



# MERU UNIVERSITY OF SCIENCE AND TECHNOLOGY

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## UNIVERSITY EXAMINATIONS 2022/2023

FIRST YEAR, SECOND SEMESTER SPECIAL/SUPPLEMENTARY EXAMINATION  
FOR DEGREE OF BACHELOR OF EDUCATION SCIENCE AND BACHELOR OF  
SCIENCE (PHYSICS)

### SPH 3100: MECHANICS I

DATE: AUGUST 2023

TIME: 2 HOURS

INSTRUCTIONS: Answer Question ONE and any other TWO questions.

#### QUESTION ONE (30 MARKS)

- Define a position vector giving an example (2 Marks)
- State the Newton's third law of motion (1 Mark)
- An elastic ball hits the ground vertically with a velocity of from a cliff of height 80 freely falling. and that the collision between the ball and the ground was perfectly elastic, find the maximum height reached by the ball in the first re-bounce (4 Marks)
- A bus of mass 3600 kg moving up a hill of inclination  $15^\circ$  to the horizontal is accelerating at  $0.5\text{m/s}^2$ , find the driving force of the bus (5 Marks)
- Show that for a constant force, the acceleration of a body is given by  $F = ma$  where  $a$  is the acceleration and  $m$  is the mass of the body (5 Marks)
- Given that  $\vec{c} = \vec{a} + \vec{b}$  and that  $\vec{a} = 4i - 2j + 2k$  and  $\vec{b} = -i + 4j$ , find  $\vec{c}$  (3 Marks)
- A circular disc rotates about its centre at the rate of 800 revolutions per minute. Calculate the angular velocity of the disc (5 Marks)
- A car of mass 1200 kg can move round a circular roundabout of radius 20 m at a maximum tangential speed of 4 m/s. Assuming that the road is perfectly horizontal (No banking). Find the coefficient of friction between the road surface and the car tyres (5 Marks)



### QUESTION TWO (20 MARKS)

- a) Show that the work done by an accelerating body is equal to the change in Kinetic energy during the acceleration period (7 Marks)
- b) A train of 40 tonnes moving at 30 m/s is brought to rest in 15 seconds. Find:
- Acceleration (2 Marks)
  - Braking force (2 Marks)
  - The change in kinetic energy of the train before it is brought to rest (4 Marks)
  - The displacement within which the train is brought to rest (3 Marks)
  - The braking power (2 Marks)

### QUESTION THREE (20 MARKS)

- a) Two masses  $m_1$  and  $m_2$  are used in a collision experiment.  $m_1$  is moving at 20 m/s at an angle of  $45^\circ$  from the x-axis in the positive direction towards south-east while  $m_2$  is moving  $30^\circ$  from the x-axis north-east at 10 m/s. The masses collide at the origin and fuse and move together. If the masses were  $m_2 = 20\text{ kg}$  and  $m_1 = 10\text{ kg}$ . Calculate:
- The component of momentum of  $m_1$  along the X-axis (3 Marks)
  - The component of momentum of  $m_2$  along the x-axis (3 Marks)
  - Assuming that the bodies move along the x-axis after collision, find their common velocity (4 Marks)
- b) Two vectors are given as that  $\vec{a} = 2i + 4j + k$  and  $\vec{b} = 3i - j + 4k$ . Find
- The cross product of the two vectors (5 Marks)
- The dot product of the two vectors (3 Marks)
  - The difference of the two vectors (2 Marks)

### QUESTION FOUR (20 MARKS)

- a) A gunner fires a bullet of 40 g that hits a target on the ground at the same firing height a distance of 400 m. If the velocity of launch of the bullet was 200 m/s and the time taken to hit the target was 3 seconds. Calculate:
- The time of flight (1 Mark)
  - The kinetic energy with which the target is hit along the horizontal direction (5 Marks)
  - The maximum height reached by the bullet (5 Marks)
  - The angle at which the bullet was shot from the horizontal (3 Marks)

- b) A metallic bob of mass 100 g is whirled by a string of length 0.5 m in a horizontal plane. Find the tangential speed of the would just maintain bob at horizontal plane (6 Marks)

