CHUKA UNIVERSITY

UNIVERSITY EXAMINATIONS

FIRST YEAR EXAMINATION FOR THE AWARD OF DEGREE OF MASTER OF SCIENCE IN PHYSICS

PHYS 831: CLASSICAL MECHANICS

STREAMS: MSC PHYSICS Y1 **TIME: 3 HOURS**

DAY/DATE: WEDNESDAY 4/12/2019 **2.30 P.M – 4.30 P.M**

INSTRUCTIONS:

- **This paper consists of FIVE Questions, [15 Marks each].**
- **You are required to answer any FOUR Questions out of FIVE**
- **Do not write anything on this question paper.**

QUESTION ONE (15 MARKS)

a) Explain what a conservative force is. (3 marks)

b) Determine whether the following vector fields are conservative. (8marks)

i. $F = (y^2 - 2xyz^3)i + (3 + 2xy - x^2 - z^3)j + (6z^3 - 3x^2yz^2)k$

ii. $F = yzi - z^2j + x^2k$

c) Determine the work done by the fields in 1 (b),if conservative, in moving a particle from the point (2,-1,2) to (-1,3,-2), taking the scalar field from which the vector fields are derivable from to be:-

$$U = -y^2x + x^2yz^3 - 3y - \tfrac{3}{2}z^4$$

(4marks)

QUESTION TWO (15 MARKS)

(a) Various mechanical quantities of a particle are constant in time, under certain conditions, often expressed in the form of conservation theories. Outline three such conditionsand identify the mechanical quantities that are conserved. (6marks)

(b) Obtain the equation of motion of a linear harmonic oscillator using both the Newtonian and Lagrangian formulations. (9 marks)

QUESTION THREE (15 MARKS)

(a) Derive Lagrange's equation in terms of a dissipation functionthat introduces dissipative forces in a system. (6 marks)

(b) Frictional forces obtainable from a dissipative function $\frac{1}{2}Cv^2$ act on a body falling under the influence of gravity. Obtain its equation of motion using the Lagrangian formulation. (9 marks)

QUESTION FOUR (15 MARKS)

(a) Using the variational principle, deduce Hamilton's canonical equations (10 marks)

(b) Using Hamilton's principle, deduce the equation of motion of one-dimensional harmonic oscillator. (5 marks)

QUESTION FIVE (15 MARKS)

(a) Outline the difficulties that are introduced by constraints in mechanical problems describing the motion of a system and state how these difficulties can be eliminated. (8 marks)

(b) A particle of mass m is on a plane in the field of a force given by F = -krCosθ, where k is a constant and r is the radial vector. Determine whether the angular momentum will be conserved. (7marks)

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