UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER 2
SESSION 2011/2012

COURSE NAME	:	DYNAMICS
COURSE CODE	:	BDA 20103/ BDA 2013
PROGRAMME	:	BDD
DATE	:	JUNE 2012
DURATION	:	3 HOURS
INSTRUCTIONS	:	PART A: ANSWER **ALL** QUESTIONS PART B: ANSWER **TWO** QUESTIONS

THIS PAPER CONTAINS (8) PAGES

PART A: Compulsory, Answer ALL Questions

Q1 The rear wheel of a mountain bike has a radius of 340 mm and is rigidly attached to 50 mm rear gear radius. The rear gear is connected to the pedal gear (radius 120 mm) where the pedal arms are rigidly attached to the pedal gear. The rider turns the pedals constantly at 5 revolutions per second. The illustration is shown in **FIGURE Q1**.

(a) Determine tangential velocity of the pedal gear that will be transmitted to the rear gear.

(5 marks)

(b) Based on the theory of instantaneous center zero velocity, draw a velocity diagram that relates the tangential velocity of the rear gear and the velocity of the bike.

(5 marks)

(c) Consider the illustration in (b), do an analysis in regard the velocity of the mountain bike. How fast the bike travels, in km/h.

(10 marks)

Q2 The elements of the mechanism for deployment of a spacecraft magnetometer boom are shown in **FIGURE Q2**. At instant when the driving link *OB* crosses the *y*-axis, the angular velocity $\omega_{OB} = 0.5$ rad/s. The position of the driven boom link *CA* at this instant is at angle θ ($\tan\theta = \frac{4}{3}$). Note: Positive direction of *y*-axis is vertical upward direction whereas positive *x*-axis is horizontal is defined as horizontal direction to the left.

(a) Draw the velocity of pin *B*, write in vector notation and calculate the magnitude of the velocity

(5 marks)

(b) Do an analysis based on vector velocity analysis diagram of link *AB* (translation + rotation) and write all equations that can be concluded from your diagram

(8 marks)

(c) Determine the angular velocity (rad/s) of boom *CA* link *AB*.

(7 marks)

Q3 Small wheels have been attached to the ends of rod *AB* and roll freely along the surfaces shown in **FIGURE Q3**. Wheel *A* moves horizontally to the left with a constant velocity of 1.5 m/s.

(a) Propose a vector velocity diagram of rod *AB* as the sum of translational and rotational motions that will be used a guide in velocity analysis.

(5 marks)

(b) Do an analysis to find the velocity of end *B* and the angular velocity of rod *AB* by using an analytical vector approach.

(8 marks)

(c) Do an analysis to find the velocity of end *B* by the method of the instantaneous centre of zero velocity.

(7 marks)

PART B: Answer TWO Questions ONLY

Q4 The structure of a Charpy impact machine is illustrated in **FIGURE Q4**. The dimensions of the arm pendulum are shown. The pendulum is made of steel with the material density of 8000 kg/m^3. The pendulum is released from rest when $\theta = 0^o$ (at horizontal position).

(a) As a design engineer you want to know the impacting velocity of the pendulum to the specimen. Propose an effective analytical approach (method) that you want to use to perform the velocity analysis.

(5 marks)

(b) Considering the dimensions provided and ignoring the cut at the pendulum head, do an analysis to locate the center of mass of the pendulum, r

(5 marks)

(c) Determine the inertia of the pendulum about the center of rotation at O

(5 marks)

(d) When the pendulum hitting the specimen ($\theta = 0^o$), do an analysis to determine the velocity of the pendulum head hitting the specimen.

(5 marks)

Q5 The slider A oscillates in the slot about the neutral position O. The displacement along x-axis in millimeters may be written $x = 50 \sin 4\pi t$ where t is the time in seconds. The disc, in turn, is set into angular oscillation about O. The angular displacement is given by a function of $\theta = 0.2 \sin 8\pi t$. The illustration can be found in **FIGURE Q5**.

(a) Propose analytical vector velocity and acceleration diagrams to analyse the movement of a particle in a moving body, then write all equations according the information given.

