**Question 1:**

1. Write down the equation of motion for the point particle of mass *m* moving in the Kepler potential *U* (*x*) = –*A* /*x* + *B* /*x*2. Neglect the dissipation.
2. Introduce a dissipative term in the equation of motion assuming that the viscous force acting on a particle is proportional to the particle velocity. Write down the modified equation of motion.
3. Mimimise the number of independent parameters in the modified equation of motion by introducing dimensionless variables for *x* and *t*.

Hint: Introduce the dimensionless variable **= *ax* and **= *bt* and chose the parameters *a* and *b* so that only one coefficient remain in the equation of motion before the term ~**–3.

1. Present the equation derived in the form of an energy balance equation and find the expressions for the effective kinetic and potential energies (*T* and *V*), and dissipative function *F*.
2. Plot the potential function for different signs of the free parameter. Find extrema of the potential function and their position on the axis **. In which cases are the extrema stable and unstable?
3. From the dimensionless equation of motion modified by viscosity (see item **(iii)**) derive a linearised equation of motion around the stable equilibrium state. Solve it and determine what is the range of values of the free parameter for which the particle moves with oscillations or without oscillations?
4. Plot the phase portrait of the system for subcritical and supercritical values of the free parameter and indicate the type of the equilibrium states in both these cases.