JARAMOGI OGINGA ODINGA UNIVERSITY OF SCIENCE AND TECHNOLOGY

UNIVERSITY EXAMINATIONS

END SEMESTER EXAMINATIONS

BECHELOR OF EDUCATION SCIENCE

YEAR 2 SEMESTER 1 AUGUST 2013

SPH201: DYNAMICS

(REGULAR PROGRAME)

This paper consists of FIVE Questions. Answer QUESTION ONE (COMPULSORY) and any other TWO Questions.

QUESTION ONE (Compulsory) (30 Marks)

a. A force of 200N acts on the rim of a wheel 25cm in radius at an angle of 45°. Find the torque created on the rim. (2marks)

b. The wheel of a grinder is a uniform 0.9kg disk of 8cm radius. It slows uniformly to rest from 1400rpm in a time of 35 seconds. Determine the frictional torque that slows it down?

(4 marks)

c. A mass, m=400g hangs from the rim of a wheel (pulley) of radius r=15cm. When released from rest the mass falls 2.0m in 6.5seconds. Find the moment of inertia of the wheel.

(4 marks)

d. Starting from rest, a hoop of 20cm radius rolls down a hill to a point 5m below its starting point. How fast is it rotating at that point? (4marks)

e. A uniform horizontal beam 5.00 m long and weighing 3.0×10^2 N is attached to a wall by a hinge that allows the beam to rotate. Its far end is supported by a cable that makes an angle of 53^0 with the horizontal. If a person weighing 6.0×10^2 N stands 1.50 m from the wall, find the magnitude of the tension in the cable and the force exerted by the wall on the beam. (6 marks)

f. Define the term relativity in reference to dynamics (1 marks)

g. Briefly discuss the Galiliean relativity hence or otherwise present the Galiliean transformations. (5 marks)

h. Distinguish between the Centrifugal and Coriolis forces citing examples of each (4marks)

QUESTION TWO (20 Marks)

a. An object of arbitrary shape lies in the *xy*-plane. The object can be considered as divided into a large number of very small particles of masses m_1, m_2, m_3. . . .etc having coordinates (x_1, y_1), (x_2, y_2), (x_3, y_3), . . . respectively. If the object is free to rotate around the origin, show that the coordinate of its centre of mass is given by;

$$\left(\frac{\sum m_i x_i}{\sum m_i}, \frac{\sum m_i y_i}{\sum m_i} \right)$$ (8 marks)

b. A system consists of 8 masses each of measuring 4kg, 7kg, 5kg, 15kg 10kg, 12kg , 8kg, and 9kg lying on the coordinates (0,1), (4,4), (-3,12), (10,-6), (7,-8), (-4, -3), (7,2) and (9,3) respectively. Determine the coordinates of its **Centre of mass**.
(4 marks)

c. (i) Define **moment of inertia** and state its SI unit (2 marks)

(ii) A solid sphere has mass, M and radius, R. Show that its moment of inertia *I* is given by

$$I = \frac{2}{5} MR^2$$ (6 marks)

QUESTION THREE (20 Marks)

a. A ball of mass, *M* and radius, *R* starts from rest at a height of 4.0 m and rolls down an inclined plane inclined at 30° to the horizontal. Determine its linear speed as it just leaves the incline. (4 marks)

Two blocks with masses m_1 =5.00 kg and m_2 = 7.00 kg are attached by a string over a pulley as shown in figure 1 below. The pulley whose mass *M* =2.0kg, which turns on a frictionless axle, is a hollow cylinder with radius 0.05 m over which the string moves without slipping. The horizontal surface has coefficient of kinetic friction 0.35. Find the speed of the system when the block of mass m_2 has dropped by 2.0 m.

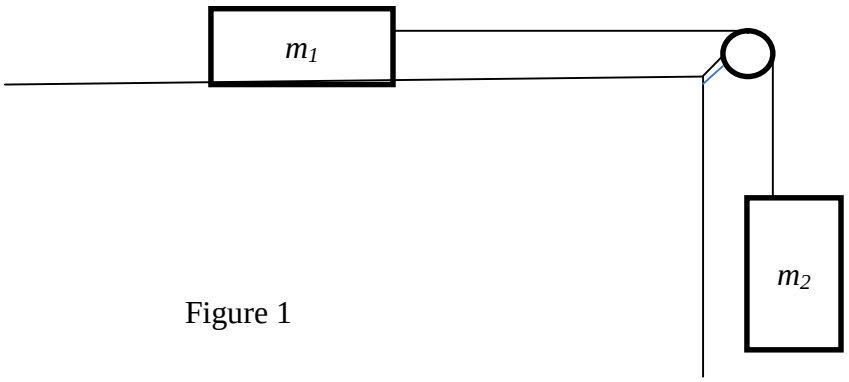

Figure 1 (6 marks)

c. A merry-go-round modeled as a disk of mass M = 1.0 x 10^2 kg and radius R = 2.0 m is rotating in a horizontal plane about a frictionless vertical axle.
(i) After a student with mass m = 60.0 kg jumps onto the merry- go-round, the system's angular speed decreases to 2.00 rad/s. The student then walks slowly from the edge toward the center, find the angular speed of the system when she reaches a point 0.5 m from the center.

(4 marks)

(ii) Find the change in the system's rotational kinetic energy caused by her movement to the center. (3 marks)

(iii) Find the work done on the student as she walks to r = 0.5 m. (3 marks)

QUESTION FOUR (20 Marks)

a. An 8.00-g bullet is fired into a 250-g block that is initially at rest at the edge of a table of height 1.00 m. The bullet remains in the block and after the impact the block lands at a range of 2.00 m from the bottom of the table. Determine the initial speed of the bullet.
(4 marks)

b. A 1 200-kg car traveling initially with a speed of 25.0 m/s in an easterly direction crashes into the rear end of a 9 000-kg truck moving in the same direction at 20.0 m/s. The velocity of the car right after the collision is 18.0 m/s to the east.
(i) What is the velocity of the truck right after the collision? (4 marks)
(ii) How much mechanical energy is lost in the collision? Account for this loss in energy. (4 marks)

c. A car with mass 1.50 x 10^3 kg traveling east at a speed of 25.0 m/s collides at an intersection with a 2.50 x10^3-kg van traveling north at a speed of 20.0 m/s. Find the magnitude and direction of the velocity of the wreckage after the collision, assuming that the vehicles undergo a perfectly inelastic collision and assuming that friction between the vehicles and the road can be neglected. (8 marks)

QUESTION FIVE (20 Marks)

a. Two airplanes fly paths I and II perpendicular to each other. Both planes have air speeds of 100 m/s and fly a distance L = 200 km. The wind blows at 20.0 m/s along the path I. Find
   (i) the time of flight to each city, (5 marks)
   (ii) the time to return, and (3 marks)
   (iii) The difference in total flight times. (2marks)

b. In one version of the Michelson–Morley experiment, the length L is 28 m. Take v to be 3.0×10^4 m/s, and find
i) the time difference caused by rotation of the interferometer and (5 marks)
(ii) the expected fringe shift (5 marks)

Assuming that the light used has a wavelength of 550 nm