Universiti Tun Hussein Onn Malaysia

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER II
SESSION 2017/2018

COURSE NAME	:	MECHANICS OF MACHINES
COURSE CODE	:	BNJ 20303
PROGRAMME CODE	:	BNG/BNH/BNK/BNL/BNM
EXAMINATION DATE	:	JUNE / JULY 2018
DURATION	:	3 HOURS
INSTRUCTION	:	ANSWERS **ALL** QUESTIONS

THIS QUESTION PAPER CONSISTS OF **NINE (9)** PAGES

Q1 (a) **Figure Q1(a)** shows a slender bar ABC having a equally distributed mass of 1.2 kg and rotate about A. Given the moment inertia about A, $I_A = \frac{1}{3} ml^2$. At the end of the bar carries a mass of 1 kg at C. Structure BD, mass of 1 kg, connecting at ABC also carries a mass of 1 kg at D. The coefficient of spring is K=1 kN/m. Determine the natural frequency (rad/s) of this system using,

(i) The energy method,
(ii) The equivalent method.

Hints :

- Draw the geometry motion schematic diagram of the system.

(8 marks)

(b) **Figure Q1 (b)** shows a structure ABOD of mass 10 kg and radius of gyration 50 mm at the pivot O, centre of gravity. Mass of 8 kg, is attached on structure ABOD at D. The motion of ABOD is controlled by the spring and dashpot C. Spring at A has the coefficient spring K_1 = 2 kN/m and at D, K_2 = 1 kN/m. Dashpot is located at distance of 40 mm from O.

(i) Using the moment equation (2nd Newton Law Equation), determine the distance *h,* so that the system oscillate with natural frequency of ω_n = 30 rad/s, and

(ii) If the amplitude vibration is reduced to ⅓ after 3 complete oscillation, determine the damped coefficient C of the dashpot.

Hints :

- Neglect the pendulum effect from mass D
- Draw the geometry motion schematic diagram of the system.
- Taking the moment inertia about O which include structure ABOD and mass D
- Peak to peak wave represent one complete oscillation

(12 marks)

Q2 (a) Four masses m_1, m_2, m_3 and m_4 are 200 kg, 300 kg, 240 kg and 260 kg respectively. The corresponding radii of rotation are 0.2 m, 0.15 m, 0.25 m and 0.3 m respectively and the angles between successive masses are 45°, 75 ° and 135°.

(i) Check the static balancing or the counterweight of this system if any,
(ii) If yes for the above **Q2(a)(i)**, determine the angle position and the counterweight using the rotation radius of 0.2 m

Hints :

- Draw the space angle diagram or the sides view of the system
- Angle between m_1 to m_2 = 45°, m_2 to m_3 = 75°, m_3 to m_4 = 135°
- List the table analysis of this system
- Using the graphical (polygon) method
- Using the scale of 1 cm = 10 kg m

(8 marks)

(b) The cranks radius and connecting rods of a 4 cylinders inline engine running at 1800 rpm are 6 cm and 24 cm each respectively and the cylinders are spaced 15 cm apart. If the cylinders, are numbered 1 to 4 in sequence from one end, the cranks appear at intervals of 90^{o} in an end view in the firing order 1- 4 - 2 - 3. The reciprocating mass corresponding to each cylinder is 1.5 kg. Determine :

(i) Unbalanced primary and secondary force, if any.
(ii) Unbalanced primary and secondary couples, if any, with reference to central plane of the engine. If yes, determine the angle position and the counterweight.

Notes :

- Draw the space angle diagram or the sides view of the system according to the firing order
- Draw the front view of the system according to the number 1 to 4 in sequence
- List the table analysis of this system
- Using the graphical (polygon) method
- Using the scale of 4 cm = 9 kg cm for primary & secondary forces
- Using the scale of 2 cm – 67.5 kg cm^2 for primary & secondary moment

(12 marks)

Q3 (a) **Figure Q3(a)** shows a clamping system to clamp a pipe E. Determine the horizontal force that must be applied perpendicular to the handle, C in order to develop a 900 N clamping force on the pipe.

