Name :	**Roll Number :**

PHY102: Quiz : 1

IISER, Pune. (4 Feb, 2019.)

Time: 50 minutes. *Marks : 25*

Answer all the questions.
For questions 1 and 2 only a sketch is required; Do not derive anything.
No marks for sketches drawn without axis lables.
Unless specified otherwise, all the symbols have their usual meanings.
Use the same symbol and notation as given in the questions.
Show all the steps of your calculations. No marks for missing steps.
Calculators not allowed. You will not require a calculator to do these problems.

1. Sketch the maximum displacement for a driven, damped oscillator as a function of driving frequency ω for two different values of damping coefficient γ_1 and γ_2 such that $\gamma_1 > \gamma_2$. (3)

2. Sketch Lissajous figure for the following motion; $x = \cos 2\omega t, \quad y = \sin \omega t$.
Mark the initial position at $t = 0$ with a visible dot. (3)

3. What is the dimension of mechanical impedance ? (3)

4. The displacement of a block attached to a spring is $x(t) = A(\cos(\omega t + \alpha) - \sin(\omega t + \alpha))$, where A and α are constants and $0 < \alpha < \pi$. At time $t = 0$, the initial position is $x(0) = 0$ cm and velocity is $v(0) = -1$ cm/sec.
(a) Find the numerical values of A and α.
(b) Find the total energy of the system in terms of mass M of the block. (3+3)

5. Consider a damped oscillator whose equation of motion is $m\ddot{x} + \gamma\dot{x} + Kx = 0$. Use the known solution (do not derive) for the damped oscillator to find the time scale τ at which the initial amplitude A_0 is reduced to half its initial value. (4)

6. A block of mass M hangs from a spring of spring constant k. This experiences resistive force given by $-\gamma v$, where v is the velocity and γ is a constant. The natural frequency of this system is ω_0 and modified frequency in the presence of resistive force is ω_1. You need NOT derive expression for ω_1. Assuming that dissipation is small ($\gamma \to 0$), show that

$$\frac{\omega_0 - \omega_1}{\omega_0} = \frac{1}{8Q^2}$$

where Q is the Q-factor of the oscillator. (6)