UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER 2
SESSION 2009/2010

SUBJECT	:	DYNAMICS
SUBJECT CODE	:	BDA 2013
COURSE	:	2 BDD
DATE	:	APRIL/MAY 2010
DURATION	:	2 HOURS 30 MINUTES
INSTRUCTION	:	PART A: ANSWER 3 QUESTIONS PART B: ANSWER 2 QUESTIONS

THIS PAPER CONSISTS OF 7 PAGES INCLUDING COVER PAGE

PART A - Basic Comprehension and Understanding - 50 Marks
(3 Questions, Answer All Questions)

Q1 A flywheel shown in FIGURE Q1 has an eccentric rotation axis at point O. The eccentric distance of the rotation axis O from the centre of gravity cg is 2 cm. The diameter of the flywheel is 15 cm and the thickness is $t = 1$ cm. The flywheel is made of material with the mass density $\rho = 7000\,^{kg}/_{m^3}$.

(a) Calculate the mass of the flywheel and the rotational inertia of the flywheel about the centre of rotation O, by implementing the parallel axis theorem. The rotational inertia of the flywheel about the centre of gravity is $I_{cg} = \frac{1}{2}mR^2$, where m is the mass of the flywheel.

(b) When the axis is rotated (from rest), after 20 s the rotation of the wheel is recorded 100 rpm, calculate the angular acceleration of the flywheel at this instant

(c) If you want to stop the flywheel when it reaches 100 rpm, calculate the torque required.

(20 marks)

Q2 The crankshaft OB as illustrated in FIGURE Q2 rotates with a constant angular velocity $\omega = 50\,^{rad}/_{s}$ (clock wise) about the centre of rotation at point O. Point B is connected to a rotating bar ED and pinned at point F by using 400 mm connecting bar BF.
At instant, when OB at horizontal position, bar ED is perpendicular to the connecting bar BF. The connecting bar BF is exactly at $\theta = 60°$,

(a) Calculate the velocity of point B and describe the direction of the velocity B (for example vertical direction, horizontal direction or inclined to certain angle)

(b) Considering the line direction of the velocity of point B (V_B) and the line direction of velocity of point F (V_F), find the location of "instantaneous centre of zero velocity". Name this centre of zero velocity as point C. Draw clearly your illustration to find the location C.

(c) Calculate the angular velocity at the centre of zero velocity, find the velocity of point F (V_F).

(d) Find the angular velocity of bar ED about the center of rotation E and find the velocity of point D (V_D).

(20 marks)

Q3 A simplified overhung crank is illustrated in FIGURE Q3 as a composite object. The material is uniformly made of steel with the density $\rho = 7850\,^{kg}/_{m^3}$

(a) Determine the inertia of the composite object about the axis x.

(b) Determine the inertia of the composite object about the axis y.

(10 marks)

PART B - Analysis, Synthesis and Applications - 50 Marks
(Answer 2 Questions out of 3 Questions)

Q4 A given mechanism is illustrated in FIGURE Q4. The bar CB oscillates (counter clockwise) about C through a limited arc, causing a disc represented OA to oscillate about point O. When the linkage passes the position as shown in that figure with CB and OA are in horizontal and vertical positions, respectively. The angular velocity of CB, ω is $4\,^{\text{rad}}/_{\text{s}}$ counter clock wise direction. For this instant,

(a) Determine the velocity of point B, V_B

(b) Determine the angular velocity of the linkage AB and the angular velocity of the disc represented by OA and the velocity of point A, V_A

(c) Find the angular acceleration of AB, the angular acceleration of OA and the acceleration of point A.

(25 marks)

Q5 A mechanism shown in FIGURE Q5 consists of bar AB with a slot and rotating bar AC. At instant when bar AC is at horizontal position, bar AB has an angular velocity $\omega = 2\,^{\text{rad}}/_{\text{s}}$ at angular acceleration $\alpha = 10\,^{\text{rad}}/_{\text{s}^2}$.

(a) Find the angular velocity of bar AC and the velocity of the pin A relative to the slot AB.

(b) Find the velocity of pin A.

(c) Calculate the Coriolis acceleration of pin A

(d) Calculate the angular acceleration of pin A and the acceleration of pin A relative to the slot AB.

(e) Calculate the acceleration of pin A.