Given, the single square-threaded screw has a mean diameter of 25 mm and a lead of 5 mm. The coefficient of static friction is $\mu_s = 0.4$

Hints :

- Draw the FBD of the clamp during tighten
- Calculate force exerts at screw B, by taking the moment at pin D

(4 marks)

(b) A multi plate clutch consists of three discs and three plates on the driving shaft and driven shaft respectively, and providing five pairs of contact surfaces. This multi plate clutch having each of 0.24 m external diameter and 0.12 m internal diameter.

(i) If a power of 25 KW at 1575 rpm is being transmit, calculate the torque and pressure occurs on this multi plate clutch. Assuming the coefficient of friction is 0.3.

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

(7 marks)

(c) **Figure Q3(c)** shows a uniform box stone has a mass of 500kg and is held in place in the horizontal position using a wedge at B. If the coefficient of static friction $\mu_s = 0.3$, at the surfaces of contact, determine,

(i) The minimum force P needed to remove the wedge.
(ii) Is the wedge self-locking?

Assume that the stone does not slip at A.

(6 marks)

(d) **Figure Q3(d)** shows a vertical shaft 150 mm in diameter rotating at 100 r.p.m. rests on a flat end footstep bearing (pivot bearing). The shaft carries a vertical load of 20 kN. Given also coefficient of friction equal to 0.05

(i) Assuming uniform pressure distribution, determine the total frictional torque.
(ii) Determine the power lost in **Q9d)(i)** above.
(iii) Assuming uniform wear, determine the new total frictional torque.

(3 marks)

Q4 (a) The gearing of a machine tool is shown in **Figure Q4(a).** The motor shaft is connected to gear A and rotates at 975 r.p.m. The gear wheels B, C, D and E are fixed parallel shafts rotating together. The final gear F is fixed on the output shaft. The number of teeth on each gear are given in **Table Q4(a)** below :

Gear	A	B	C	D	E	F
No. of teeth	20	50	25	75	26	65

Table Q4(a)

(i) State the function of each gear (A, B, C, D, E, F) either driver or driven.
(ii) Determine the speed of gear F in r.p.m.

(5 marks)

(b) **Figure Q4(b)** shows a mass M kg load should be increased to the track that leans on the slope 1 in 20. The total torque on the hoist is 929 Nm, so that the load accelerates with an acceleration of 0.8 m/s^2. The frictional force on the slope is 1500 N. The diaphragm hoist has a diameter of 0.8 m and was driven by an electric motor through a gear system. Efficiency is 95% gear contact and frictional torque is equal to the torque of 10 Nm at motor shaft and 20 Nm on the diaphragm shaft.

If the motor speed is 477.5 rpm to accelerate the load with acceleration of 0.8 m/s^2, obtain the mass and motor power. Given moment inertia, $I_m = 9$ kgm^2 and $I_G = 60$ kgm^2, no of teeth $t_1 = 25$, $t_2 = 125$).

Hints:

- Draw the FBD at the slope during motion up

(15 marks)

Q5 (a) **Figure Q5(a)** shows, a belt drive is used to transmit power from an electric motor to a fan. The electric motor, is rated at 3000 rpm. The radii of motor's and fan's pulley is 2 cm and 8 cm respectively. Calculate, the velocity ratio the operating speed of the fan and the belt speed.

(3 marks)

(b) An open V belt drive with the following data transmits power from an electric motor to a compressor. Specification are :

- Power transmitted=100kW,
- Speed of the electric motor = 750 rpm,
- Speed of the compressor=300 rpm,
- Diameter of compressor pulley=800 mm,
- Centre distance between pulleys=1.5 m,
- Maximum speed of the belt = 30 m/s,
- Mass density of the belt = 900kg/m^3,
- Cross sectional area of belt=350 mm^2.
- Allowable stress in the belt= 2.2 N/mm^2.
- Groove angle of the pulley – 38°.
- Coefficient of friction = 0.28.

Determine the number of the belts required and the length of each belt.

