MACHAKOS UNIVERSITY

University Examinations 2021/2022

SCHOOL OF PURE AND APPLIED SCIENCES

DEPARTMENT OF PHYSICAL SCIENCES

FIRST YEAR FIRST SEMESTER EXAMINATION FOR

BACHELOR OF SCIENCE (ELECTRICAL AND ELECTRONIC ENGINEERING)

BACHELOR OF SCIENCE (MECHANICAL ENGINEERING)

BACHELOR OF SCIENCE (CIVIL ENGENEERING)

ECU 101: PHYSICS FOR ENGINEERS I

DATE: 3/2/2022 **TIME: 8:30 – 10:30 AM**

INSTRUCTIONS TO CANDIDATES

Answer QUESTION ONE which is ***COMPULSORY*** and **ANY OTHER TWO** questions.

Question 1 carries **30** marks and the others carry **20**marks each.

YOUMAYUSE:

You may need to use the following constants

- Density of water= 1.0 x 10^3kg/m^3
- Acceleration due to gravity g=9.8 m/s^2
- Universal gravitational constant G=6.67 x10^{-11}N$m^2$$kg^{-2}$
- Mean radius of the earth R_e=6400 km
- Mass of the Earth, Me, = 5.98 x 10^{24} kg
- Mass of the Sun, Ms, = 1.98 x 10^{30} kg
- Permittivity of free-space, $\varepsilon_o = 8.85 \times 10^{-12}$ F/m

QUESTION ONE (30 MARKS)

a) State the first Newton's law of motion (2 marks)

b) A block of 100 N weight is resting on a rough horizontal table. What force P inclined at 30° to the horizontal is required to move the block horizontally with an acceleration of 2 m/s^2. Given that, the coefficient of kinetic friction between the contact surfaces is 0.2 as shown in fig 1 (4 marks)

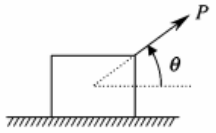

Fig 1

c) The displacement of a body of 5 kg mass with respect to time is given as $x = 3t^2 + 2$, where x is in meters and t is in seconds. Determine the force acting on it causing the motion (3 marks)

d) A body moves along a straight line according to the law $s = 1.5t^2 - 2t$. Determine its velocity and acceleration at the end of 2 seconds (3 marks)

e) A varying force $F = t^2 i + 2tj$ is applied on a particle from $t = 0$ s to $t = 3$ s. determine the impulsive force in 3 seconds (3 marks)

f) Determine the gravitational attraction between the earth (m= 5.98 x 10^{24} kg) and a 90 kg man if the man is in an airplane at 13000 metres above the earth's surface (Radius of the earth 6380000 metres) (3 marks)

g) Suppose a load of 1.5 kg attached to the end of a wire 3 m long of diameter 0.46 mm stretches it by 2 mm. Find the young`s modulus of the wire (3 marks)

h) If vectors **A**=2**i**-**j**-3**k** and **B**=3**i**-6**j**-**k**. Find $\boldsymbol{A} \times \boldsymbol{B}$ and angle between **A** and **B** (3 marks)

i) A wave travelling along strings is described by $y(x,t) = 0.004\sin(72x - 3t)$. The numerical values are in SI units. Calculate the following from the equation amplitude, wavelength, period and velocity (4 marks)

j) Briefly describe a blackbody (2marks)

QUESTION TWO (20 MARKS)

a) State Newton's third law of motion (2 marks)

b) Two blocks of masses M_1 and M_2 ae suspended by an inextensible string passing over a massless and frictionless pulley as shown in **fig 2**. When released from rest, determine the expressions and value for the acceleration of the system and the tension in the string. Take M_1 =2 kg and M_2 = 3 kg (8 marks)

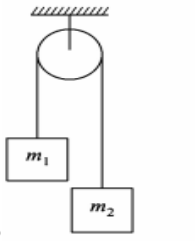

Fig 2

c) A ball is thrown from the ground with a velocity of 20m/s at an angle of 30° to the horizontal. Determine

i. The velocity of the ball at $t = 1.5$ s (2 marks)

ii. Total time of flight of the ball (2 marks)

iii. Maximum height reached (3 marks)

iv. maximum Range of the ball (3 marks)

QUESTION THREE (20 MARKS)

a) Describe the term Simple harmonic motion (SHM) (2 marks)

b) A particle executing SHM has a maximum velocity of 10 m/s and a maximum acceleration of 20 m/s^2. Determine

i. Period and amplitude of the motion (2 marks)

ii. Displacement, velocity and acceleration of the particle at t=2 s from the mean position (2 marks)

iii. Displacement, velocity and acceleration of the particle at t=0.5 s, from the extreme right position (3 marks)

iv. Velocity and acceleration t a point 3 m to the right mean position and the time taken to reach it (3 marks)

c) A mass of 5 kg extends a spring vertically by 15 cm. the same spring supports a mass of 2 kg attached at its lower end. Determine the frequency of oscillation when displaced vertically from its equilibrium position (4marks)

d) The speed of transverse waves on a string is $60ms^{-1}$. In addition, a mass of 981g mass hung on the string. Find the mass that should hung on the string to increase the speed to 150 ms^{-1}. G = $9.81ms^{-2}$ (4marks)

QUESTION FOUR (20 MARKS)

a) State the first law of thermodynamics (2 marks)

b) The value of specific heat at constant pressure and constant volume for an ideal gas are 0.984 Kj/Kg.K and 0.798 Kj/Kg.K.. If 1 kg of this gas is heated at constant pressure from 25°C to 200°C. Given, c_p = 0.984 Kj/Kg.K, c_v = 0.728 Kj/Kg.K, m= 1kg, T_1 = 25°C = 298K, T_2 = 200°C = 473 K and $V_1 = 2m^3$. Find

i. The values of characteristic gas constant ® and ratio of specific heats (γ) for the gas (6 marks)

ii. Estimate the heat added (3 marks)

iii. Ideal work (3 marks)

c) A force of 175 N magnitude acting parallel to the inclined plane pulls a block of 25 kg mass at rest on an inclined plane. Determine the acceleration of the block if the coefficient of kinetic friction between the block and the plane is 0.3. (6 marks)

QUESTION FIVE (20 MARKS)

a) A pendulum of of mass 50g is attached to one end of the string of length 1.5 m. the bob moves in a horizontal circle in such a way that the string is inclined at 8 ° to the vertical. Calculate

i. The tension on the string (4 marks)

ii. The period of the motion (5 marks)

b) The line of action of force of magnitude 50 N passes through points A (4, 5, 6) and B (2,-2, 2). Express the force in vector form (8 marks)

c) A very bright star has effective surface temperature of 20, 000K. find the wavelength at which the spectral radiant power is maximum. (3 marks)

(Wein's displacement constant $2.898 \times 10^{-3} m.K$)