Universiti Tun Hussein Onn Malaysia

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER II
SESSION 2022/2023

COURSE NAME	:	MECHANICS OF MACHINES
COURSE CODE	:	BDJ 20303
PROGRAMME CODE	:	BDJ
EXAMINATION DATE	:	JULY / AUGUST 2023
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 CONSISTSOF **SEVEN (7)** PAGES

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Q1 (a) **Figure Q1(a)** shows the ABC lever ($I = \frac{1}{3} ml^2$) that has a uniform section and masses of 3 kg. It is in pivot at C and carries a mass of 1 kg at A. Arm BD of 1.5 kg and carries a mass of 4.5 kg at D. The spring constant at A is 330 N / m and at BD is 2 kN / m.

If the ABC lever is pulled and then released,

(i) Sketch the geometry displacement diagram for the lever.

(2 marks)

(ii) Determine the height (extension/compression of spring) at A & B.

(2 marks)

(iii) Calculate the natural frequency of the system in Hz unit, by using the 2nd Newton Law method.
Ignore all pendulum effects.

(8 marks)

(iv) Calculate the natural frequency of the system in Hz unit, by using the Energy method.
Ignore all pendulum effects.

(8 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)

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(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) A body of mass 50 kg and with a surface for which on the same plane. the friction coefficient is 0.15, is to be moved by a force P directed at an angle 15° to the plane. i.e at 35° to the horizontal. Calculate the value of P which will cause downward movement becomes possible. Any formulae use should be established or explained by vector diagrams of forces.

(8 marks)

(b) A screw jack having square threads of 5 cm mean diameter and 1.25 cm pitch is operated by a 50 cm long hand lever. Coefficient of friction at the threads is 0.1. Determine the effort needed to be applied at the end of the lever to lift a load of 20 kN.

(5 marks)

(c) **Figure Q3(c)**, shows the lawn roller having a mass of 80 kg. If the arm BA is held at an angle of 30° from the horizontal and the coefficient of rolling resistance for the roller is 25 mm, determine the force P needed to push the roller at constant speed.

Neglect friction developed at the axle A, draw the FBD force acting and assume that the resultant force P acting on the handle is applied along arm BA.

(7 marks)

Q4 (a) Differentiate between velocit ratio and slip. Discuss the effect of belt thickness and slip on velocity ratio.

(5 marks)

(b) The slack side of the belt drive is preferable to place on the top side as shown in **Figure Q4(b)**. Discuss the possible reason behind this.

(3 marks)

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(c) An open belt drives connects two pulleys 120 cm and 50 cm diameter, on parallel shafts 4 metres apart. The mass of belt per metre length is 0.9 kg and maximum tension is not to exceed 2000 N. The coefficient of friction is 0.3. The 120 cm pulley, which is the driver, runs at 200 rpm. Because of belt slip on one of the pulleys, the velocity of the driven shaft is only 450 rpm. Calculate

(i) the torque on each of the two shafts.

(6 marks)

(ii) the power transmitted and

(2 marks)

(iii) the power lost in friction.

(2 marks)

(iv) the efficiency of the drive

(2 marks)

Q5 (a) Gears can be classified according to the relative position of the axes of mating gears. Describe the types of axes of the mating gears and give one example for each type.

(6 marks)

(b) An electric motor is used to accelerate a hoist with diameter of 450 mm through a set of reducing gear. The number of teeth for the motor and hoist's gear is 30 and 130 respectively. Moment of inertia for the motor shaft is 3 kgm^2 and 25 kgm^2 for the hoist's shaft. The motor has a rated power of 3 kW that can produce maximum speed of 150 rpm. Given the gear efficiency is 95%. If the friction torque for the motor shaft is 10 Nm and for the hoist's shaft is 50 Nm, find the maximum load that can be lifted with acceleration of 0.2 m/s^2

(14 marks)

END OF QUESTIONS

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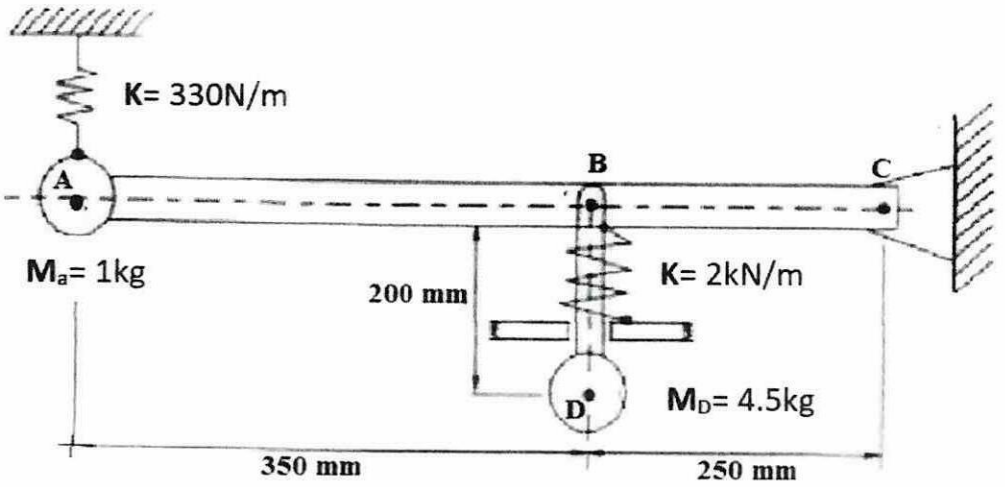

