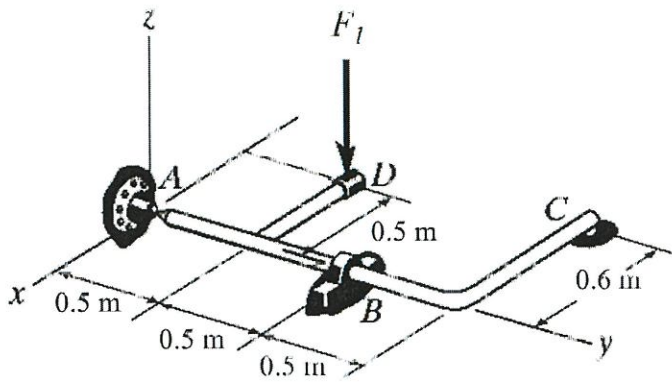


Figure Q1(b)

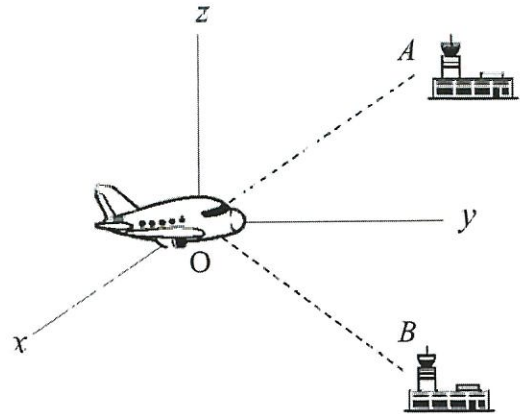


Figure Q1(c)

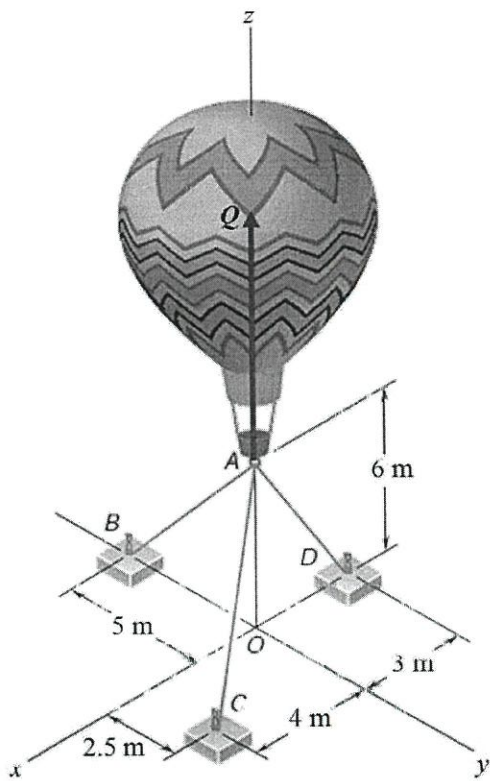


Figure Q2

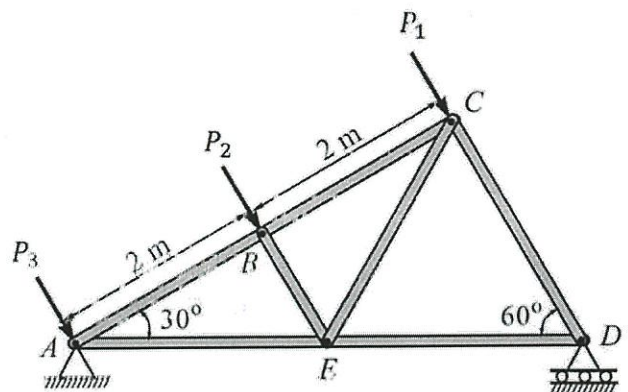


Figure Q3

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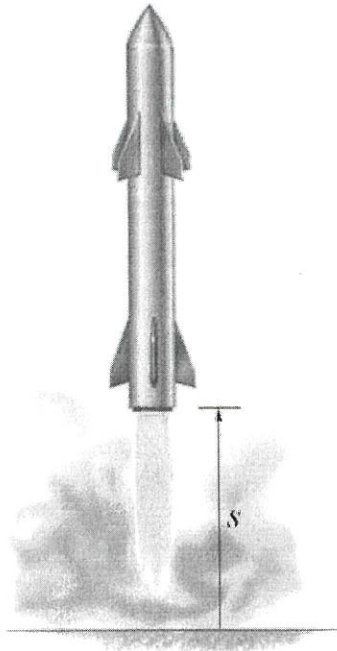


Figure Q4(b)

