Universiti Tun Hussein Onn Malaysia

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER II
SESSION 2021/2022

COURSE NAME	:	MECHANICS OF MACHINES
COURSE CODE	:	BNJ 20303
PROGRAMME CODE	:	BNG/BNL/BNM
EXAMINATION DATE	:	JULY 2022
DURATION	:	3 HOURS
INSTRUCTION	:	1. ANSWER **ALL** QUESTIONS 2.THIS FINAL EXAMINATION IS CONDUCTED VIA **CLOSED BOOK** 3.STUDENTS ARE **PROHIBITED** TO CONSULT THEIR OWN MATERIAL OR ANY EXTERNAL RESOURCES DURING THE EXAMINATION CONDUCTED VIA CLOSED BOOK

THIS QUESTION PAPER CONSISTS OF **EIGHT (8)** PAGES

Q1 (a) **Figure Q1(a)** shows a system that vibrates in single degree of freedom mode. The body ABD is attached at point B with two masses m_1, 8 kg and m_2, 4 kg, attached at point A and D, respectively. The body is linked by means of spring that is connected at point A and C. The stiffness coefficient of spring, k is 200 N/m. The body is displaced and vibrates within a small angle.

(i) Demonstrate the free body diagram of the system.

(1 mark)

(ii) Find the natural frequency of system in rad/s if the given frequency is 0.71 Hz.

(1 mark)

(iii) Using the information in **Q1(a)(ii),** identify the distance L which was measured from point C to D using Energy Method.

(8 marks)

(b) **Figure Q1(b)** shows 4 kg of ABC bar having a moment of inertia ($(I = ml^2)$ with 75 mm centrifugal radius measured at point B. Rod GDF has 1.2 kg mass ($I = \frac{ml^2}{3}$) which also carries 1 kg mass at the end of the rod. ECD has 1 kg mass and carries 1 kg mass at point E. The ECD only moving in vertical direction. Two springs K_1 and K_2 are attached at A and C point with the stiffness coefficient is 400 N/m and 1 kN/m, respectively. Find the natural frequency of the system in rad/s, using Equivalence method.

(10 marks)

Q2 (a) **Figure Q2(a)** shows a shaft carries four masses A, B, C and D of magnitude 200 kg, 300 kg, 400 kg and 200 kg respectively and revolving at radii 80 mm, 70 mm, 60 mm and 80 mm in planes measured from A at 300 mm, 400 mm and 700 mm. The angles between the cranks measured anticlockwise are A to B 45°, B to C 70° and C to D 120°, respectively. The balancing masses are to be placed in planes X and Y. The distance between the planes A and X is 100 mm, between X and Y is 400 mm and between Y and D is 200 mm. If the balancing masses revolve at a radius of 100 mm.

(i) Tabulate the data balancing for this system.

(4 marks)

(ii) Determine the magnitudes and angular positions for balance system of moment polygon using the Vector Diagram method on the graph paper given. Use scale, 1 cm = 1 unit.

(4 marks)

(iii) Determine the magnitudes and angular positions for balance system of force polygon using the Vector Diagram method on the graph paper given. Use scale, 1 cm = 2 unit.

(4 marks)

(b) **Figure Q2(b)** shows four crank engine has the two outer cranks set at 120° to each other, and their reciprocating masses are each 400 kg, respectively. The distance between the planes of rotation of adjacent cranks are 450 mm, 750 mm and 600 mm, respectively.

(i) Tabulate the data balancing for this system.

(2 marks)

(ii) If the engine is to be in complete primary balance, determine the reciprocating mass and the relative angular position for each of the inner cranks. Use scale, 1 cm = 20 unit.

(6 marks)

Q3 (a) The three flat blocks are positioned on the 30° incline as shown in **Figure Q3(a)**, and a force P parallel to the incline is applied to the middle block. The upper block is prevented from moving by a wire which attaches it to the fixed support. The coefficient of static friction for each of the three pairs of mating surfaces is shown. Determine the maximum value which P may have before any slipping takes place.