Figure Q1(a)

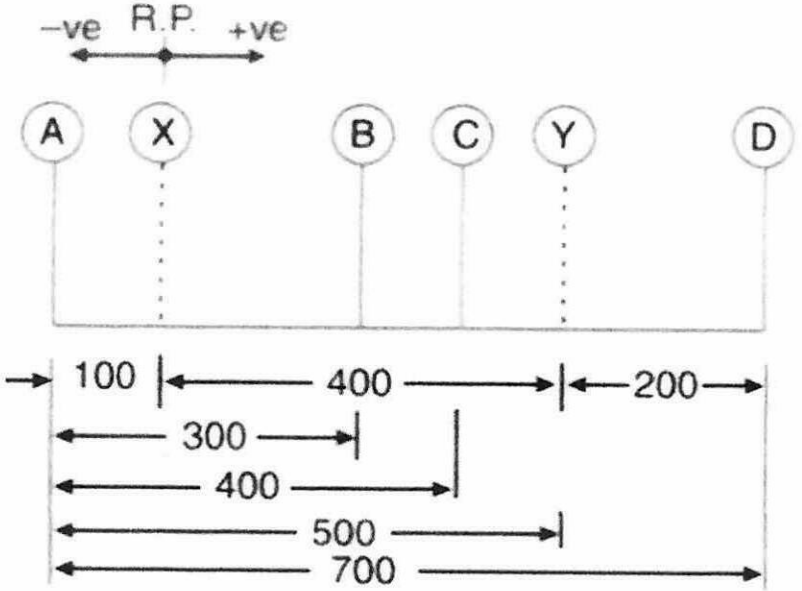

Figure Q2(a)

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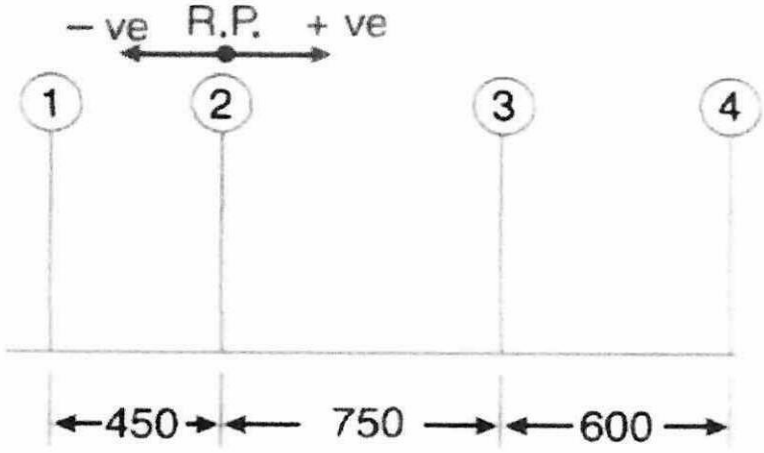

Figure Q2(b)

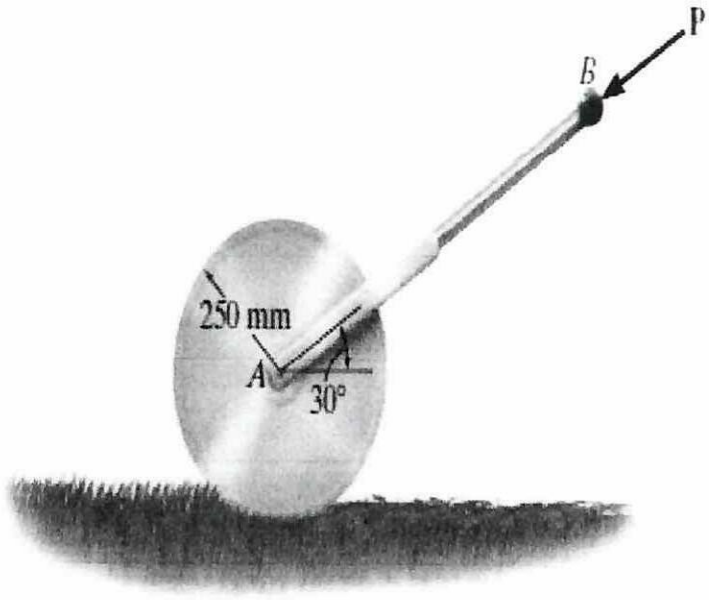

Figure Q3(c)

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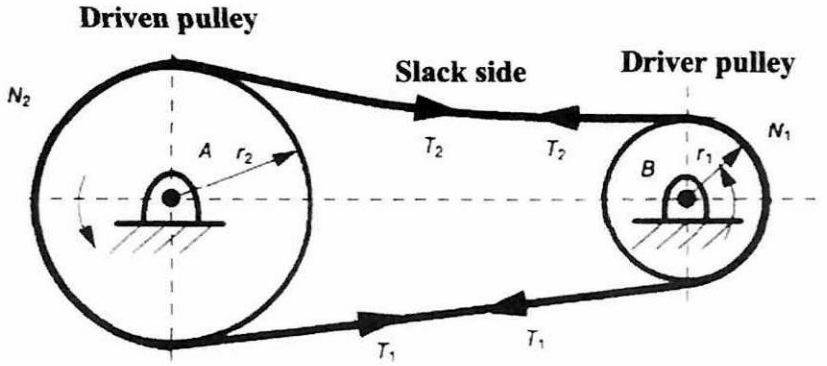

Figure Q4(b)

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