Physics 4321/7305 Professor Scalise
Homework Assignment #7 Spring 2020

4321

1. Consider the damped, cosinusoidally driven harmonic oscillator. Show all work below, not just the answers.

   (a) What is the amplitude resonance frequency (that is, for what frequency ω is D the largest)?

   (b) What is the potential energy resonance frequency?

   (c) What is the velocity resonance frequency?

   (d) What is the kinetic energy resonance frequency?

2. (a) Use the Green function $G(t,t')$ derived in lecture for the underdamped SHO with zero displacement and zero velocity initial conditions to find the general solution $x(t)$ for an exponentially decaying driving force $F(t) = F_0 e^{-\beta t}\theta(t)$.

   (b) Plot electronically a graph of the force and a graph of the response versus time. Choose reasonable values for the constants (F_0, β, ω_0, etc.) to make the plot interesting.

   (c) How many times does the mass visit the origin?

   (d) Is the graph of displacement versus time continuous?

   (e) Is the graph of velocity versus time continuous?

7305

1. Perform the limits described in the lecture notes to derive the Green function $G(t,t')$ for the underdamped SHO. Show all steps.

2. Underdamped oscillations result whenever $\beta < \omega_0$.

   (a) What are the MKS units of β?

   (b) What is the pseudoperiod of undriven oscillations if $\omega_0 = 1$ (MKS) and $\beta = 0.8$ (MKS)?

   (c) At what driving frequency ω does the amplitude of oscillations peak with these values of ω_0 and β? (If your answer is imaginary, I will hit you.)

   (d) Sketch a graph of amplitude of oscillations $D(\omega)$ versus driving frequency ω for these values of ω_0 and β.

   (e) How long does it take for the complementary solution to decay to less than 1% of its initial size?

Bonus: Solve as much of the other class' assignment as you can.