



MACHAKOS UNIVERSITY

SCHOOL OF ENGINEERING AND TECHNOLOGY

DEPARTMENT OF MECHANICAL AND MANUFACTURING ENGINEERING

**SECOND YEAR SUPPLEMENTARY/SPECIAL EXAMINATION FOR DEGREE
BACHELOR OF SCIENCE IN MECHANICAL ENGINEERING**

MARCH 2021

EMM208 ENGINEERING MECHANICS II

DATE:.....

TIME: 2 Hours

Instructions

Attempt question 1 (compulsory) and any other TWO questions

QUESTION ONE – (COMPULSORY, 30 MARKS)

1.a) Distinguish between the following terms

i) distance and displacement

ii) speed and velocity (4 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 30m/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 $t=0$

ii) the time when velocity is zero and the corresponding distance from the origin (10 marks)

b) A key falls from a bridge that is 55m above the surface of the sea water below. It is observed that the key falls directly into a tour boat moving with a constant velocity and that was 42m away from the point of impact when the key was released.What is the speed of the boat (7 marks)

d) i) Distinguish between work and energy.

ii) A trolley of mass 4kg slides along a horizontal frictionless surface at a speed of 1.5m/s. It then runs onto a spring stopper of stiffness 750 N/m. when the trolley is momentarily stopped by the spring, how much does the spring compress? (9 marks)

QUESTION TWO – (20 MARKS)

a) i) State Newton's law of gravitation

ii) Describe Keplers 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= $6.67 \times 10^{-11} \text{m}^3/\text{kg.s}^2$,

Mass of earth= $5.98 \times 10^{24} \text{kg}$, Mass of sun= $1.99 \times 10^{30} \text{kg}$) (6 marks)

c) i) Distinguish between work and energy

ii) A truck of mass 15 tonnes travelling at 16m/sec impacts onto a spring loaded buffer stop which compresses 2.5mm per kN force. Find the maximum compression of this buffer (6 marks)

QUESTION THREE – (20 MARKS)

(a)i) State Newton's second law of motion

ii) Show that from Newtons second law, $\mathbf{F}=\mathbf{ma}$ where the symbols have their usual meaning (6 marks)

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

i) the scale reading when the cab is stationary

ii) the scale reading when the cab is accelerating upwards at 3.20m/s^2

iii) the acceleration when the scale reading is 477N. (7 marks)

c) A certain force gives an object of mass $\mathbf{m_1}$ an acceleration of 18.0 m/s^2 and another object of mass $\mathbf{m_2}$ an acceleration of 6.30 m/s^2 . Determine the acceleration which this force would impart to an object of mass;

i) $(\mathbf{m_1+m_2})$

ii) $(\mathbf{m_2 -m_1})$ (7 marks)

QUESTION FOUR – (20 MARKS)

a) i) State D'Alemberts principle

ii) A one tonne vehicle moving down a 1 in 15 incline at 80km/hr is braked and comes to a halt in 86m. If the frictional resistance to motion is 362N, determine the braking force applied. (11 marks)

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° determine the resulting acceleration. (9 marks)

QUESTION FIVE – (20 MARKS)

a) i) Distinguish between centroid and centre of gravity

ii) Show that the centroid of a triangular section of base **b** and height **h** occurs at a distance $\frac{h}{3}$ from the base (8 marks)

b) i) 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

ii) A model coin in the form of a circular disc has a diameter 600 mm and a thickness 25mm. If the material of the coin has a density of 6300kg/m^3 , determine the mass moment of inertia of the coin about its diameter. (12 marks)