JARAMOGI OGINGA ODINGA UNIVERSITY OF SCIENCE AND TECHNOLOGY

SCHOOL OF BIOLOGICAL AND PHYSICAL SCIENCES

UNIVERSITY EXAMINATION FOR THE DEGREE OF BACHELOR OF EDUCATION SCIENCE WITH IT

2ND YEAR 1ST SEMESTER 2016/2017 ACADEMIC YEAR

MAIN CAMPUS

COURSE CODE: SPH 201

COURSE TITLE: DYNAMICS

EXAM VENUE: **STREAM: (BED SCI.)**

DATE: 22/04/16 **EXAM SESSION: 2.00 – 4.00 pm**

TIME: 2 HOURS

Instructions:

1. **Answer question 1 (compulsory) and ANY other 2 questions.**
2. **Candidates are advised not to write on the question paper.**
3. **Candidates must hand in their answer booklets to the invigilator while in the examination room.**

QUESTION ONE

a. A uniform metre rule of mass 40g is supported by two pivots A and B each at 12cm mark and at 80cm mark respectively. Two identical point masses of 60g and 75g are suspended on the metre rule at 40cm mark and at 90cm mark respectively. Determine the reactions at the pivots. (3 marks)

b. A uniform ladder 12 m long and weighing 80.0 N rests against a smooth vertical wall. The coefficient of static friction between the ladder and ground is 0.36. The ladder makes a 50˚ angle with the ground. How far along the length of the ladder can a 70kg painter climb before the ladder begins to slip. (3 marks)

c. Consider the following mass distribution, where x- and y- coordinates are given in meters: 5.0 kg at (2, 1) m, 3.0 kg at (-2, 4) m, and 4.0 kg at (3, -3) m. Where should a fourth object of 8.0 kg be placed so that the center of gravity of the four-object arrangement will be at (0, 0) m? (3 marks)

d. Show that the moment of inertia *I* of a thin spherical shell (hollow sphere) of mass M and radius R is given by $I = \frac{2}{3}MR^2$ (5 marks)

e. An object of mass m rotates about an axis of radius ***r*** at a linear velocity ***v***. show that this mass has a rotational kinetic energy given by $K.E = \frac{1}{2}I\omega^2$ (3 marks)

e. A hoop of mass *M* and radius *R* starts from rest at a height of 8.00 m and rolls down a slope, without slipping, determine the linear speed of the ball as it just leaves the incline. (3 marks)

f. Two bodies of masses m_1 and m_2 initially moving with velocities, $\boldsymbol{u_1}$ and $\boldsymbol{u_2}$ are involved in a perfectly elastic collision such that their final velocities are $\boldsymbol{v_1}$ and $\boldsymbol{v_2}$. Show that the ratio of the difference of their final velocities to the difference of their initial velocities is -1. i.e

$$\frac{v_1 - v_2}{u_1 - u_2} = -1$$ (4 marks)

g. Define the term **relativity** (1 mark)

h. Define the term **frame of reference** hence distinguish between an inertial **reference frame** and **non inertial reference frame** . (3 marks)

QUESTION TWO

a. A solid ball, a solid cylinder and a hoop all of equal masses M and uniform radii R are placed side by side without touching each other up a smooth inclined plane of height 4m. The two are simultaneously released to roll freely down the incline. In which order will they leave the base of the incline?
(8 marks).

b. Two blocks with masses m_1 and m_2 are attached by a string over a pulley of mass M as shown in figure 1. The pulley,which turns on a frictionless axle is a hollow cylinder (hoop) with radius $r$over which the string moves without slipping. The horizontal surface has coefficient of kinetic friction μ_k. The system is released such that m_2 falls through a vertical height h