(25 marks)

Q6 A uniform 50 cm slender bar of 7 kg mass with light end rollers is released from the rest at $\theta = 30°$ as depicted in the FIGURE Q6. Two linear springs, with spring coefficient $k_1 = 180\,\text{N/m}$ and $k_2 = 15\,\text{N/m}$ are attached to one end of the bar. Those two springs are unstretched when bar AB is at a horizontal position (unstretched k_1 is 15 cm and unstretched k_2 is 50 cm). After releasing from its initial position, as shown in FIGURE Q6,

(a) Is there any external force in this problem?

(b) Write the energy equation that you want to consider

(c) Write the equation of the change of kinetic energy when the bar AB is moving from initial to the final location

(d) Find the change of potential energy when the bar AB is moving from initial to the final location

(e) Determine the angular velocity of the slender bar when the bar at horizontal position

(f) Calculate the corresponding velocity of point A and point B at that position

(25 marks)

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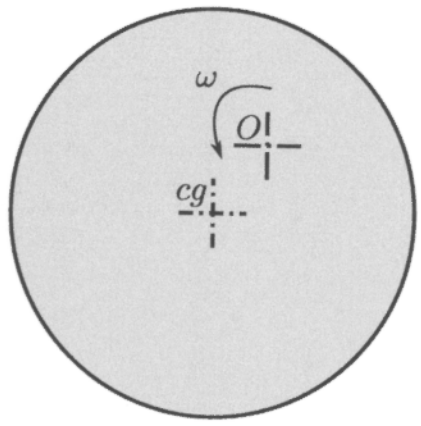

FIGURE Q1: Eccentric flywheel

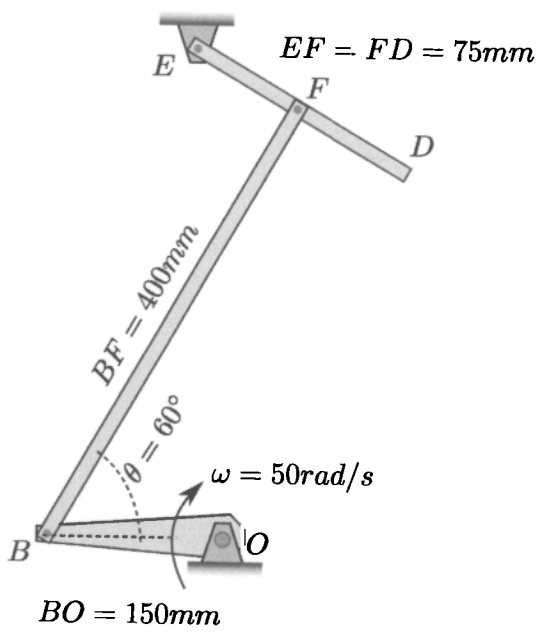

FIGURE Q2: Rotating bar

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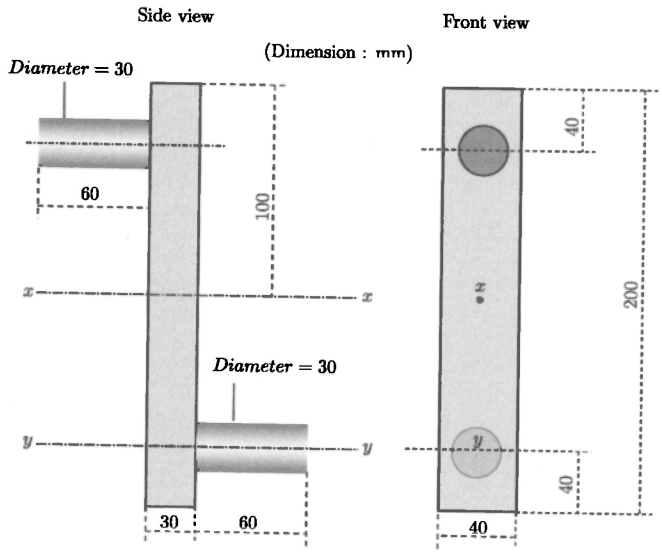

