Universiti Tun Hussein Onn Malaysia

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER II
SESI 2014/2015

COURSE NAME	:	MECHANICS OF MACHINES
COURSE CODE	:	BNJ 20303
PROGRAMME	:	2 BNG/BNM/BNL
EXAMINATION DATE	:	JUNE/JULY 2015
DURATION	:	3 HOURS
INSTRUCTION	:	ANSWER **FIVE (5)** QUESTIONS ONLY

THIS QUESTION PAPER CONSISTS OF EIGHT (8) PAGES

Q1 (a) Explain briefly about velocity ratio, slip and 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 Q1(b)**. Discuss the possible reason behind this.

(3 marks)

(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.

(2 marks)

(iii) The power lost in friction.

(2 marks)

(iv) What is the efficiency of the drive?

(2 marks)

Q2 (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 (1) 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,

(i) Determine the maximum load that can be lifted with acceleration of 0.2 m/s^2

(8 marks)

(ii) Draw the free body diagram.

(6 marks)

Q3 (a) The pitch of 50 mm mean diameter threaded screw of a screw jack is 12.5 mm. The coefficient of friction between the screw and the nut is 0.13. Determine the torque required on the screw to raise a load of 25 kN, assuming the load to rotate with the screw.

(i) Determine the ratio of the torque required to raise the load to the torque required to lower the load.

(5 marks)

(ii) Determine the efficiency of the machine.

(5 marks)

(b) A plate clutch has three discs on the driving shaft and two discs on the driven shaft, providing four pairs of contact surfaces. The outside diameter of the contact surfaces is 240 mm and inside diameter 120 mm. Assuming uniform pressure and coefficient friction, $\mu = 0.3$;

(i) Determine the total spring load pressing the plates together to transmit 25 kW at 1575 r.p.m.

(5 marks)

(ii) If there are 6 springs each of stiffness 13 kN/m and each of the contact surfaces has worn away by 1.25 mm, determine the maximum power that can be transmitted, assuming uniform wear.

(5 marks)

Q4 (a) Given FIVE (5) masses revolve in the same plane for balancing in a system. Each mass A, B, C, D and E has a radius of 10 cm, 15 cm, 10 cm, 10 cm and 15 cm respectively. The angular position of mass B, C , D and E measured from A are 60^0, 120^0, 225^0 and 300^0 respectively. Also given mass A, B and C are 5, 10 and 8 kg respectively.

(i) Sketch the angular position of masses A, B, C, D and E.

(2 marks)

(ii) List out the force for masses A, B, C, D and E in a table.

(3 marks)

(iii) From (ii), using a graph paper, draw the force diagram and find the masses of D and E for complete balance of the system.

(5 marks)

(b) **Figure Q4(b)(i)** shows the front view of a shaft carries THREE (3) pulleys (A, B and C) ONE (1) at each end and ONE (1) at the middle of its length. The shaft is also supported in bearings 180 cm apart and projects 45 cm beyonds bearing at each end. **Figure Q4(b)(ii)** shows the side view of the shaft , the mass of the ennd pulley is 48 kg and 20 kg and their centre of gravity are 1.5 cm and 1.25 cm respectively from the shaft axis. The mass of centre pulley is 56 kg and its centre of gravity is 1.5 cm from the shaft axis,

(i) List out the forces in kg m and moment in kg m^2, for masses of pulley A, B, and C in a table, by taking mass of pulley B as a references.

(2 marks)

(ii) From (i), if the pulleys are arranged so as to give static balancing, draw the force polygon diagram for masses of pulley A, B, and C, by using a graph paper.

(3 marks)

(iii) From (ii), using a graph paper, draw the force diagram and determine the relative angular position.

(3 marks)

(iv) From (iii), determine the dynamic force and load produced by each bearing when the shaft rotates at 300 rpm.

(2 marks)

Q5 (a) Give definition of vibration, free vibration and also give ONE (1) examples of undamped free vibration.

(3 marks)

(b) Determine the equivalent natural frequency of a vibrating system as shown in **Figure Q5(b).**

(2 marks)

(c) Determine the natural frequency of a vibrating system as shown in **Figure Q5(c)**

(5 marks)

(d) **Figure Q5(d)** shows 4 kg of *AOB* bar. It has 100 mm of centrifugal radius *(radius of gyration)* that is measured from *A* to *B*. Two springs K_1 and K_2 are attached at *A and B* point with the stiffness coefficient is *5000* N/m. The point *B* also has a 1 kg mass connected between spring and bar. Determine the natural frequency of the system. *(Tips : Using the Newton's Law and pendulum motion concepts, sketch the action of the forces and moment at minimum and maximum position).*

(10 marks)