(13 marks)

(b) A vertical screw with single start square threads 50 mm mean diameter and 12.5 mm pitch is raised against a load of 10 kN by means of a hand wheel, the boss of which is threaded to act as a nut. The axial load is taken up by a thrust collar that supports the wheel boss and has a mean diameter of 60 mm. If the coefficient of friction is 0.15 for the screw and 0.18 for the collar and the tangential force applied by each hand to the wheel is 100 N, determine the suitable diameter of the hand wheel.

(7 marks)

Q4 (a) A pinion gear with 32 teeth and a module of 6 mm has a rotational speed of 1500 rpm and drives a gear at 880 rpm. Determine:

(i) The number of teeth on the gear.

(2 marks)

(ii) The theoretical centre distance.

(2 marks)

(b) **Figure Q4(b)** shows a motor used to accelerate a hoist through two sets of gear reducing system. The moment of inertia for the motor shaft is 7 kgm^2, middle shaft is 50 kgm^2 and hoist shaft is 400 kgm^2. The gear ratio for gear set 1 and 2 is 1/3.5 while for gear set 3 and 4 is 1/ 4.5. Gear efficiency for both gear set is 95%. By neglecting the friction effect, determine the total torque required by the motor to accelerate the load of 6 tones at acceleration of 0.4 m/s^2 upward.

(16 marks)

Q5 **Figure Q5** shows a flat type of pulley with diameter of 200 mm rotating at speed of 1750 rpm drives another pulley with diameter of 800 mm using open belt type arrangement. The distance between the shafts centre is 1 metre and the mass of belt material is 0.5 kg/m. The coefficient of friction between the belt and pulley's contact surface is 0.3. When in operation, the belt tension at the slack side is 300 N.

(i) State **THREE (3)** advantageous and **THREE (3)** disadvantageous of belt drive system over gear drive system.

(6 marks)

(ii) For an open belt drive system, show that

$$\theta = (180^{o} - 2\alpha)\frac{\pi}{180} \text{ rad}$$

(4 marks)

(iii) If the belt maximum permissible tension is 350 N, discuss what will happen to the belt.

(10 marks)

-END OF QUESTIONS-

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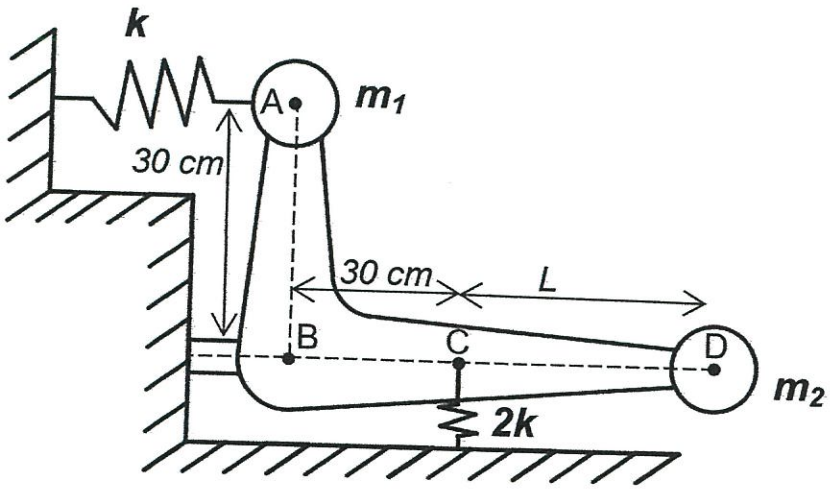

Figure Q1(a)

