TECHNICAL UNIVERSITY OF MOMBASA

Faculty of Applied & Health Sciences

DEPARTMENT OF MATHEMATICS & PHYSICS

UNIVERSITY EXAMINATION FOR DEGREE OF:

BACHELOR OF TECHNOLOGY IN RENEWABLE ENERGY
BACHELOR OF TECHNOLOGY IN APPLIED PHYSICS
(BTRE 13S/BTAP 13S)

APS 4201: MECHANICS II

END OF SEMESTER EXAMINATION
SERIES: DECEMBER 2014
TIME ALLOWED: 2 HOURS

Instructions to Candidates:
You should have the following for this examination
- *Mathematical tables*
- *Scientific Calculator*

This paper consist of **FOUR** questions
Answer question **ONE (COMPULSORY)** and any other **TWO** questions
Maximum marks for each part of a question are as shown
This paper consists of **THREE** printed pages

Question One (Compulsory)

a) We claim that momentum is conserved. Yet most moving objects eventually slow down and stop. Explain. **(3 marks)**

b) A light object and a heavy object have the same kinetic energy. Which has the greater momentum? Explain with relevant equations. **(4 marks)**

c) Two bodies of masses 2kg and 10kg have position vectors (3i + 2j –k) and (i – j + 3k) respectively. Find the position vector of their centre of mass and the distance of their centre of mass from the origin. **(3 marks)**

d) Starting from the equation defining the angular momentum of a particle, prove that the rate of change of the angular momentum is actually the net torque on the particle. **(6 marks)**

e) Show that the total angular momentum of a system of particular about the origin of an inertial reference frame can be written as the sum of the angular momentum about the centre of mass plus the angular momentum of the centre of mass about the origin. **(6 marks)**

f) A playful astronaut releases a bowling ball, of mass m = 7.20kg, into circular orbit about Earth at an altitude h of 350km. What is the Mechanical energy E of the ball in its orbit? (Radius of earth = 6370km and G = 6.67 x $10^{-11}Nm^{-2}/kg^2$, Mass of Earth = 5.98 x 10^{24}kg). **(3 marks)**

g) The life time of Mu-mesons is 2.2 x 10^6sec and their speed is 0.998c, so that they can cover only a distance of 658.6 metres in their entire life time, and yet they are found in profusion at sea level i.e. at a depth of 10km from the upper atmosphere where they are produced. How may this be explained on the basis of Lorentic – Fitzgerald contraction? **(5 marks)**

Question Two

a) State and explain TWO consequences of Lorentz transformation. **(4 marks)**

b) Calculate the percentage contraction in the length of a rod in a frame reference moving with velocity 0.8C in a direction:
   (i) Parallel to its length **(4 marks)**
   (ii) At an angle of 30o with its length **(7 marks)**
   (iii) What is the orientation of the rod in the moving frame of reference in case (ii)? **(5 marks)**

Question Three

a) Calculate the gravitational force between two lead spheres of radius 10cm in contact with one another G = 6.67 x 10^{-11} MKS units. Density of lead 11,300kg/m^3 **(4 marks)**

b) If the earth – moon distance is d and the mass of earth is 81 times that of the moon, locate the neutral point on the line joining the centres of the earth and moon. **(6 marks)**

c) If W1 is the work done in taking the satellite from the surface of the earth of radius R to a height h and W2 the extra work required to put the satellite in the orbit at altitude h, and $h = R/2$ then show that the ratio $W_1/W_2 = 1.0$ **(10 marks)**

Question Four

a) (i) What in the angular momentum of a 2.8kg uniform cylindrical grinding wheel of radius 11cm when rotating at 1300rpm?
   (ii) How much torque is required to stop it in 6.0S? **(3 marks)**

b) A uniform horizontal rod of mass M and length l rotates with angular velocity w about a vertical axis through its center. Attached to each end of the rod is a small mass m. Determine the angular momentum of the system about the axis. **(5 marks)**

c) Three particles, each of mass 2.50kg, are located at the corners of a right triangle whose sides are 2.00m and 1.50m long. Locate the centre of mass of the system. **(6 marks)**

Question Five

A geosynchronous satellite is one that stays above the same point on the Earth; (i.e. satellite revolves around the earth with the same period that the Earth rotates on its axis). Determine:

a) The height above the Earth's surface such a satellite must orbit. **(10 marks)**
b) The speed of the satellite **(6 marks)**
c) Compare to the speed of satellite orbiting 200km above Earth's surface **(4 marks)**