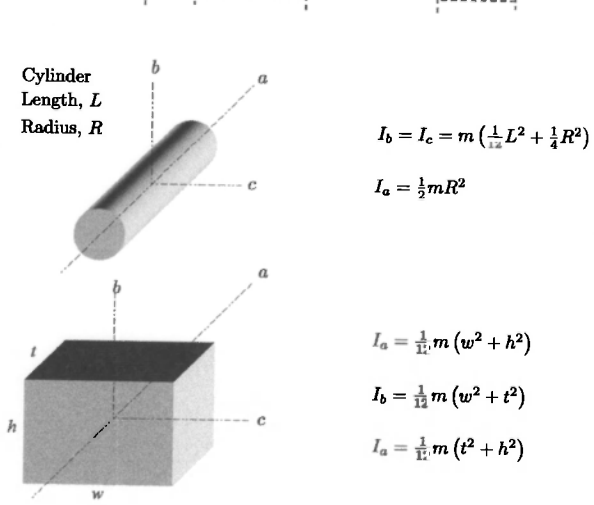

FIGURE Q3: Composite object

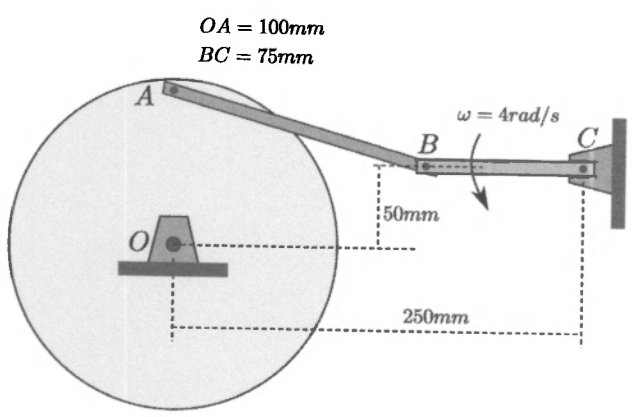

FIGURE Q4: Rotating mechanism

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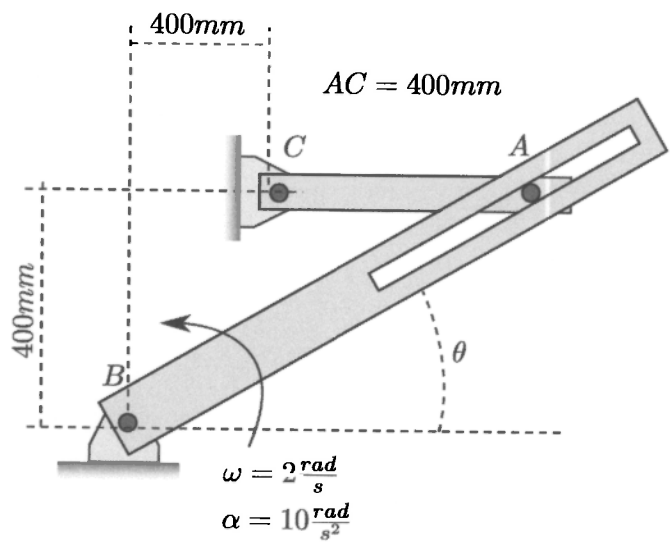

FIGURE Q5: Slider bar

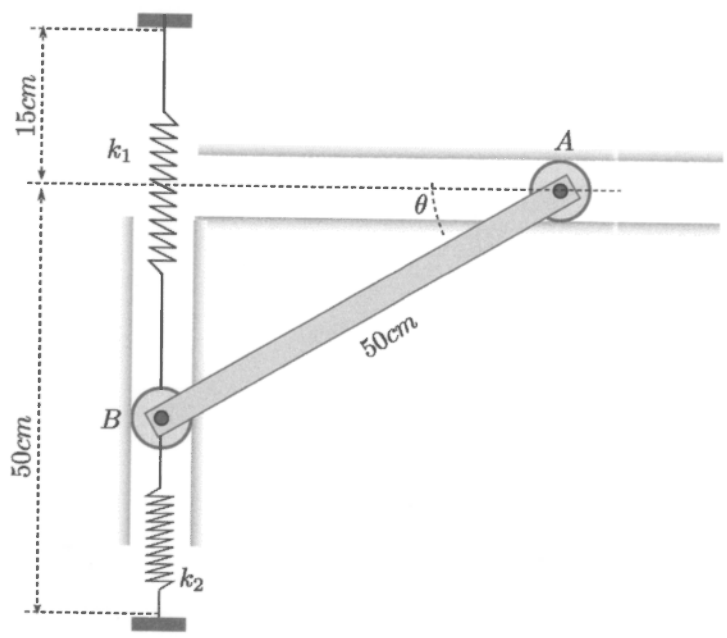

FIGURE Q6: Bar with springs