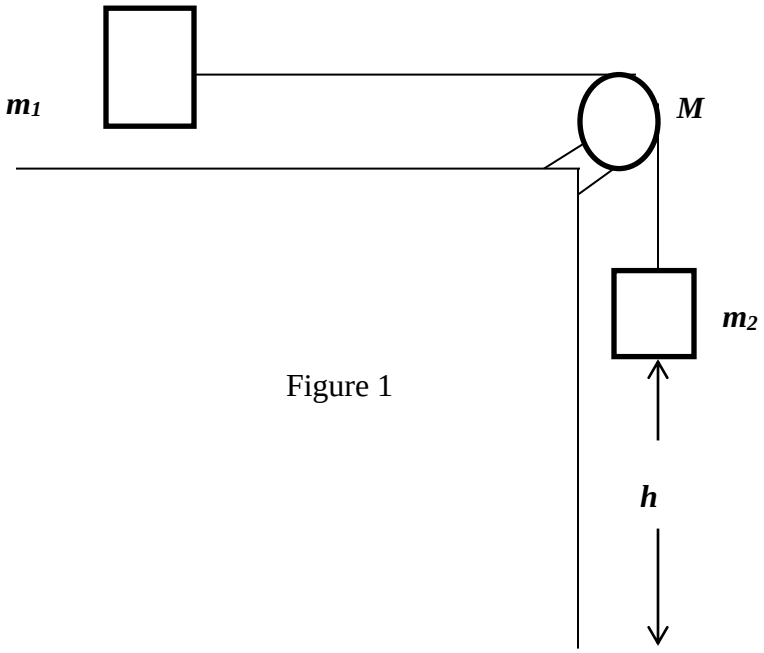

Figure 1

i. Show that the speed of the system when the mass m_2 falls through a vertical height h is given by

$$v = \sqrt{\frac{2gh(m_2 - \mu_k m_1)}{m_1 + m_2 + M}}$$ (6 marks)

ii. Obtain a similar equation for v if the pulley would have been a solid sphere

(6 marks)

QUESTION THREE

a. Distinguish between elastic and inelastic collisions (2 marks)

b. A 3,600 kg car traveling initially with a speed of 15.0 m/s in an easterly directioncollides head on with a 8 000-kg truck moving in the western direction at 20.0 m/s. Given that the collision is perfectly elastic, determine the velocity of the each vehicle right after collision. (6 marks)

c. An 18 g bullet is fired at a velocity of 1400m/s into a 15kg monkey suspended freely on a tree. The bullet gets embedded into the monkey and the two swing as a simple pendulum. Determine the maximum height risen by the system from the rest position of the monkey. (5marks)

d. A car with mass 900 kg traveling due East at a speed of 150 m/s collides at an intersection with a 1500-kg van traveling due North at a speed of 180m/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.
(7 marks)

QUESTION FOUR

a. State the principal of conservation of angular momentum (2 marks)

b. A student sits on a pivoted stool that is free to rotate about a vertical circle. He is holding a pair of identical masses on each arm. The moment of inertia of the student, stool and weights is 4.0kgm^2. The student is set into rotation with arms outstretched making 600 revolutions per minute.

i. Determine the initial angular speed of the system (3 marks)

ii. As he rotates, he pulls the weights inwards so that the new moment of inertia becomes 3.2 kgm^2. What is the new angular speed (3 marks)

iii. Find the work done by student on the system while pulling the weights inwards (4 marks).

c. The system shown in figure 2 consists of small identical masses each of mass 2kg is rotating at an angular speed of 2.0 rev/s. The objects are connected by light, flexible spokes of length 1.0m.the lengths of the spokes that can be lengthened or shortened. Determine

i. The initial moment of inertia (2 marks)

ii. The initial angular speed (2 marks)

iii. The new moment of inertia if the spokes are shortened to 0.50 m (2 marks)

iv. The new angular speed if the spokes are shortened to 0.50 m (2 marks)

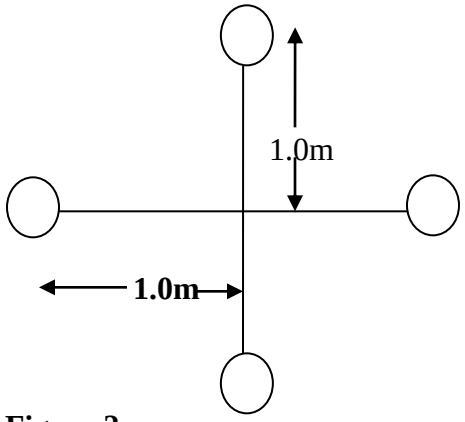

Figure 2

QUESTION FIVE

a. Using well labeled frames of reference obtain the Galiliean coordinate transformations. (10 marks)

b. A bus is moving at a speed of 120m/s. The conductor collecting fare from the passengers is walking at 15m/s from the driver's seat towards the rear seats. The bus passes by a stationary observer standing by the roadside. Another cyclist cycling at 40m/s in the same direction of the bus is being overtaken by the bus. Determine
   i. The velocity of the conductor in the bus relative to the stationary observer (3 marks)
   ii. The velocity of the conductor in the bus relative to the cyclist (3 marks)
   iii. The velocity of cyclist relative to the bus (3 marks)

c. Define an invariant quantity with reference to relativistic mechanics (1 mark)