Indian Institute of Science Education and Research, Mohali

Classical Mechanics (PHY301)

(August – December 2022)

Quiz 2: October 18, 2022

Name: Rill Number:

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1. Consider the potential:

$$U(x) = -ax^3 - bx^2$$

Here, a and b are positive constants.

(a) Plot the potential $U(x)$ assuming $a = 1, b = 1$. [1]

(b) Does the potential have a local minima? Find the location of the minima. [2]

(c) What is the frequency of small oscillations about this minima? [2]

2. Consider a three dimensional Harmonic oscillator. The Lagrangian may be written as:

$$L = \frac{1}{2}\left(m\dot{r}^2 + \frac{J^2}{mr^2}\right) - \frac{1}{2}kr^2$$

Here, $k > 0$ is a constant, m is the mass of the oscillator, and $J = mr^2\dot{\phi}$ is the angular momentum.

(a) Write down the effective potential and find the minimum of the effective potential. [1]

(b) Find out the time period of small oscillations about this minimum. [2]

(c) Find out the orbital time period for circular orbit corresponding to the minimum of the potential. [1]

(d) Compare the two time periods and comment. [1]