JARAMOGI OGINGA ODINGA UNIVERSITY OF SCIENCE AND TECHNOLOGY

SCHOOL OF BIOLOGICAL AND PHYSICAL SCIENCES

UNIVERSITY EXAMINATION FOR THEDEGREE OF BACHELOR OF EDUCATION (SCIENCE)

MAIN

SPECIAL RESITS EXAMINATIONS FEB 2022

COURSE CODE: SPB 9209/SPH 205

COURSE TITLE: DYNAMICS

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

DATE: **EXAM SESSION:**

TIME: 2:00HRS

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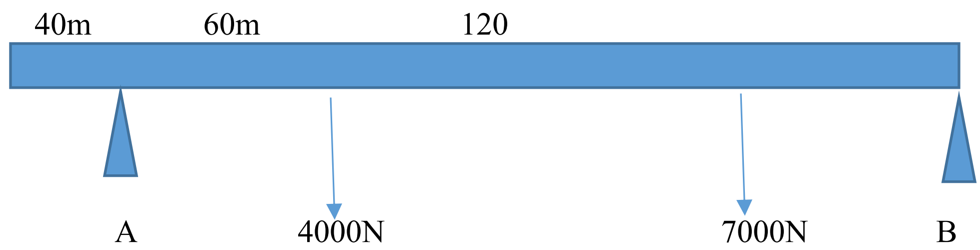
1. **Instructions:** **Answer question 1 (Compulsory) in Section A and ANY other 2 questions in Section B.**
2. **Answer Question 1 (compulsory) and ANY other 2 questions**
3. **Candidates are advised not to write on the question paper.**
4. **Candidates must hand in their answer booklets to the invigilator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

SECTION A

QUESTION ONE (Compulsory) (30 Marks)

a. Define mechanical equilibrium (2 marks)

b. A uniform beam of mass 500kg and length 300m is supported by two pivots as shown in the diagram below. Three forces are acting on it as shown. Determine the reactions on the pivots A and B.



(4 marks)

c. A uniform horizontal beam 15m long and of mass 45kg is attached to a wall by a pin connection that allows it to rotate. Its far end is supported by a cable that makes an angle of 48° with the horizontal. A solid of mass 65kg rests on the beam 5m from the wall, find the magnitude of the tension T in the cable and the Reaction R on the beam by the wall.

(6 marks)

d. Five particles of masses 7kg, 12kg, 10kg, 8kg and 6kg are placed in three dimensional space at the coordinates (5,3,), (0,5-2), (-3-2-1), (4,-2-6) and (3,2,8) respectively. Determine the coordinate of the center of gravity of the system constituted by the particles (4 marks)

e. A uniform ladder of length 12m and weight 500N rests on smooth vertical wall while standing on a rough floor at an angle 60 degrees relative to the ground. How far up the ladder will a painter of mass 60 climb the ladder before the ladder begins to slip. Take the coefficient of static friction to be 0.42. (4 marks)

f. A 12g bullet is fired horizontally into a 100g bob of a simple pendulumn. The bullet gets embedded in the bob and the two swing freely. If the bullet-bob system rises to a vertical height of 14cm, what was the speed of the bullet at impact with the bob. (4 marks)

g. State the rotational analogue of Netwon's second law of motion 2 marks

h. Define a reference frame and distinguish between inertial and non-inertial frames of reference (4 marks)

SECTION B

QUESTION TWO **(20 Marks)**

a. By use of calculus or otherwise, obtain the equation of the moment of inertia of a solid cylinder of mass M and radius R (5 marks)

b. A uniform ladder of length ***l***, and of mass ***m*** standing on a rough floor resting against a smooth vertical wall. The ladder is in a static equilibrium when the angle between the ladder relative to the horizontal ground ***θ.*** Show that the coefficient of static friction between the ground and the ladder obeys the law.

$$2\mu = Cotan\,\theta$$

(5 marks)