Q6 (a) A uniform thin rod, *AB* shown an oscillation system as in **Figure 6(a),** has a mass of m at point *B*. The rod is hinged at *A* and is maintained in the horizontal position by a spring of stiffness *K*. The mass *B* is supported by a damper with the damping coefficient is *C*. Given also *a=(1/3)b.*

(i) Find the mass in the oscillation system. *(Tips : Using the equivalence of mass concept and also sketch the diagram)*

(2 marks)

(ii) Find the damping coefficient in the oscillation system. *(Tips : Using the equivalence of damping coefficient concept and also sketch the diagram).*

(2 marks)

(iii) Find damped natural frequency of oscillation system. *(Tips : Solutions relates to natural frequency, damping ratio and critical damping coefficient).*

(4 marks)

(b) **Figure Q5(b)** shows an oscillation system of a structure *ABDE* having a mass 2.5 kg with radius of gyration of 50 mm about *D*. Given also a mass at E, 8 kg with radius of gyration about D, 65 mm and another extra mass at the damper , M_p = 0.5 kg. Consider the system has a pendulum effect,

(i) Find the natural frequency. *(Tips : Using the second Newton's Law that relates the moment about D and sketch the action of forces at minimum and maximum position).*

(7 marks)

(ii) From (i), the amplitude was reduced to HALF (½) after THREE (3) complete oscillations. Find the damping ratio, coefficient damping ratio, critical coefficient damping ratio and damped natural frequency.

Given the logarithmic decrement : $In\left(\frac{x_1}{x_r}\right) = \frac{(r-1)2\pi\xi}{\sqrt{1-\xi^2}}$

(5 marks)

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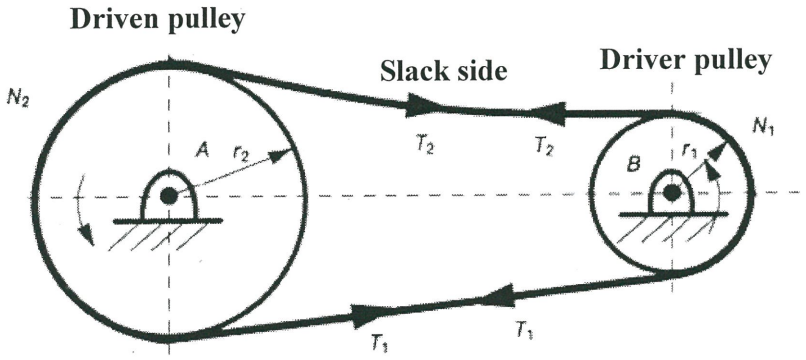

Figure Q1(b)

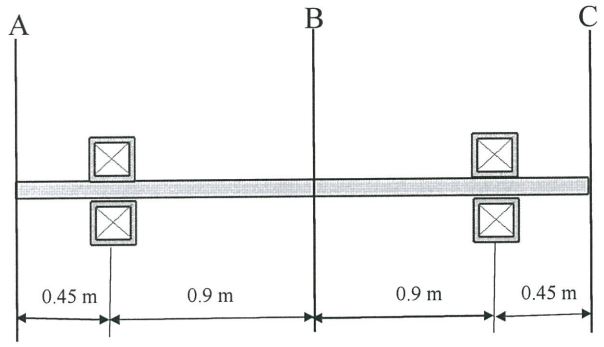

Figure Q4(b)(i) : Front View

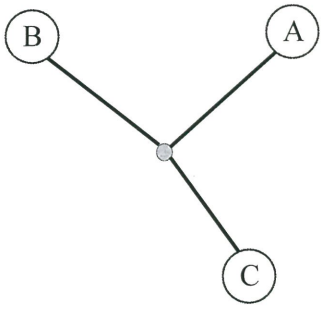

Figure Q4(b)(ii) : Side View

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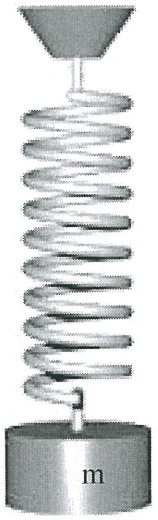
Figure Q5(b)