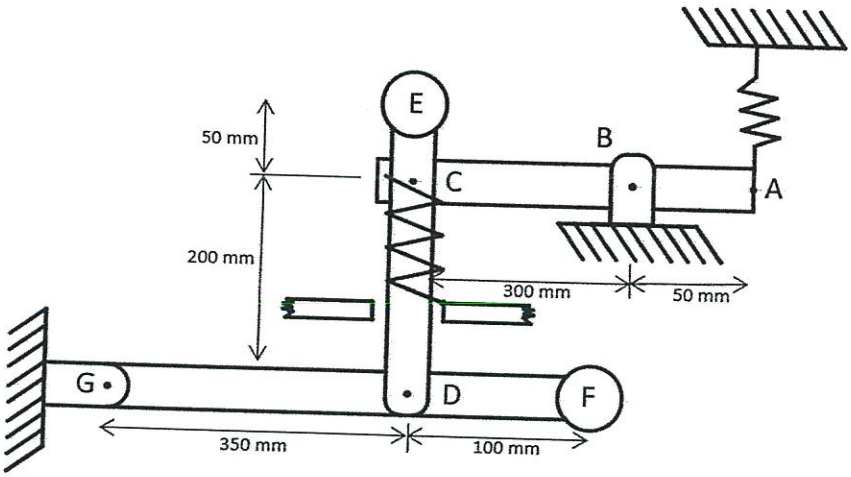

Figure Q1(b)

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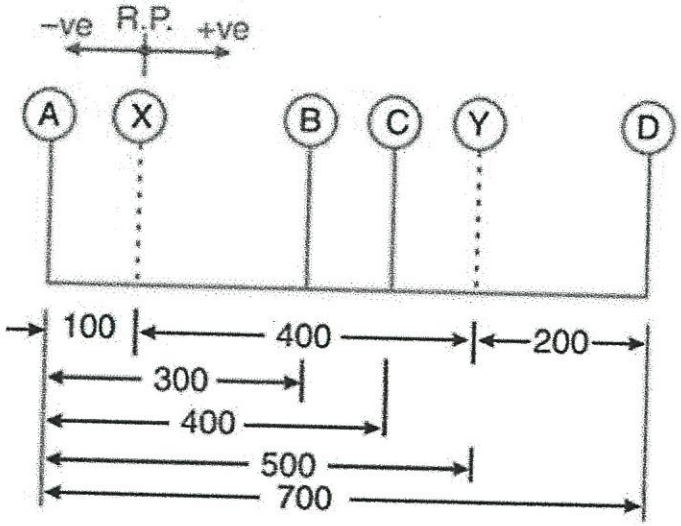

Figure Q2(a) : Position of Planes

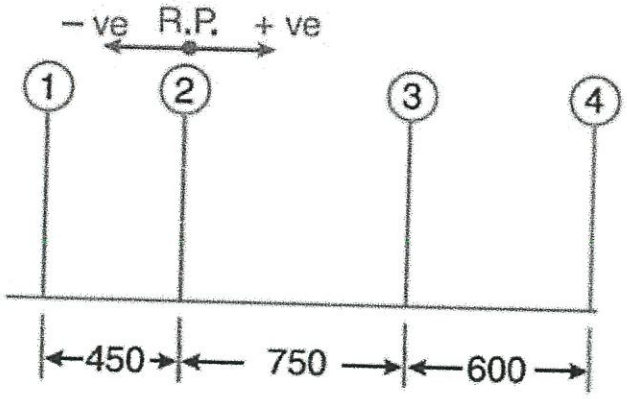

Figure Q2(b): Position of Planes

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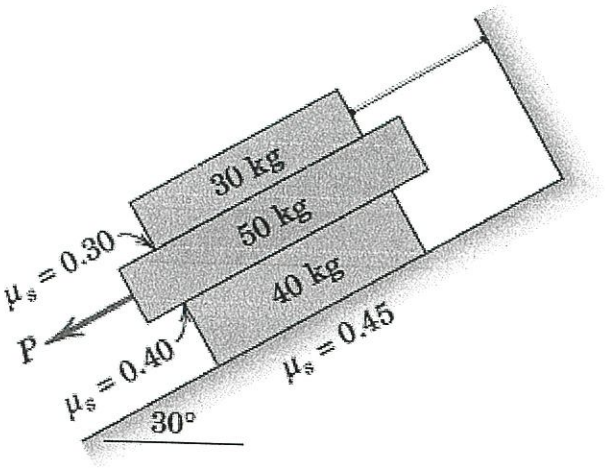