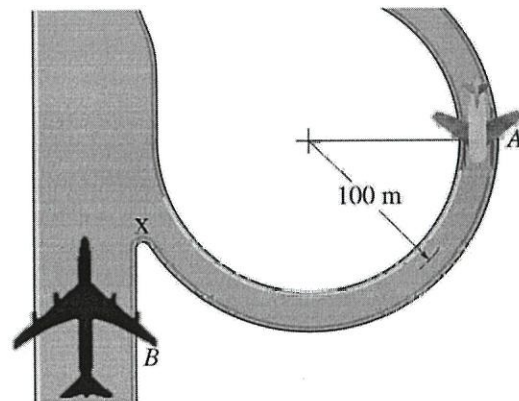


Figure Q4(c)

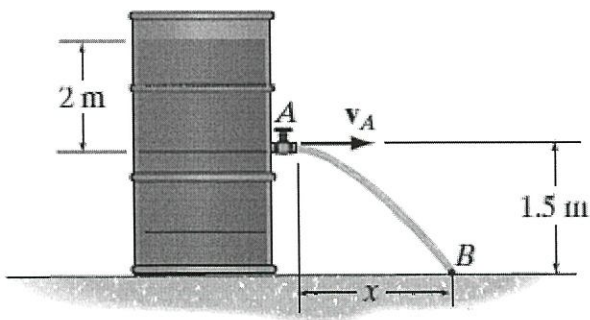


Figure Q5(b)

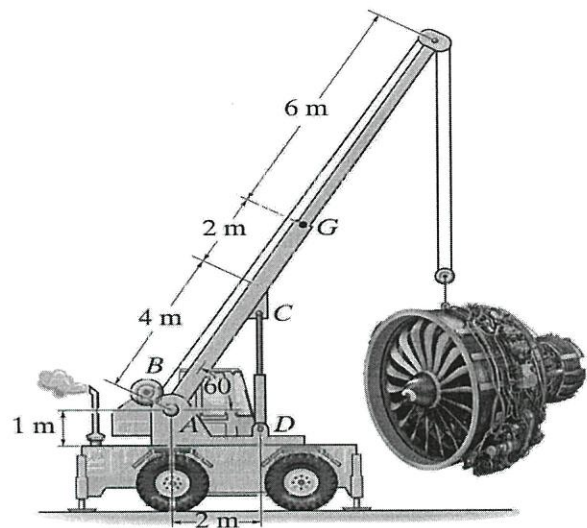


Figure Q5(c)

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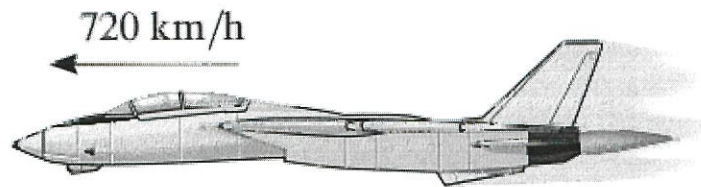


Figure Q6(b)

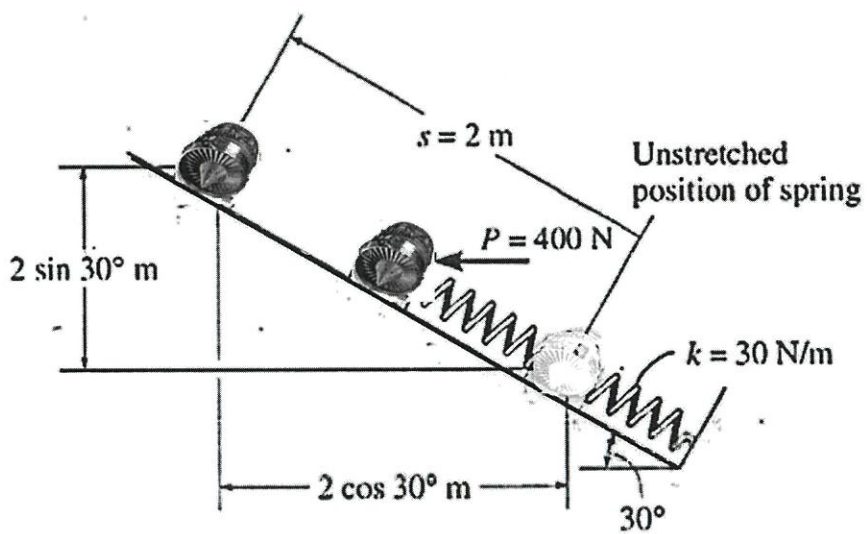


Figure Q6(c)

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