CHUKA UNIVERSITY

UNIVERSITY EXAMINATIONS

FIRST YEAR EXAMINATION FOR THE AWARD OF DEGREE OF DOCTOR OF PHILOSOPHY IN PHYSICS

PHYS 931: CLASSICAL MECHANICS

STREAMS: PhD (PHYS) TIME: 3 HOURS

DAY/DATE: FRIDAY 07/12/2018 11.30 A.M. – 2.30 P.M.

INSTRUCTIONS:

- **This paper consists of FIVE questions**
- **You are required to answer any FOUR questions out of FIVE**
- **Do not write anything on this question paper**

QUESTION ONE

(a) Outline the difficulties that are introduced in mechanical problems describing the motion of a system and state how these difficulties can be eliminated [6 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 [9 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 $F = -kr\cos\theta$, where k is a constant and r is the radial vector. Determine whether the angular momentum will be conserved. [7 marks]
