

CHUKA



UNIVERSITY

UNIVERSITY EXAMINATIONS

**THIRD YEAR EXAMINATION FOR THE AWARD OF DEGREE OF BACHELOR OF SCIENCE
IN DEGREE IN PHYSICS, BACHELOR OF EDUCATION SCIENCE AND BACHELOR OF
SCIENCE**

PHYS 335: CLASSICAL MECHANICS

STREAMS: BSC PHYSICS, BSC, B Ed. SCIENCE Y3S2

TIME: 2 HOURS

DAY/DATE: THURSDAY 13/04/2023

2.30 P.M. –4.30 P.M.

INSTRUCTIONS:

- Attempt question ONE (30 marks) and any other TWO questions (20 marks each).
- Start each question on a fresh page

QUESTION ONE (Compulsory 30 Marks)

- a) Explain what a rigid body is. (2 marks)
- b) Distinguish between holonomic and non-holonomic constraints. Give one example of each. (4 marks)
- c) Giving two examples, illustrate what a conservative force is. (4 marks)
- d) Illustrate the effect of conservative forces on the conservation of energy of a system (3 marks).
- e) 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 as shown in Figure 1.

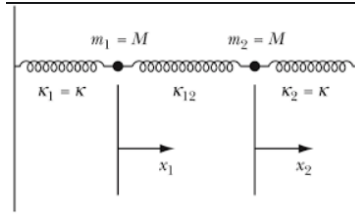


Figure 1.

Use the Lagrangian equation to set up the differential equation of the vibrating mass (5 marks)

f) Determine whether the following vector fields are conservative.

i. $F(x, y, z) = yzi - z^2j + x^2k$ (4 marks)

ii. $F(x, y, z) = zi + 2yzj + (x + y^2)k$ (4 marks)

g) Explain the following phenomena as used in special relativity (4 marks)

(i) Time dilation

(ii) Length contraction

QUESTION TWO (Elective: 20 Marks)

(a) Explain the Hamilton's variational principle. (5 marks)

(b) Deduce Hamilton's canonical equations using the variational principle (10 marks)

(c) Derive the equation of motion of a one-dimensional harmonic oscillator using Hamilton's principle. (5 marks)

QUESTION THREE (Elective: 20 Marks)

(a) Constraints introduce difficulties in mechanical problems. Outline two such difficulties and state how these difficulties can be eliminated. (6 marks)

(b) Define generalized coordinates (3 marks)

(c) Obtain expressions for: -

(i) Generalised velocities (3 marks)

(ii) Generalised displacement (4 marks)

(iii) Generalised force. (4 marks)

QUESTION FOUR (Elective: 20 Marks)

(a) Conservation theories express the consequences of various mechanical quantities of a particle remaining constant in time. With the aid of appropriate equations, explain the consequences of:-

i. the total force acting on a particle being equal to zero. (3 marks)

- ii. the total torque being equal to zero. (5 marks)
- (b) Obtain the equation of motion of a linear harmonic oscillator using; -
 - i. Newtonian (6 marks)
 - ii. Lagrangian formulations. (6 marks)

QUESTION FIVE (Elective: 20 Marks)

- (a) Explain what dissipative systems are and state the major effect arising from dissipation in the system. (4 marks)
 - (b) Derive Lagrange's equation for a dissipative system. (6 marks)
 - (c) The dissipative function $\frac{1}{2}kv^2$ is used to obtain the frictional forces acting on a body falling under the influence of gravity.
 - i. Write down the Lagrangian for the system. (4 marks)
 - ii. Obtain its equation of motion using the Lagrangian formulation. (6 marks)
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