UNIVERSITI SAINS MALAYSIA

Second Semester Examination
2022/2023 Academic Session

July/August 2023

EEM222 – Dynamics and Mechanisms

Duration : 3 hours

Please check that this examination paper consists of **NINE (9)** pages of printed material including appendix before you begin the examination.

Instructions : This paper consists of **FOUR (4)** questions. Answer **ALL** questions.

1. a) The 75 kg man (as in Figure 1a) pushes on the 150 kg crate with a horizontal force *F*. If the coefficients of static and kinetic friction between the crate and surface area are μ_s = 0.3 and μ_k = 0.2, and the coefficient of static friction between man's shoes and the surface is μ_s = 0.8, show that the man can move the crate. What is the greatest acceleration the man can give the crate?

(30 marks)

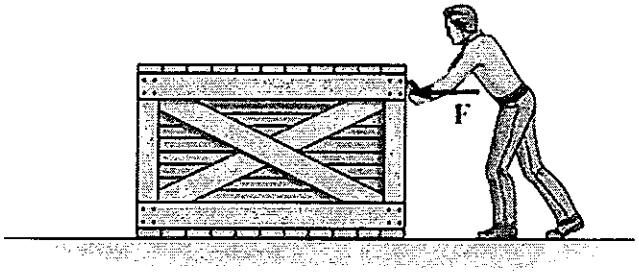

Figure 1a

b) If the force exerted on cable *AB* by the motor is $F = (100\ t^{3/2})$ N (as in Figure1b), where *t* is in seconds, determine the 50 kg crate's velocity when *t* = 5 s. The coefficient of static and kinetic friction between the crate and the ground are μ_s = 0.4 and μ_k = 0.3, respectively. Initially the crate is at rest.

(40 marks)

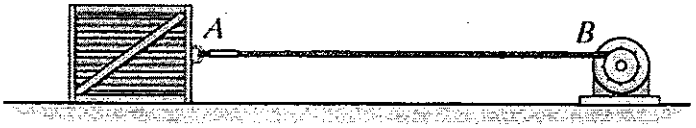

Figure 1b

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c) A car (as in Figure 1c) of mass m is travelling at a slow velocity v_0. If it is subjected to the drag resistance of the wind, which is proportional to its velocity, i.e., $F_D = kv$, determine the distance and the time the car will travel before its velocity become 0.5 v_0. Assume no other frictional forces act on the car.

(30 marks)

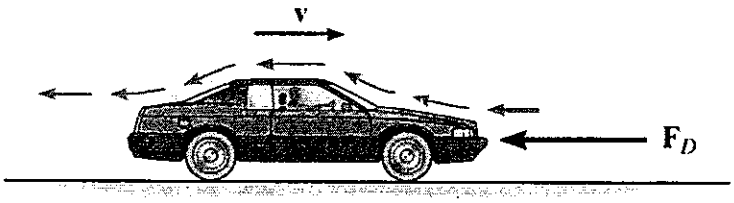

Figure 1c

2. a) If the force exerted by the motor M on the cable is 280 N (as in Figure 2a), determine the speed of the 110 kg crate when it is raised to s = 2 m. The crate is at rest when s = 0.

(30 marks)

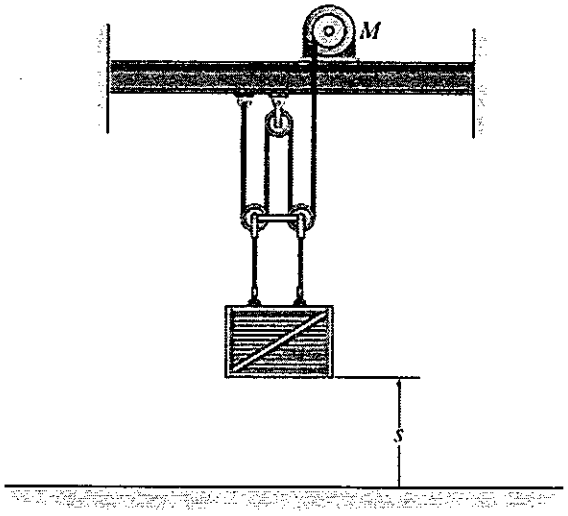

Figure 2a

b) The sports car (as in Figure 2b) has a mass of 2.3 Mg, and accelerates at 9 m/s^2 starting from rest. If the drag resistance on the car due to the wind is F_D = (10v) N where v is the velocity in m/s, determine the power supplied to the engine when t = 3 s. The engine has a running efficiency of = 0.66.

(40 marks)

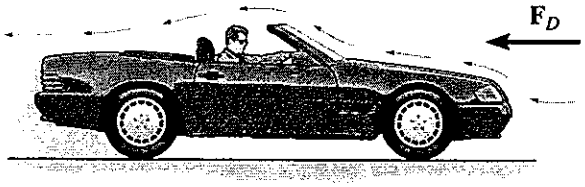

Figure 2b

c) The spring in the toy gun (as in Figure 2c) has an unstretched length of 100 mm. It is compressed and locked in the position shown. When the trigger is pulled, the spring stretches 15.5 mm, and the 30 g ball moves along the barrel. Determine the speed of the ball when it leaves the gun. Neglect friction.

