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 2018/2019 ACADEMIC YEAR

MAIN CAMPUS

COURSE CODE: SPH 201

COURSE TITLE: Dynamics

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

DATE: **EXAM SESSION:**

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 (30 MARKS)

a. Calculate the magnitude and direction of the net torque on the beam in Figure 1.

i) When rotated about point M **(3 marks)**

ii) When rotated about point N **(3 marks)**

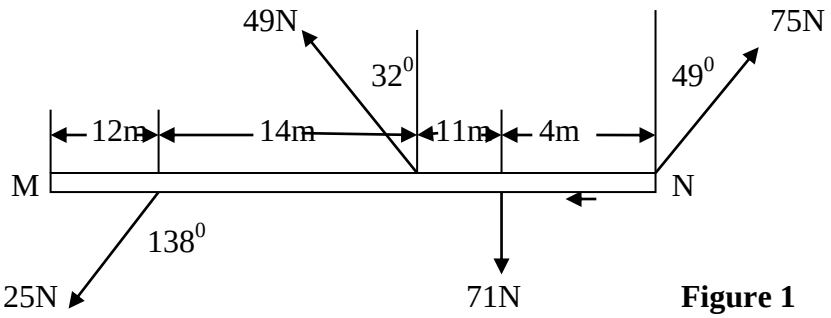

Figure 1

b. A 100-N uniform beam of wood 16m long is supported by two pivots A and B, each 3m away from each end of the beam. A 200-N baby is seated on the board 6m away from pivot B. Determine the reactions on the pivots (4 marks)

c. A uniform ladder 18 m long and weighing 180.0 N rests against a smooth vertical wall. The coefficient of static friction between the ladder and ground is 0.42. The ladder makes a 53˚ angle with the wall. A mason weighing 360N starts climbing the ladder from the ground. Find the maximum vertical height the mason will rise before the ladder begins to slip. **(5 marks)**

d. A bullet of mass m_1 moving with initial speed v_1 collides inelastically with a block of mass m_2 that is suspended as a pendulum. After the collision, the block-bullet system rises to some height h. show that the initial velocity of the bullet is given by

$$v_1 = \frac{m_1 + m_2}{m_1}\sqrt{2gh}$$ (5 marks)

e. Consider the following mass distribution in the Cartesian plane 5 kg at (0, 0), 3 kg at (0, 4), and 4 kg at (3,0). Where should a fourth object of 8 kg be placed so that the center of gravity of the four-object arrangement will be at (2,2) (3 marks)

f. 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)**

g. State the two postulates of relativity (2 marks)

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

QUESTION TWO (20 MARKS)

a. A uniform horizontal beam 15.0 m long and weighing 300 N is attached to a wall by a pin connection that allows the beam to rotate. Its far end is supported by a cable that makes an angle of 60° with the horizontal. A person weighing 750 N stands on the beam at 4.5 m from the wall while a 1000 N sack is suspended freely at 4.5 m from the supporting cable end, find

i) the magnitude of the tension in the cable. (4 marks)

ii) the magnitude and direction of the force exerted by the wall on the beam.(6 marks)

b. A pulley made in the form of a solid sphere of mass M and radius R is used to draw water from a well of depth h. A bucket of mass m is attached to a rope that wraps around the pulley. The bucket is released to fall freely as the rope unwraps from the pulley.

i) Show that the acceleration of the bucket as it drops down the well is given by

$$a = \frac{mg}{m + \frac{2}{5}M}$$ **(3 marks)**

ii) Show that the tension T on the rope holding the bucket is given by

$$T = \frac{mg}{1 + \frac{2m}{5M}}$$ (4 marks)

iii) The bucket falls to a height ***h*** just to hit the surface of water. Show that the velocity of the bucket just before it hits the water surface is given by

$$v = \sqrt{\frac{2gh}{1 + \frac{2M}{5m}}}$$ (4 marks)

QUESTION THREE (20 MARKS)

a. 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 solid sphere 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***

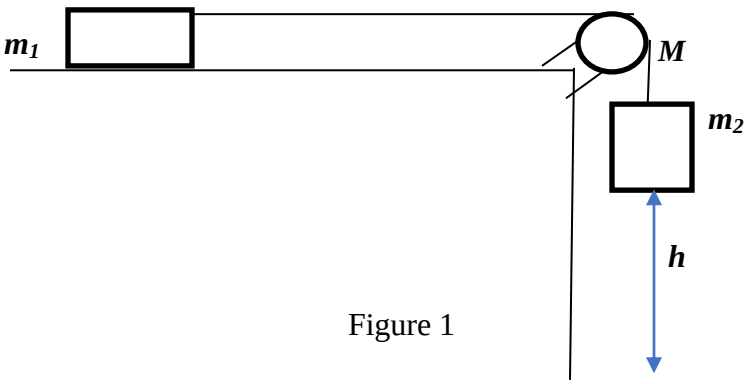

Figure 1

c. Show that the speed of the system when the mass m_2 falls through a vertical height h is given by $$v = \sqrt{\frac{10gh(m_2 - \mu_k m_1)}{5m_1 + 5m_2 + 2M}}$$ **(7 marks)**

d. An electric motor exerts a constant torque of on a grindstone mounted on its shaft for 8.0s. The moment of inertia of the grindstone is ***I=2.0Kg.m^2***. If the system starts from rest, Find
   i) The work done by the motor in 8.0 s (3 marks)
   ii) the kinetic energy of the grindstone at the end of this time. (3 marks)
   iii) the average power delivered by the motor (2 marks)

a. A small block on a frictionless horizontal surface has a mass of 2.5 kg. It is attached to a massless cord passing through a hole in the surface. The block is originally revolving at a distance of 3.0 m from the hole with an angular speed of 1.75rad/sec. The cord is then pulled from below, shortening the radius of the circle in which the block revolves by 1.80 m. Find the change in kinetic energy of the block. **(5 marks)**

QUESTION FOUR (20 MARKS)

a. A bullet of mass m_1 moving with initial speed v_1 collides inelastically with a block of mass m_2 that is suspended as a pendulum. After the collision, the block-bullet system rises to some height *h*. show that the initial velocity of the bullet is given as

$$v_1 = \frac{m_1 + m_2}{m_1}\sqrt{2gh}$$ 5 marks

Show that the coefficient of restitution is -1 5 marks

b. A 900-kg jet flying due South Eeast with a speed of 250.0 m/s accidentally plunges into 500-kg boulder flying due North East at 300.0 m/s. If the collision is perfectly inelastic, calculate the velocity and direction of the fused system just after the accident (10 marks)

QUESTION FIVE (20 Marks)

a. Clearly Present the Galiliean coordinate transformations. **(7 marks)**

b. **Analytically discuss** the Michelson-Morley experiment stating clearly the experiment objectives, setup, procedure and the findings. **(13 marks)**