K = 5 N/mm

m = 10 kg

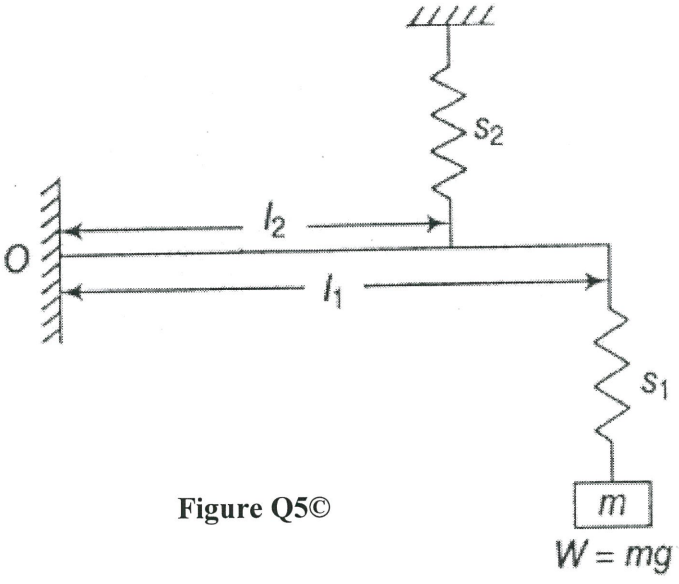


Figure Q5©

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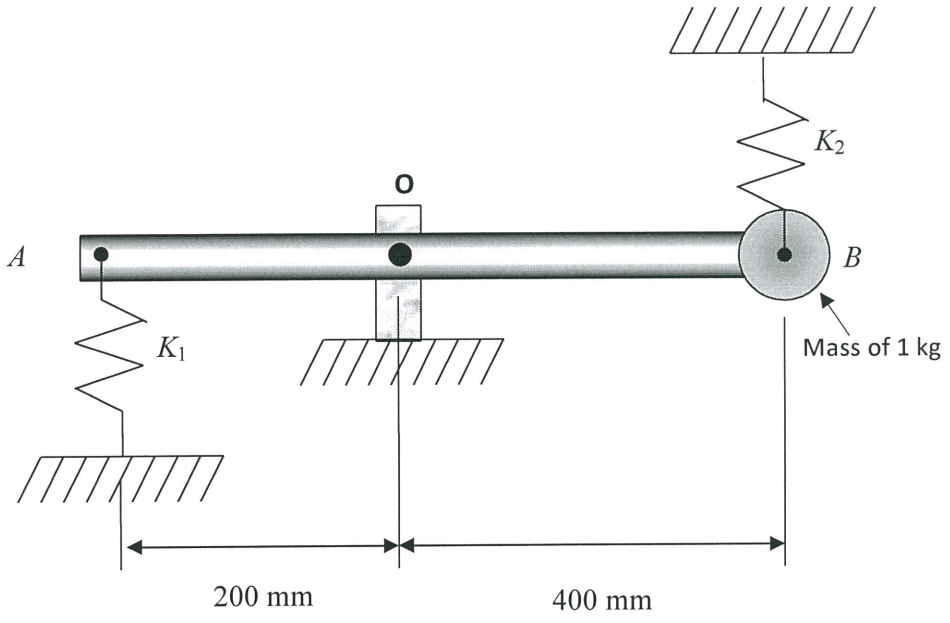

Figure Q6(a)

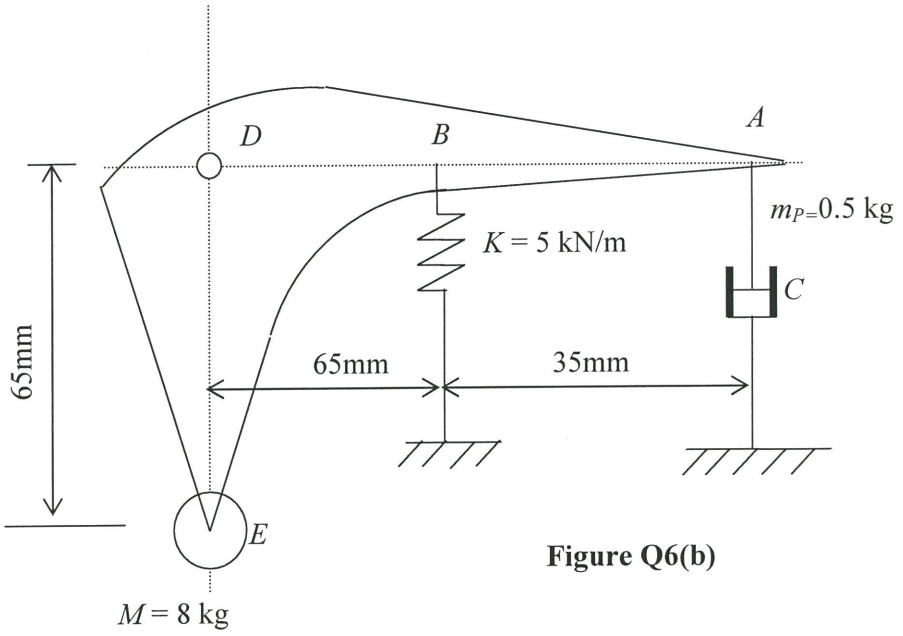

Figure Q6(b)