CHUKA UNIVERSITY

UNIVERSITY EXAMINATIONS

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

PHYS 831: CLASSICAL MECHANICS

STREAMS: MSC (PHYS) **TIME: 3 HOURS**

DAY/DATE: THURSDAY 08/04/2021 **2.30 P.M. – 5. 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

a) Determine whether the following vector fields are conservative.

i. $F=\left(y^2-2xyz^3\right)i+\left(3+2xy-x^2-z^3\right)j+\left(6z^3-3x^2yz^2\right)k$ [4 Marks]

ii. $F=yzi-z^2j+x^2k$ [4 Marks]

(b) Mechanical quantities are constant in time under certain conditions, often expressed in the form of conservation theories. Outline three such cases in classical mechanics using appropriate equations. [7 Marks]

QUESTION TWO

(a) Set up a Lagrangian for a simple pendulum and obtain the equation to describe its motion. [5 Marks]

(b) Use the Lagrangian equation to set up the differential equation of the vibrating mass in a system where two equal masses m are connected by springs having equal spring constant K,

so that the masses are free to slide on a frictionless table. The ends of the springs are attached with fixed walls. [10 Marks]

QUESTION THREE

(a) State the Hamilton's principle. [2 Marks]

(b) Using the variational principle, deduce Hamilton's canonical equations [13 Marks]

QUESTION FOUR

(a) (i) Derive Lagrange's equation in terms of a dissipation function that introduces dissipative forces in a system. [11 Marks]

(ii) Deduce the equation of motion of a particle that falls vertically under the influence of gravity, with the frictional forces expressed as $\frac{1}{2}Kv^2$ acting on it. [4 Marks]

QUESTION FIVE

(a) Using Hamilton's principle, deduce the equation of motion of one dimensional harmonic oscillator [8 Marks]

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