# KIBABII UNIVERSITY

## UNIVERSITY EXAMINATIONS
## 2020/2021 ACADEMIC YEAR

### FIRST SEMESTER
### MAIN EXAMINATIONS

### FOR THE DEGREE OF MASTERS (PHYSICS)

**COURSE CODE:** SPH 810

**COURSE TITLE:** CLASSICAL MECHANICS

**DURATION: 2 HOURS**

**DATE: 14TH JUNE, 2021** **TIME: 8.00A.M – 10.00A.M**

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**INSTRUCTIONS TO CANDIDATES**

- Answer **any three** (3) Questions.
- Indicate **answered questions** on the front cover.

Start every question on a new page and make sure question's number is written on each page

This paper consists of **2** printed pages. Please Turn Over

KIBU observes ZERO tolerance to examination cheating

## QUESTION ONE [20 Marks]

a) Illustrate the importance of action angle variables [3Marks]

b) Using the action-angle formalism, proof that the frequency, $\nu$ of a simple one-dimensional harmonic oscillator is given by; [4Marks]

$$\nu = \frac{\sqrt{k/m}}{2\pi}$$

c) Using an example, illustrate the necessary and sufficient conditions for a transformation to be canonical [6Marks]

d) Derive the time-dependent HJ equations [4Marks]

e) Define Hamilton's principle and explain it [3Marks]

## QUESTION TWO [20 Marks]

a) What is the main problem of calculus of variation? [2 Marks]

b) Show that the shortest distance between two points in a plane is a straight line the two joints [9 Marks]

c) Derive an expression of the minimum surface area of revolution [9 Marks]

## QUESTION THREE [20 Marks]

a) The Hamiltonian of a physical system is given by;

$H = \omega^2 p(q + t)^2$ .Where $\omega$ is a constant.

Determine $q$ as a function of time [14 Marks]

b) Prove that the following transformation is canonical;

$P = \frac{1}{2}(p^2 + q^2)$; $Q = tan^{-1}(\frac{q}{p})$ [6 Marks]

## QUESTION FOUR [20 Marks]

a) Derive the Langranges equation [10Marks]

b) Set up the langrangian of a simple pendulum and obtain an equation describing its motion [10Marks]

## QUESTION FVE [20 Marks]

a) Write the Hamiltonian for the 1-dimensional harmonic oscillator of mass, m [6Marks]

b) Write the corresponding Hamilton-Jacobi equation [2Marks]

c) Use the Hamilton-Jacobi equation method to obtain the motion of the oscillator [12Marks]

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