

Examination 1 for PHYS 6220/7220, 17th October 2025

First

Last

Student Name:

Instructions:

1) This test is worth a total of 19 points which will be scaled to a weight of 18% of the final letter grade.

2) Use more pages as needed for question 10.

1. How is the Rayleigh dissipation function related to the rate of energy loss from the system? [**1 point**]

2. Write an expression for the Lagrangian for a particle moving in an electromagnetic field consisting of an electric field $\mathbf{E}$ and magnetic field $\mathbf{B}$. Relate any potential you may use to these fields. [**2 points**]

3. Define the δ derivative of a functional. [**1 point**]

4. State Hamilton's principle. [**1 point**]

5. Under what conditions is the energy function h as constant? [**1 point**]

6. When can one say that the energy function h equals the total energy in a system? [**1 point**]
7. Write down Hamilton's equations for a system of N particles. [**2 points**]
8. When a particular generalized q_i coordinate is cyclic what quantity is preserved? Write an expression for it in terms of the Lagrangian of the system. [**1 point**]
9. The method of Lagrange's un-determined multipliers helps us obtain some physical quantity which would otherwise not be possible to obtain from Euler-Lagrange's equations. What is that physical quantity? [**1 point**]
10. A particle of mass m under a constant gravitational field, with acceleration due to gravity is of magnitude g , is constrained to move on the surface of a sphere of radius b .
- (1) Choose appropriate generalized coordinates and clearly define them with a figure and words. [**2 points**]
 - (2) Write the Lagrangian for the system. [**3 points**]
 - (3) Note any symmetry or cyclic coordinates and hence the corresponding constants of motion. [**1 point**]
 - (4) Note in words any other conserved quantities and write an expression for them in terms of generalized coordinates and momenta. [**2 points**]