Figure Q3(a)

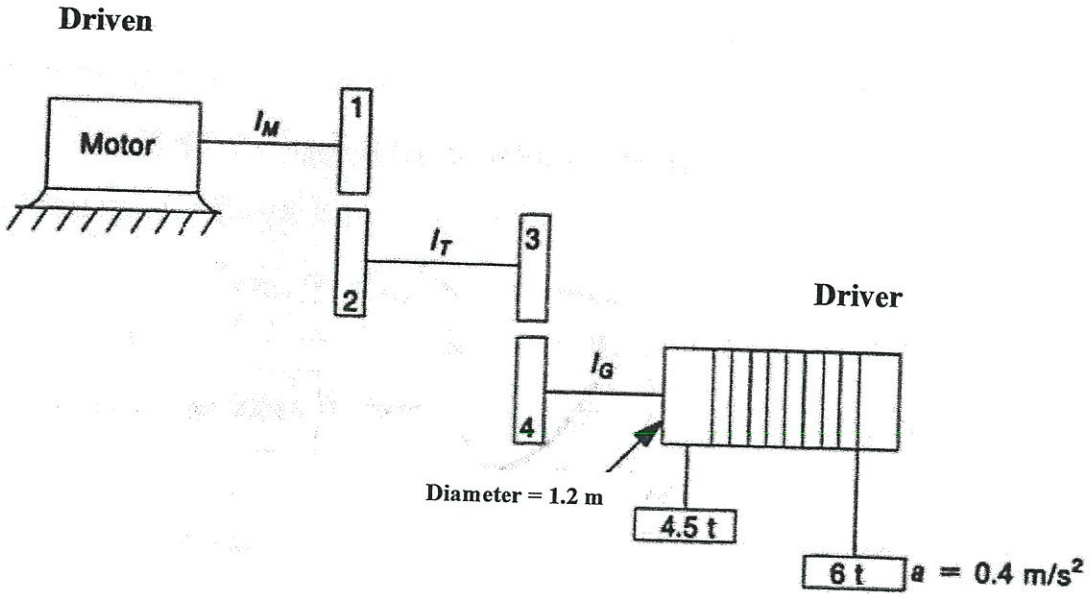

Figure Q4(b)

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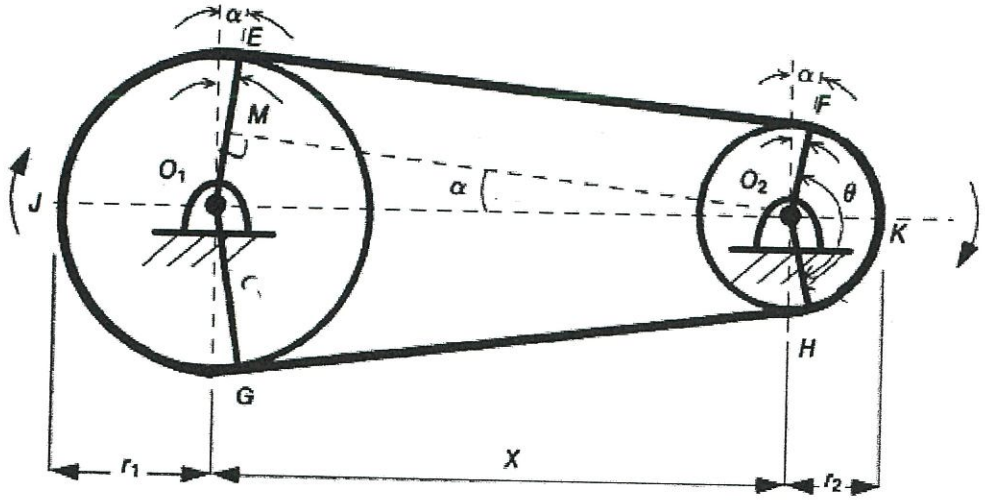

Figure Q5