1. The dimensionless equation of motion of a frictionless pendulum is

\[ \frac{d^2 \theta}{dt^2} + \sin \theta = 0. \]

In the limit of small amplitude, the period is $2\pi$ to leading order. Compute the next term in the expansion of the period for small amplitude.

2. Find the first term approximation valid for long time to the initial value problem

\[ \ddot{u} + \epsilon (u^2 - 1) \dot{u} + u = 0 \]
\[ u(0) = 0, \quad \dot{u}(0) = 1. \]