THE MOMBASA POLYTECHNIC UNIVERSITY COLLEGE

(A Constituent College of JKUAT)

Faculty of Applied & Health Sciences

DEPARTMENT OF MATHEMATICS & PHYSICS

UNIVERSITY EXAMINATION FOR BACHELOR OF SCIENCE, ENGINEERING & TECHNOLOGY IN ELECTRICAL & ELECTRONIC ENGINEERING, MECHANICAL & AUTOMOTIVE ENGINEERING, BUILDING & CIVIL ENGINEERING & COMPUTER TECHNOLOGY

SPH 2170/APS 4101: PHYSICS/PHYSICS FOR ENGINEERS I

SPECIAL/SUPPLEMENTARY EXAMINATION

SERIES: MAY/JUNE 2012

TIME: 2 HOURS

Instructions to Candidates:

You should have the following for this examination

- *Answer Booklet*

This paper consists of **FIVE** questions

Answer question **ONE (COMPULSORY)** and any other **TWO** questions

Maximum marks for each part of a question are clearly shown

This paper consists of **FOUR** printed pages

Take:

Speed of light in a vacuum = 3.0 x 108m/s

Gravitational acceleration, g = 9.81m/s^2

Refractive index of air, $\eta = 1.00$

Density of water = 1000kg/m^3

Radius of the Earth R_e = 6400km

Radius of the Moon R_m = 1740km

Specific heat capacity of water = 4200 JKg^{-1} K^{-1}

Linear expansivity of brass = 1.9 x 1^{-5} K^{-1}

Question 1 (Compulsory - 30 Marks)

a) Describe the types of measurement errors and explain how they can be reduced. (4 marks)

b) Express the following into SI units giving your answers in standard form.

i) 0.25 fs

ii) 140 TB (1 mark)

c) Verify if the expression below is dimensionally correct

$$\frac{T}{m} = \frac{v^2}{r} - g$$

where T, m, v and g are tension 0

Where T, m, v and g are tension, mass, speed and gravitational pull per unit mass respectively.

d) A bus travelling at $80ms^{-1}$ is negotiating a curve of radius 60m. Calculate the force exerted on a 60kg person leaning on the inner wall situated 50m from the centre of the curve (2 marks)

e) The Moon revolves around the earth in a nearly circular path of radius 382,400km from the centre of the Earth, once in 27.3 days.
   (i) Calculate the speed of the Moon in ms^{-1} (3 marks)
   (ii) How far is the Moon accelerating towards the centre of the Earth? (2 marks)

f) State **TWO** conditions necessary for uniform circular motion (2 marks)

g) A mass of 2kg on a spring is extended by 0.3m from its equilibrium position and released from rest. The spring constant is $65Nm^{-1}$. Find:
   (i) The characteristic frequency of the vibrating spring (2 marks)
   (ii) The maximum speed of the mass after it is released (3 marks)

h) A ray of light is incident on the plane surface of a tra nsparent material at such an angle that the reflected and refracted rays are at right angles to each other. Calculate the relative refractive index if the angle of refraction is 30^o (3 marks)

i) A particle moves along the x-axis according to the equation $x(t) = 2.0 + 3.0t - 1.0t^2$, where x is in metres and t is in seconds. Find:
   (i) The average velocity between $t = 1.0$ and $t = 3.0$ seconds (2 marks)
   (ii) The acceleration of the particle at $t = 2.5$ seconds (2 marks)

Question 2 (20 Marks)

a) Distinguish between average and instantaneous acceleration (2 marks)

b) Derive the **THREE** equations for describing uniformly accelerated motion (8 marks)

c) A projectile is fired with an initial speed $v_o = 30m/s$ from a level ground at a target that is on the ground at a distance $R = 20m$. Find the launch angles that will allow the projectile to hit the target (4 marks)

d) Two masses $m_1 = 14kg$ and $m_2 = 10kg$ are connected to each other by a massles inextensible cord that runs over a frictionless pulley as shown below.

m_1

If the angle of inclination $R = 30^o$ and the masses move with uniform velocity, calculate the coefficient of kinetic friction μ_k (6 marks)

Question 3 (20 Marks)

a) Distinguish between traverse and longitudinal waves (4 marks)

b) A travelling wave on a string is described by $y = 2.0\sin[\, 2\pi\left(\frac{t}{0.4} + \frac{x}{80}\right)]$ where x and y are in centimeters and t is in seconds. Determine the wave's:

(i) Amplitude (1 mark)
(ii) Frequency (2 marks)
(iii) Velocity (2 marks)
(iv) Wavelength (2 marks)

c) Explain why radio waves diffract around buildings although visible light waves do not (3 marks)

d) Two parallel slits are illuminated with monochromatic light of wavelength 500nm. An interference pattern is formed on a screen one metre from the slits, and the fourth bright band is located 1.68cm from the central bright band on the screen. Find:

(i) The pathlength difference corresponding to the forth bright band (2 marks)
(ii) The distance between the two parallel slits (3 marks)

Question 4 (20 Marks)

a) Define the following terms as used in materials
   (i) Stress (1 mark)
   (ii) Young's modulus (1 mark)
   (iii) Fatigue (1 mark)

b) Sketch a general stress-strain graph for materials and explain the shape of your graph (4 marks)

c) Briefly describe the **THREE** modes of heat transfer (6 marks)

d) At 20ºC, a brass cube has an edge length of 30cm. Calculate the increase in the cube's surface area when it is heated from 20ºC to 75ºC (3 marks)

e) A container made of metal has a mass of 3.6 kg and contains 14kg of water. A 1.8kg piece of the metal initially at a temperature of 180ºC is dropped into the water. Calculate the specific heat capacity of the metal if the initial temperature of the container and water was 16ºC, and the final temperature of the entire system is 18ºC (4 marks)

Question 5 (20 Marks)

a) Distinguish between conservative and non-conservative forces (2 marks)

b) From Newton's third law, derive the principle of conservation of linear momentum (5 marks)

c) A billiard ball moving at 5.00m/s strikes a stationary ball of the same mass. After collision, the first ball moves at 4.33m/s at an angle of 30.0° with respect to the original line of motion. Assuming an elastic collision (and ignoring friction and rotational motion), find the struck ball's velocity after collision. (5 marks)

d) A flea of mass 5g is located at co-ordinates (0, -4.0m, 5.0m) when forces $\vec{F}_1 = 3.0\hat{k}\,N$ and $\vec{F}_2 = -2.0\hat{j}\,N$ act on it. Calculate:
   (i) Net torque on the flea (3 marks)
   (ii) Its tangential acceleration (2 marks)
   (iii) Its angular acceleration (2 marks)