MACHAKOS UNIVERSITY

University Examinations for 2019/2020Academic Year

SCHOOL OF ENGINEERING AND TECHNOLOGY

DEPARTMENT OF MECHANICAL AND MANUFACTURING ENGINEERING

…… YEAR SECOND SEMESTER EXAMINATION FOR

BACHELOR OF SCIENCE IN MECHANICAL ENGINEERING

EMM208: ENGINEERING MECHANICS II

DATE: **TIME:**

INSTRUCTIONS

Answer Question One and Any Other Two Questions

QUESTION ONE (30 MARKS)

a) At a certain instant, a body of mass 5 kg falling freely under the force of gravity was found to be falling at the rate of 20m/s. Determine from that instant, the force required to stop the body

i. in 2 seconds (3 marks)

ii. in 2 meters (3 marks)

b) The acceleration of a particle varies with time **t** and is given by **a = 6 - 5t.** It is observed that the velocity of the particle is 30 m/s when time is 8 sec and also that the particle is 125m from the origin when time is 15 sec. Determine:

i the acceleration, velocity and distance when t = 0 (5 marks)

ii the time when velocity is zero and the corresponding distance from the origin (4 marks)

c) i A 50 kg block rests on a horizontal plane for which the coefficient of friction is 0.3. If the block is acted upon by a 400 N Force acting at 30^0 from the horizontal as shown in fig Q1c.

Determine:

i. the velocity of the block after 5 sec (3 marks)

ii. the horizontal distance covered by the block within that time (3 marks)

fig Q1c.

d) i Distinguish between work and energy. (2 marks)

ii A wagon of mass 50 tonnes starts from rest at the top of a slope inclined at 10^0 to the horizontal and travels 30 m down the slope before being stopped by a bumber spring. If in its motion, the wagon experiences a rolling resistance of 50 N/tonne and the bumper spring has a compression of 1mm per 20 kN force, determine:

i) the velocity with which the wagon strikes the bumber spring. (4 marks)

ii) the amount by which the spring will be compressed (3 marks)

QUESTION TWO (20 MARKS)

a) i) State Newton's law of gravitation

ii) Describe with suitable sketches Kepler's laws of planetary motion. (8 marks)

b) An astronaut releases a navigation ball of mass 7.2 kg into a circular orbit about the earth at an altitude of 350km.

Determine;

i) the mechanical energy of the ball in its orbit

ii) the mechanical energy of the ball at the point of launch

(Take radius of earth=6370km, Gravitational constant=6.67 $\times 10^{-11} m^3/kg.s^2$, Mass of earth=$5.98\times10^{24}$kg, Mass of sun=$1.99\times10^{30}$kg) (6 marks)

c) Determine the constant speed of a satellite so that it circles the earth with an orbit of radius $15x10^6$ m. Take the mass of the earth as 5.98 $x10^{24}$kg (6 marks)

QUESTION THREE (20 MARKS)

a) The angular displacement of a particle moving along a circular path of radius 20 m is given by the equation: $\Theta=18t+3t^2-2t^3$; where Θ is the angular displacement after time t. Find:

i. the angular acceleration at the start (2 marks)

ii. the time when the particle attains its maximum angular velocity (2 marks)

iii. the maximum angular velocity (2 marks)

iv. the linear velocity corresponding to(iii) above (2 marks)

b) A passenger of mass 82 kg stands on a scale inside an elevator cabin. Determine

i the scale reading when the cab is accelerating upwards at 3.20m/s2 (2 marks)

ii the acceleration when the scale reading is 477 N. (3 marks)

c) A certain force gives an object of mass $\mathbf{m_1}$ an acceleration of 15.0 m/s^2 and another object of mass $\mathbf{m_2}$ an acceleration of 6.0 m/s^2. Determine the acceleration which this force would impart to an object of mass;

i. $(\mathbf{m_1 + m_2})$ (4 marks)

ii. $(\mathbf{m_2 - m_1})$ (3 marks)

QUESTION FOUR (20 MARKS)

a) i) State D'Alemberts principle (2 marks)

ii) Two blocks of mass 90 kg and 40 kg respectively are connected by a cable and move along a rough horizontal plane under the action of a force of 500 N applied to the first body as shown in figure Q4a. If μ=0.25 between the contacting surfaces, determine the acceleration of the two blocks the tension in the connecting cable (9 marks)

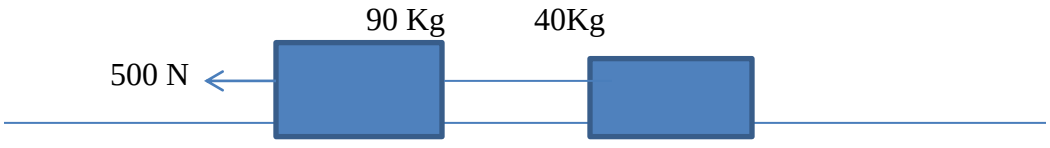

Fig Q4a

b) A body of mass 80 kg is moved at a constant acceleration up an inclined plane over a distance of 15m by a force of 100 N applied upwards and parallel to the plane. If the total resisting force acting on the body is 15 N and the angle of inclination of the plane to the horizontal is 35^0, determine the resulting acceleration. (9 marks)

QUESTION FIVE (20 MARKS)

a) Derive from first principles the equation for the mass moment of inertia of a solid sphere of radius **r** and material density **ρ** about an axis passing through its centre (6 marks)

b) i) Describe the role of a flywheel in an engine (3 marks)

ii) A flywheel with a radius of gyration of 1.2 m is fitted to an engine which runs at a mean speed of 350 rpm. If the engine speed varies from 2% above the mean and 3% below it and the fluctuation of energy is 30 KN-m, determine the mass of the flywheel (5 marks)

c) Two bodies A and B of masses 800 kg and 600 kg are attached at the ends of a flexible rope. The rope passes over a pulley of 800 mm diameter. The pulley has a mass of 100kg with a radius of gyration of 400 mm about its axis of rotation. Neglecting friction at the spindle, determine the torque which must be applied to the pulley in order to raise the 800 kg body with an acceleration of 1 m/s^2 (6 marks)