EMBU UNIVERSITY COLLEGE

(A Constituent College of the University of Nairobi)

2015/2016 ACADEMIC YEAR

FIRST SEMESTER EXAMINATION

THIRD YEAR EXAMINATION FOR THE DEGREE OF BACHELOR OF SCIENCE

SPH 305: CLASSICAL MECHANICS

DATE: DECEMBER 30, 2015 **TIME: 8:30-10:30**

INSTRUCTIONS:

You may use the following constants:

Density of the earth, $\rho = 5.51 \times 10^3 kg/m^3$

Gravitational constant $G = 6.67 \times 10^{-11} Nm^2/kg^2$

Gravitational acceleration, $g = 10 m/s^2$

Answer Question ONE and ANY Other TWO Questions.

QUESTION ONE: 30 MARKS

a) Show that $\overrightarrow{P} = \overrightarrow{F(e)}$ which gives the conservation theorem for the linear momentum of a system of particles. (6 marks)

b) Write down the sequence of the procedures followed when constructing the Hamiltonian by Lagrangian formulation. (5 marks)

c) Find the principal moment of inertia and the centre of the uniform rectangular plate of size ***a*** and ***b*** given that the moment of inertia about side ***a*** is $\frac{1}{3}mb^2$. (7 marks)

d) The Atwood machine has two masses M_1 and M_2 connected by an inextensible string of negligible mass passing over a fixed frictionless pulley of negligible mass. Show that the equation of motion is $\ddot{x} = \frac{M_1 - M_2}{M_1 + M_2} g$ (8 marks)

e) Differentiate between Holonomic and Non-Holonomic constraints giving example of each. (4 marks)

QUESTION TWO (20 MARKS)

A square plate has side of dimensions ***a***. Find:

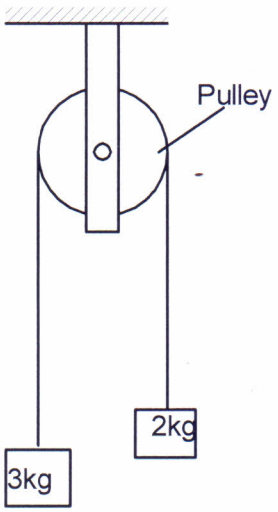
a) The principle moments of inertia (10 marks)

b) The directions of the principle axis at the vertex of the square plate. (10 marks)

QUESTION THREE

a) Use the Lagrangian methods to construct an equation of the motion of a particle acted by a force $\vec{F}$ with no constraints in the Cartesian coordinates. (15 marks)

b) A particle of mass 3kg is interconnected to another of mass 2kg through a thin string passing over a suspended pulley as shown in the figure below. Determine the acceleration of the particle system and state any two assumptions made. (5 marks)



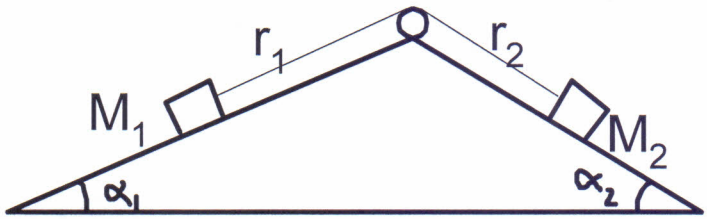
QUESTION FOUR

(a) A bead is sliding on a uniformly rotating wire in a force free space. The wire is straight and rotated uniformly about some fixed axis perpendicular to the wire. Show that $\ddot{r} = r\omega^2$ (10 marks)

(b) Using the Hamiltonian method, derive an expression that describes the motion of a particle executing simple harmonic motion. (10 marks)

QUESTION FIVE

(a) Two particles of masses M_1 and M_2 are located on a frictionless double incline and connected by an inextensible mass less string passing over a smooth peg.



Use the principle of virtual work to show that for equilibrium we must have $\frac{Sin\alpha_1}{Sin\alpha_2} = \frac{M_2}{M_1}$ (10 marks)

(b) Use D'Alemberts principle to describe the motion of the masses in question five (a) above. (10 marks)

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