(5 marks)

(b) Calculate the Coriolis acceleration of pin A. Express the Coriolis acceleration of the slider A in vector notation.

(5 marks)

(c) Investigate the acceleration of A for the positions $x = 0$ with $\dot{x}$ positive.

(5 marks)

(d) Investigate the acceleration of A for the positions x = 50 mm

(5 marks)

Q6 A mechanism shown in **FIGURE Q6** consists of bar AB with a slot and rotating bar AC. At instant when bar AC is at vertical position, bar AB has an angular velocity ω = 5 rad/s at angular acceleration α = 5 rad/s^2.

(a) Propose vector velocity diagram and vector acceleration diagram of link AB that can be used to analyse unknown variables of the system.

(5 marks)

(b) Do an analytical vector analysis in order to investigate the magnitudes of the following parameters: angular velocity of bar AC (ω_{AC}) the velocity of the pin A relative (V_{Arel}) to the slot AB, and the velocity of pin A (V_A).

(5 marks)

(c) Calculate the Coriolis acceleration of pin A. Express the Coriolis acceleration of pin A in vector notation.

(5 marks)

(d) Determine the acceleration of pin A based on the analysis of angular acceleration of pin A and the acceleration of pin A relative to the slot AB.

(5 marks)

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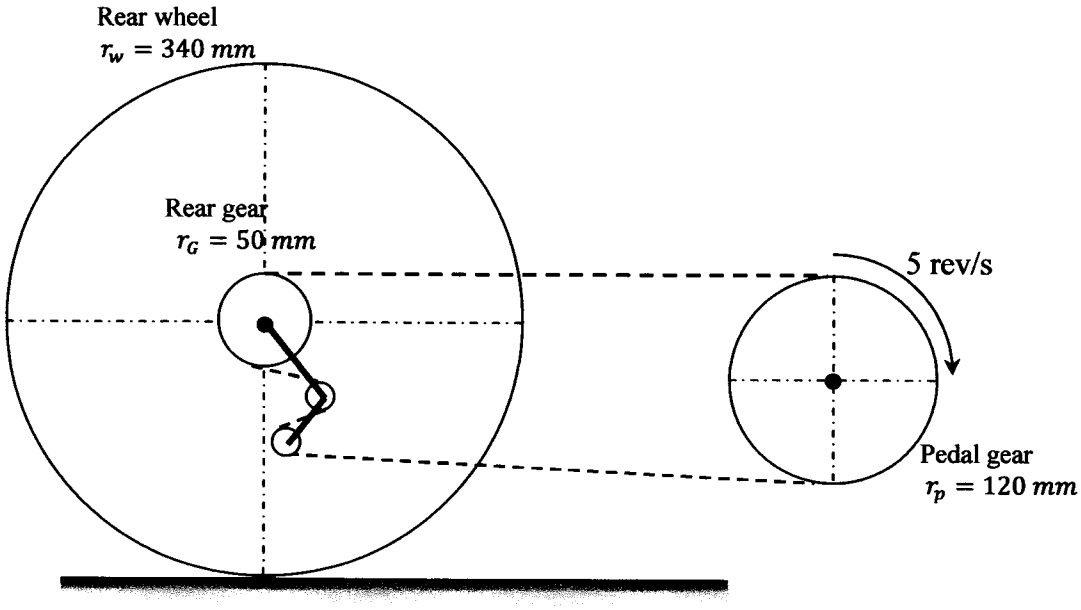