Hints :

$$L_{open} = 2\left[r_1\left(\frac{\pi}{2}+\alpha\right) + X - \left(\frac{(r_1 - r_2)^2}{2X}\right) + r_2\left(\frac{\pi}{2}-\alpha\right)\right]$$

(17 marks)

- END OF QUESTIONS -

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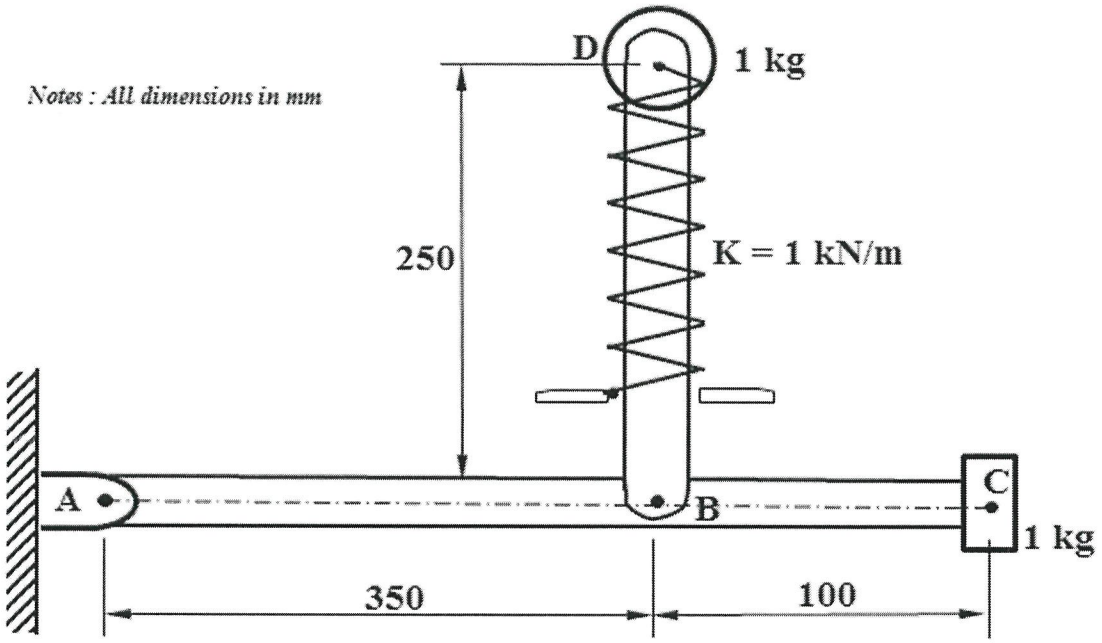

Figure Q1 (a)

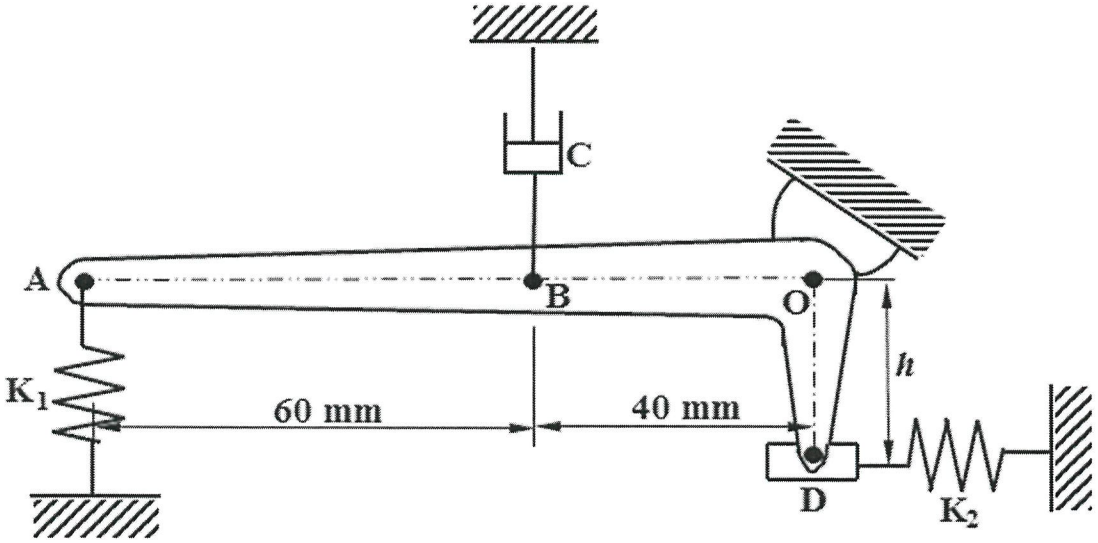

Figure Q1 (b)

