TECHNICAL UNIVERSITY OF MOMBASA

SCHOOL OF APPLIED AND HEALTH SCIENCES

MATHEMATICS AND PHYSICS

UNIVERSITY EXAMINATION FOR:

UNIT: ANALYTICAL MECHANICS

UNIT CODE: AMA 4434

END OF SEMESTER EXAMINATION

SERIES: MAY SERIES

TIME: 2HOURS

Instructions to Candidates

You should have the following for this examination

-Answer Booklet, examination pass and student ID

This paper consists of five questions. Attempt Question one and any other two.

Do not write on the question paper.

Question ONE

(a) Show that the ratio of gravitational to electrostatic forces between two electrons is about 1042. Given $1/4\pi$ $=9*10^{19}NM^2/C^2$ $e=1.6*10^{19}c$ $G=6.7*10^{11}NM/^2kg^2$ $Me=9.1*10^{31}kg$ (4mks)

Define the term

i. Rigid body
ii. Mechanical constraint

(4mks)

(c) Show that the motion of one projectile as seen from another projectile will always be straight

(6mks)

(d) A body is allowed to slide on a frictionless track from rest position under gravity. The track ends in a circular loop of diameter D. find the minimum height of the body in terms of D so that it may complete successfully the loop.

(5mks)

(e) A mass is revolving in a vertical circle at the end of a string at 4 metres length. Calculate the difference in kinetic energy at the top and bottom of the circle. Prove that the tension of the string at the lowest point exceeds the tension at the top most point by 6Mg.

(5mks)

(f) A rocket starts from rest with an initial mass M_0 and reaches a final velocity V_f at burnout when its mass is M_f.

i. Show that

$M_f/M_0=\exp[-V_f/V_{ex}$

Where Vex is the exhaust velocity

ii. Show that the rocket speed is equal to the exhaust speed when the ratio M_0/M is e and equal to twice the exhaust speed when M_0/M is e^2

(6mks)

Question TWO

(a) Define

i. A closed system
ii. Internal and external forces (6mks)

(b) A two stage rocket is employed to carry a payload of 50kg to an altitude R/4 above earth's surface. The radius of the earth is R=6000km. the first stage of rocket is 5 times heavier as compared to the second stage and total mass ratios for both are 10. Find the minimum total mass required of exhaust velocity is 1500m/s. Neglect atmosphere drag and rotation of earth that you may assume that both the stages of rockets are fired in quick succession.

(14mks)

Question THREE

(a) What do you understand by the term rigid body (2mks)

(b) Give two examples of rigid bodies (2mks)

(c) A uniform disc of radius R and mass M is mounted on an axle supported in affixed frictionless bearing. A body of mass M hungs from the code wrapped around the rim of the disc. Find the angular acceleration and the tangential acceleration of a point on a rim (7mks)

(d) A metal stick is hold vertically with one hand on the floor and then is allowed to fall. Find the speed of the other hand when it hits the floor Assuming that the hand of the floor doesn't slip.

(7mks)

Question FOUR

(a) In a two body oscillator the masses of the two bodies are equal can we think it as if the connecting wire were cut two halves and each mass were oscillating independently. (4mks)

(b) A horizontal platform with an object placed on it is executing SHM in vertical direction. The amplitude of oscillating is 2.5cm what must be the least period of these oscillations so that the object is not detatched from the platform. Take $g=10m/s^2$ (6mks)

(c) A uniform spring whose unstressed length is 1_1 has a force constant k the spring is cut into two pieces of unstressed length 1_1 and 1_2 where $1_1=n1_2$, n being an integer. What are the corresponding force Constance k_1 and k_2 in terms of n and k (10mks)

Question FIVE

(a) What will be the Hamiltonian of a particle moving with a potential U in a uniformly rotating frame of reference (4mks)

(b) What is a Hamiltonian function of a holonomic system having n degrees of freedom (5mks)

(c) Construct the langrgian and the equation of motion of a spherical pendulum placed in a uniform gravitation field. (11mks)