(30 marks)

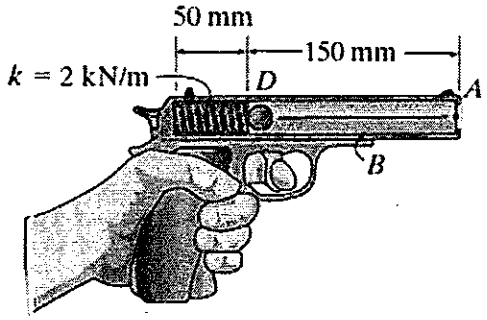

Figure 2c

3. a) Figure 3a and 3b show two types of lifting mechanisms. Draw the kinematic diagram and determine the mobility for both mechanisms.

(30 marks)

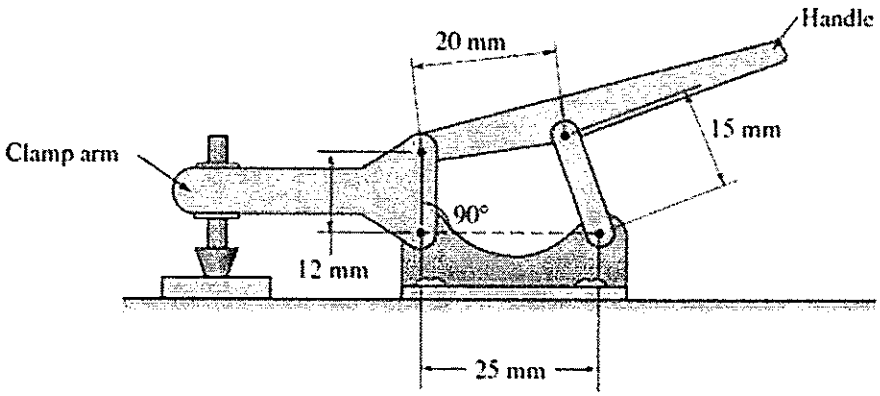

Figure 3a.

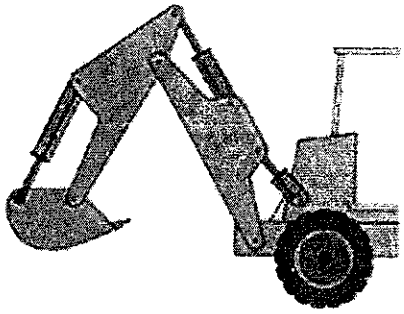

Figure 3b

b) Graphically position the links for the small aircraft nose wheel actuation mechanism shown in Figure 3c. Then reposition the links as the 12 cm crank is rotated 60° clockwise from the orientation shown. Determine the resulting angular displacement of the wheel assembly.

(40 marks)

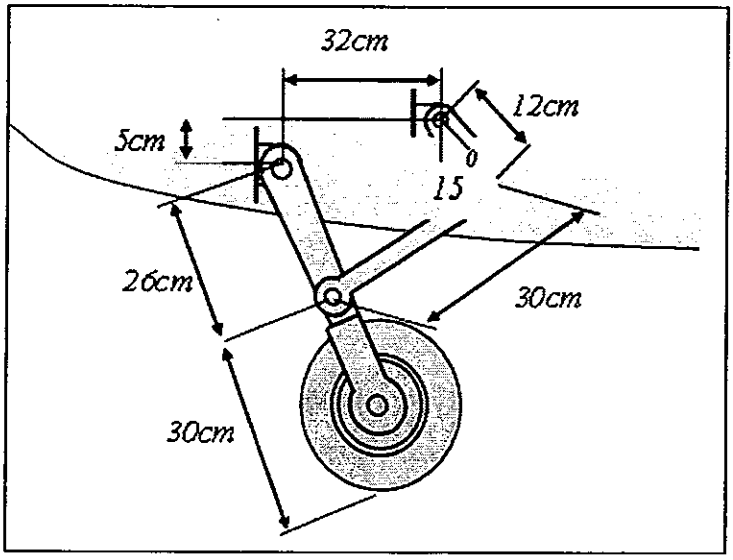

Figure 3c

c) A quick-return mechanism is to be designed, where the outward stroke must consume 1.2 s and the return stroke 0.8 s. Determine the time ratio Q , imbalance angle β, cycle time Δt_{cycle} , and speed ω_{crank} at which the mechanism should be driven.

(30 marks)

4. a) Figure 4a shows a cam with an offset roller follower. Plot a displacement diagram and determine the required speed of the cam when the follower motion sequence is as follow: Rise 2 cm in 1.2 s, Dwell for 0.3 s, Fall 1 cm in 0.9 s, Dwell 0.6 s, Fall 1 cm in 0.9 s.