FIGURE Q1

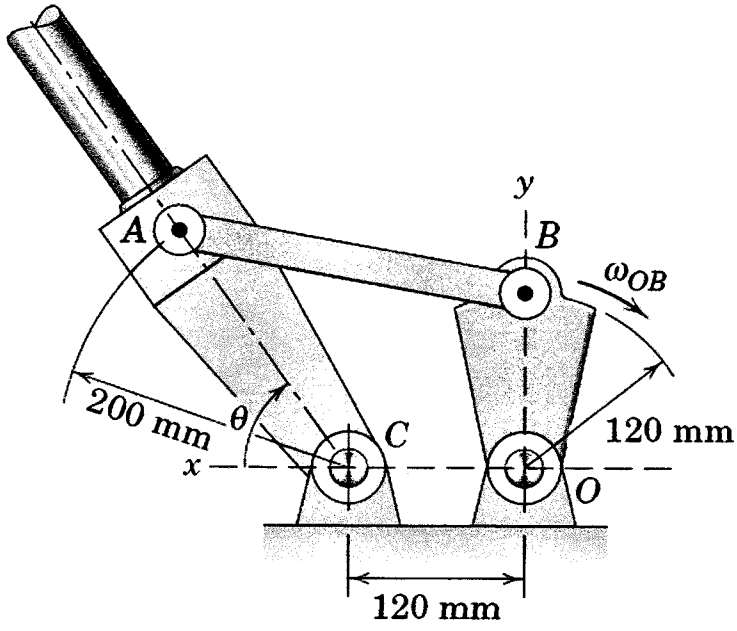

FIGURE Q2

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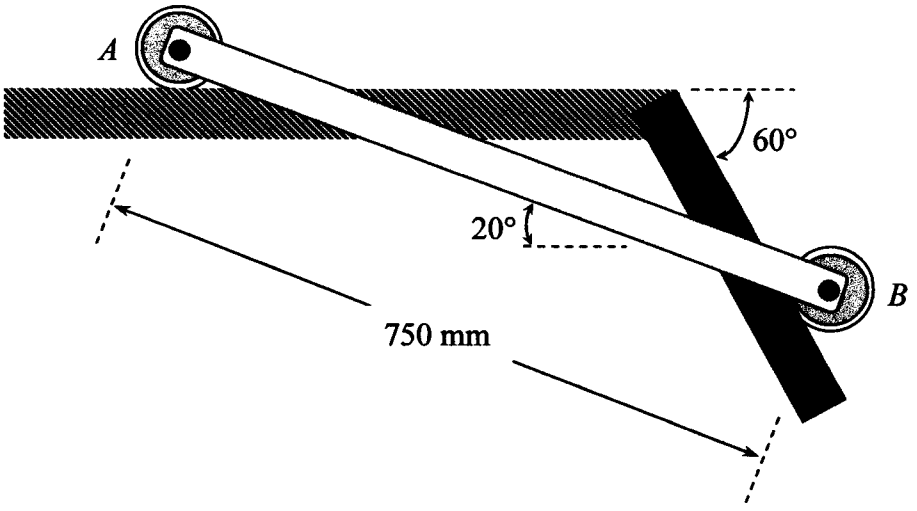