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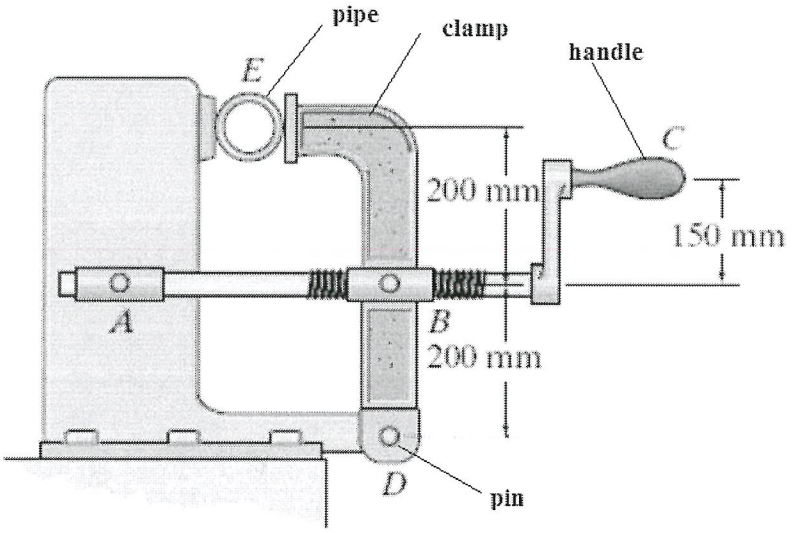

Figure Q3 (a)

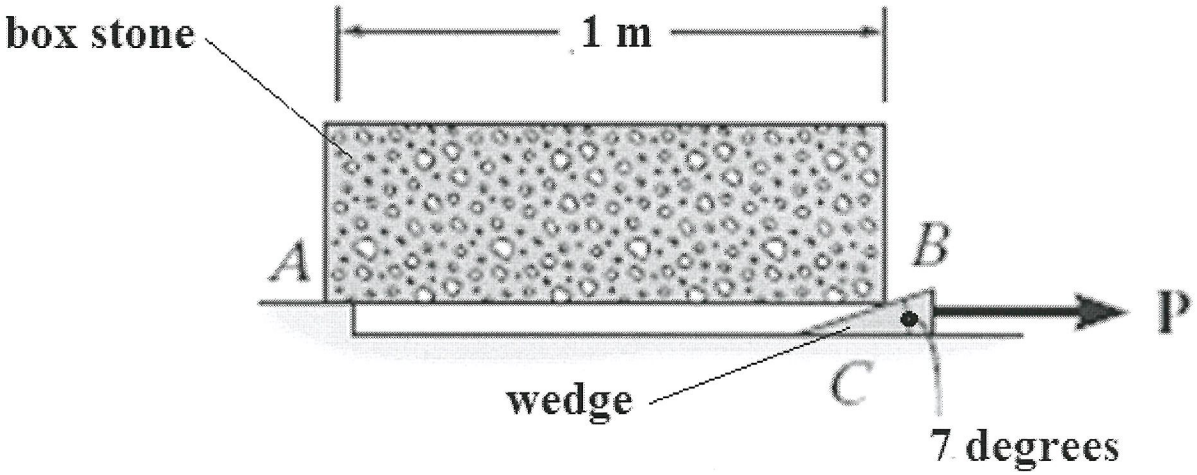

Figure Q3 (c)

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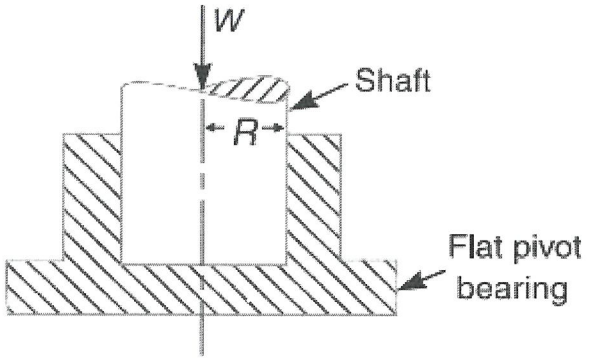