(40 marks)

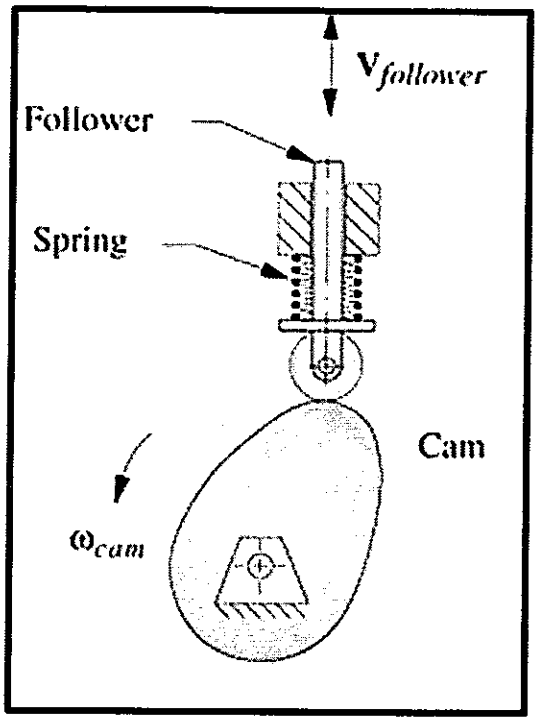

Figure 4a

b) A gear train is shown in Figure 4b. The gears have the following properties: N_2 = 18 teeth; N_3 = 72 teeth and P_d = 10; N_4 = 16 teeth and P_d = 8; and N_5 = 48 teeth. Determine the velocity of gear 5 as gear 2 drives at 1200 rpm clockwise. Also determine the center distance between gears 2 and 5.

(30 marks)

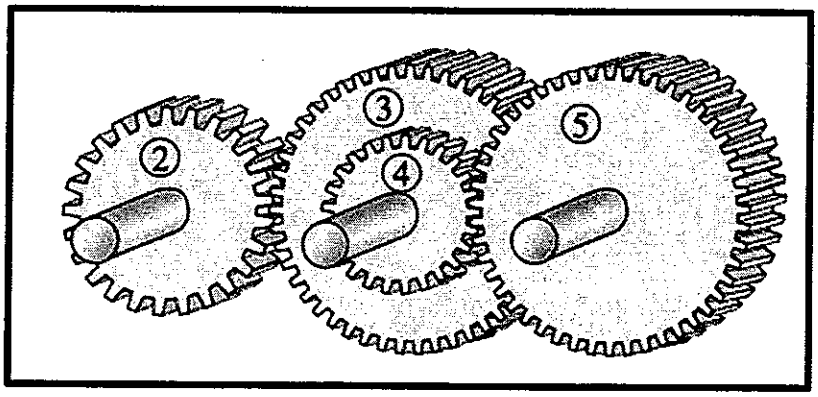

Figure 4b

c) A gear train is shown in Figure 4c. The gears have the following properties: N_1 = 18 teeth and P_d = 20; d_2 = 5.5 cm.; and d_3 = 2.5 cm. and P_d = 8. Determine the required speed of gear 1 for the rack 4 to move at a rate of 50 cm/min.

(30 marks)

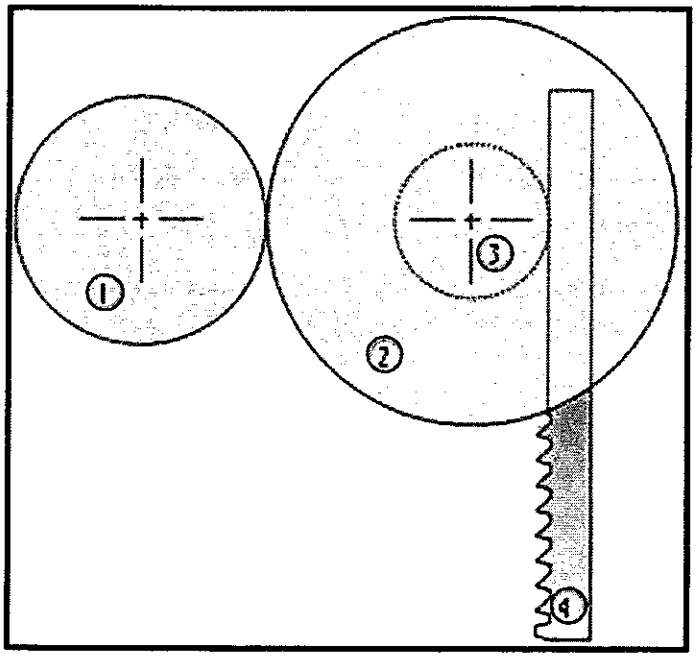

Figure 4c

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APPENDIX

Question	Course Outcome (CO)	Programme Outcome (PO)
1	1	PO2
2	2	PO2
3	3	PO3
4	3	PO3