FIGURE Q3

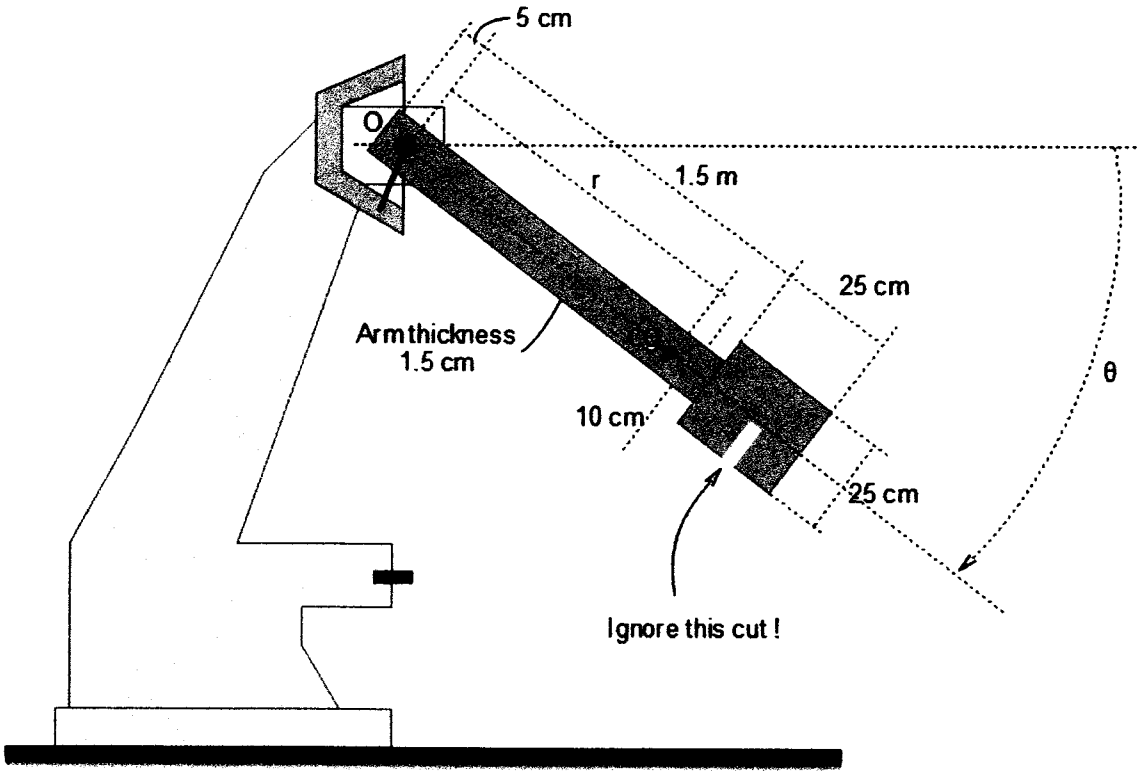

FIGURE Q4

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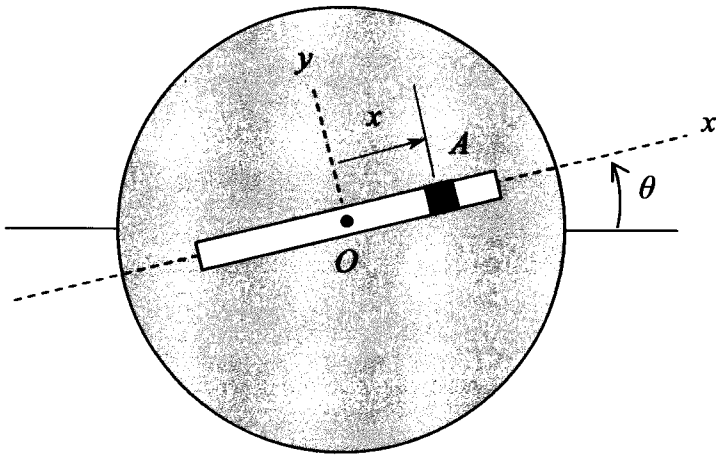

FIGURE Q5

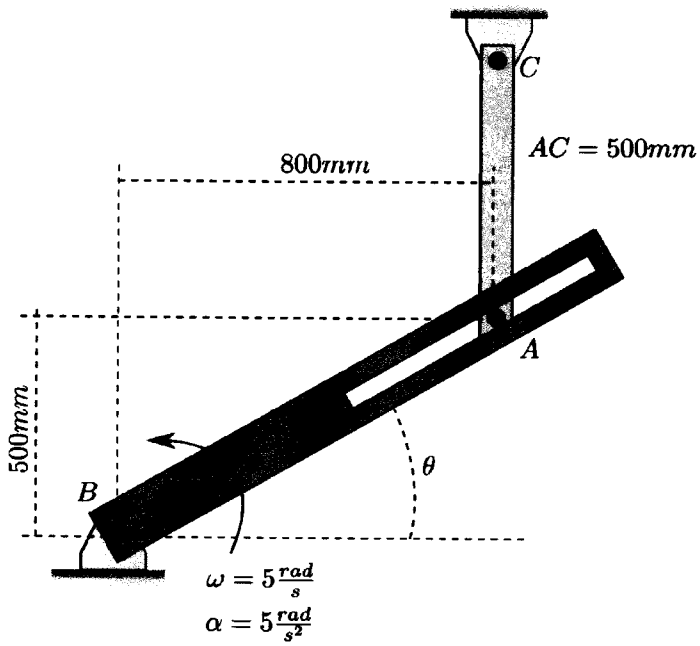

FIGURE Q6