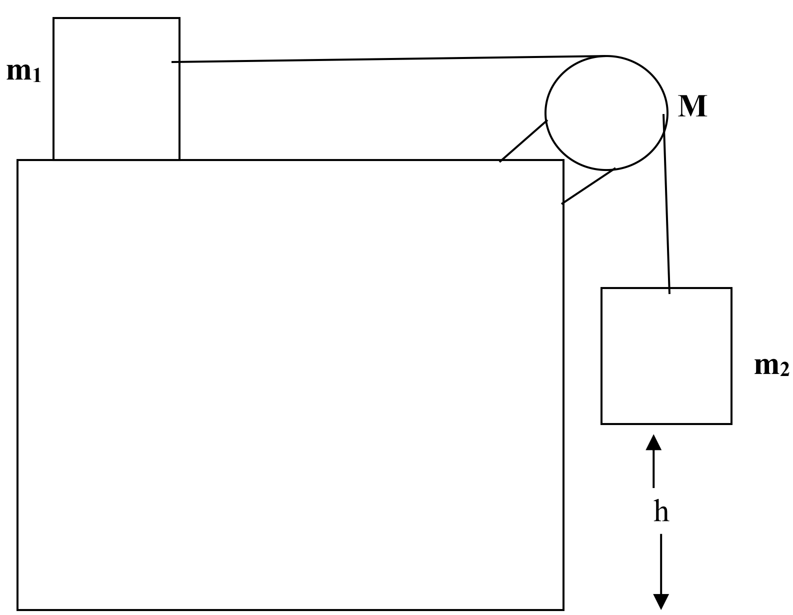
c. Three regular solids; a solid ball, a shell and a solid cylinder all of uniform masses **M** and uniform radii **R** are simultaneously released from the top of an incline at an initial linear velocity ***v*** while rolling at an initial angular velocity ***w*** up the incline without slipping. Which solid will rise to the highest height ***h*** up the incline? (10 marks)

QUESTION THREE **(20 Marks)**

a. A pulley in the shape of a hoop of mass M and radius R is used to draw water from a well. A bucket of mass m is attached to a cord that is wrapped around the cylinder. Find an expression for the tension ***T*** in the cord and acceleration ***a*** of the bucket.

(10 marks)

b. Two blocks with masses $\mathbf{m_1}$ and $\mathbf{m_2}$ are attached by a string over a pulley with mass **M** such that $\mathbf{m_1}$ lies on a rough horizontal surface while $\mathbf{m_2}$ hangs freely. The pulley, which turns on a frictionless axle, is a solid cylinder with radius **R** over which the string moves without slipping. The horizontal surface has coefficient of kinetic friction $\boldsymbol{\mu_k}$.



i) Find the expression of the velocity **v** of the system when the block of mass $\mathbf{m_2}$ has dropped through a height **h**. **(6 marks)**

ii) If the motion takes 40 seconds, determine the horizontal distance **d** covered by $\mathbf{m_1}$ given that $\mathbf{m_1}$=6kg, $\mathbf{m_2}$**=10kg, M=20kg, R=40cm,** μ_k**=0.25 and g=10N/Kg** **(4 marks)**

QUESTION FOUR **(20 Marks)**

a. In a dancing competition, Achieng' was spotted dancing initially with an angular speed of 12.0rad/sec with her arms and legs fully outstretched. Her moment of inertia being 16kgm^2. She than changes the dancing style by pulling her legs and arms tight to her body, reducing her moment of inertia to 2kgm^2.
   i) What is her angular speed in the last dance style (5 marks)
   ii) What is the ratio of new kinetic energy to the initial kinetic energy (5 marks)

b. A stone of mass 3kg moving towards East at 80m/s hits a bird of mass 6kg moving towards North at 120m/s. The stone gets embedded into the bird's stomach and the two continue moving in some direction. Find the common velocity and direction of the two after collision. (7 marks)

c. A pool table ball of mass $\mathbf{m_1}$ moving at a speed $\mathbf{u_1}$ collides and gets stuck to another ball twice it's mass moving initially in the same direction as the car at a lower speed $\mathbf{u_2}$.
   In terms of $\mathbf{m_1}$**,** $\mathbf{m_2}$**,** $\mathbf{u_1}$ **and** $\mathbf{u_2}$ find the final speed **v** of the two balls immediately after collision. (3 marks)

QUESTION FIVE **(20 Marks)**

a. Define the term general relativity (2 mark)

b. Define a frame of reference hence distinguish between inertial and non-inertial frames of reference (3 marks)

c. Fully discuss the Galilean transformations (5 marks)

d. Explain the concepts of time retardation and length contraction as in general theory of relativity (10 marks)