Figure Q3(d)

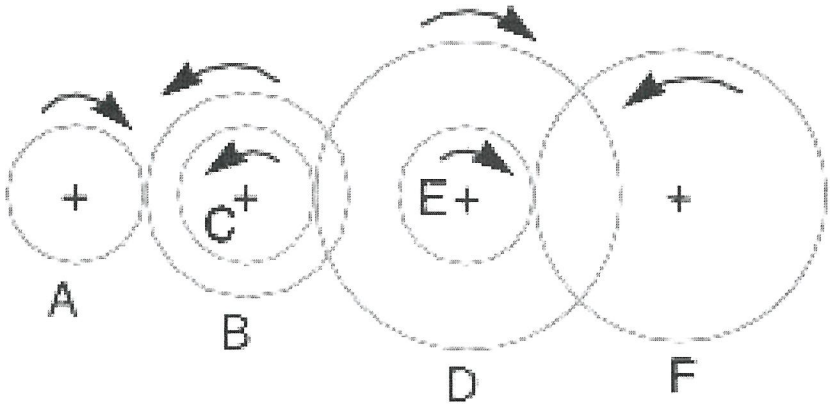

Figure Q4 (a)

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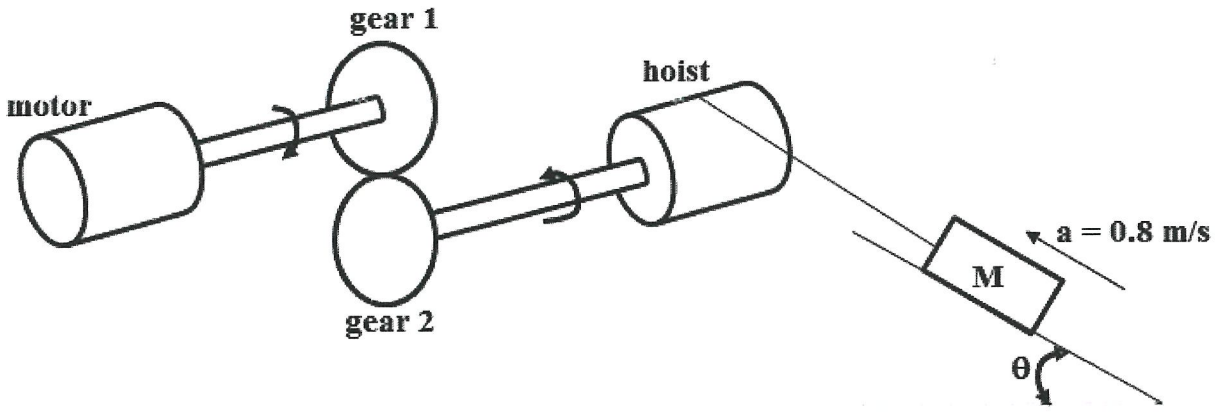

Figure Q4 (b)

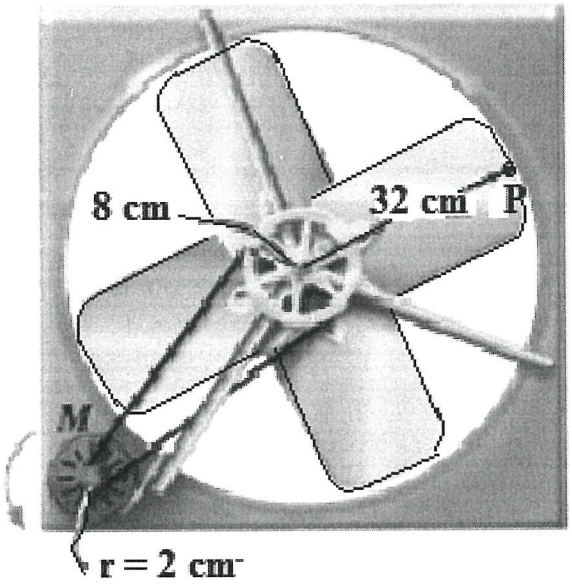

Figure Q5(a)