DEPARTMENT OF PHYSICS
Indian Institute of Technology Kharagpur
Classical Mechanics-I
Course: PH20007
Assignment-11: Assignment-11 (Lagrangian-3 and Small oscillation-1)

1. If q_j is a cyclic co-ordinate, which of the following is true
   (a) $\frac{\partial L}{\partial \dot{q}_j} = 0$
   (b) $\frac{\partial L}{\partial p_j} = 0$
   (c) $\frac{\partial L}{\partial q_j} \neq 0$
   (d) $p_j = constant$

2. The principle of least action for a conservative system can be expressed as

   (a) $\delta \int_{t_1}^{t_2} \sum_j p_j \dot{q}_j \, dt > 0$
   (b) $\delta \int_{t_1}^{t_2} \sum_j p_j \dot{q}_j \, dt = 0$
   (c) $\delta \int_{t_1}^{t_2} \sum_j p_j \dot{q}_j \, dt < 0$
   (d) $\int_{t_1}^{t_2} \sum_j p_j \dot{q}_j \, dt = 0$

3. δ variation of any function $f = f(q_j, \dot{q}_j, t)$ is given by
   (a) $\delta f = \partial_i f + \frac{df}{dt} \delta t$
   (b) $\delta f = \partial f - \frac{df}{dt} \delta t$
   (c) $\delta f = df + \frac{\partial f}{\partial t} \delta t$
   (d) $\delta f = \partial f + \frac{df}{dt}$

4. Virtual displacement means in the sense that
   (a) it occurs in a finite time interval
   (b) it occurs in absence of any external force
   (c) there is no passage of time during such displacement
   (d) none of the above is true.

5. From the calculus of variation, the total length of any curve between any two points 1 and 2 can be expressed as
   (a) $S = \int_{x_1}^{x_2} dS = \int_{x_1}^{x_2} \sqrt{1 - (\frac{dy}{dx})^2} dx$
   (b) $S = \int_{x_1}^{x_2} dS = \int_{x_1}^{x_2} \sqrt{1 + (\frac{dy}{dx})^2} dx$
   (c) $S = \int_{x_1}^{x_2} dS = \int_{x_1}^{x_2} \sqrt{1 + (\frac{dx}{dy})^2} dx$
   (d) $S = \int_{x_1}^{x_2} dS = \int_{x_1}^{x_2} \sqrt{(\frac{dy}{dx})^2} dx$

6. A particle slides from rest at one point (say at origin) on a frictionless wire in a vertical plane to another point (x_0, y_0) under the influence of gravity. Assuming $y = y(x)$, the total time

taken

(a) $\tau = \frac{1}{\sqrt{2g}} \int_{y=0}^{y_0} \frac{\sqrt{1+y'^2}}{\sqrt{y'}} dx$

(b) $\tau = \frac{1}{\sqrt{2g}} \int_{y=0}^{y_0} \frac{\sqrt{1+y'}}{\sqrt{y}} dx$

(c) $\tau = \frac{1}{\sqrt{2g}} \int_{y=0}^{y_0} \frac{\sqrt{1-y'^2}}{\sqrt{y}} dx$

(d) $\tau = \frac{1}{\sqrt{2g}} \int_{y=0}^{y_0} \frac{\sqrt{1+y'^2}}{\sqrt{y}} dx$

7. For unstable equilibrium which one of the following is true
   (a) $\frac{d^2V}{dx^2} = 0$
   (b) $\frac{d^2V}{dx^2} < 0$
   (c) $\frac{d^2V}{dx^2} > 0$
   (d) $\frac{d^2V}{dx^2} = \infty$

8. Condition for stable and unstable equilibrium of a simple pendulum are
   (a) $\theta = 0$ *and* π *respectively*
   (b) $\theta = 0$ *and* $\frac{\pi}{2}$ *respectively*
   (c) $\theta = \pi$ *and* 0 *respectively*
   (d) $\theta = \frac{\pi}{2}$ *and* 0 *respectively*

9. Normal modes of a string mean
   (a) the modes of vibration in which the string oscillates with the different frequency over the whole length
   (b) the modes of rotation in which the string oscillates with the same frequency over the whole length
   (c) the modes of vibration in which the string oscillates with the same frequency over the whole length
   (d) the modes of vibration and rotation both in which the string oscillates with the same frequency over the whole length

10. For coupled harmonic oscillators, the Lagrange's equations of motion, in terms of generalized co-ordinates q_j, can be written as
   (a) $\sum_j T_{ij} q_j + \sum_j V_{ij} q_j$
   (b) $\sum_j T_{ij} + \sum_j V_{ij} q_i$
   (c) $\sum_j T_{ij} q_i - \sum_j V_{ij} q_i$
   (d) $\sum_j T_{ij} \ddot{q}_j + \sum_j V_{ij} q_j$

End