EE2703 : Applied Programming Lab
Experiment 6

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Abstract

The objective of this assignment is to learn to use tools for analysing linear time invariant systems in python.

Introduction

A set of tools for analysing LTI systems is available in the `scipy.signal` package. Various problems involving continuous time Laplace transforms are solved. We deal with only rational polynomial transfer functions.

Results

1.Spring mass system

A forcefully oscillated spring mass system is considered. The force applied is sinusoidal and decays exponentially with time. To solve this, the transfer function is computed and then the impulse response is found. This response is plotted from $t = 0$ to $t = 50$

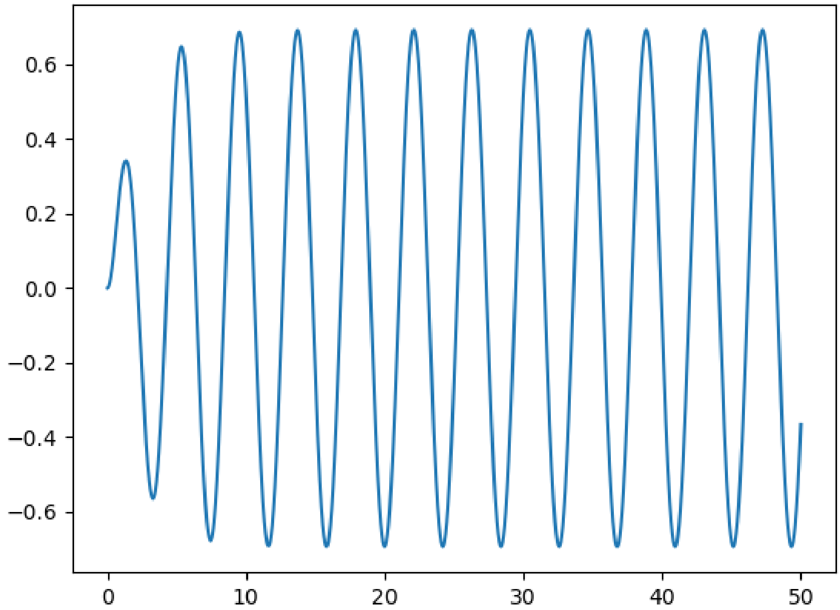

Figure 1: Position of mass under forced oscillation

2.Smaller decay

The same computation is done for force that decays slowly with time.

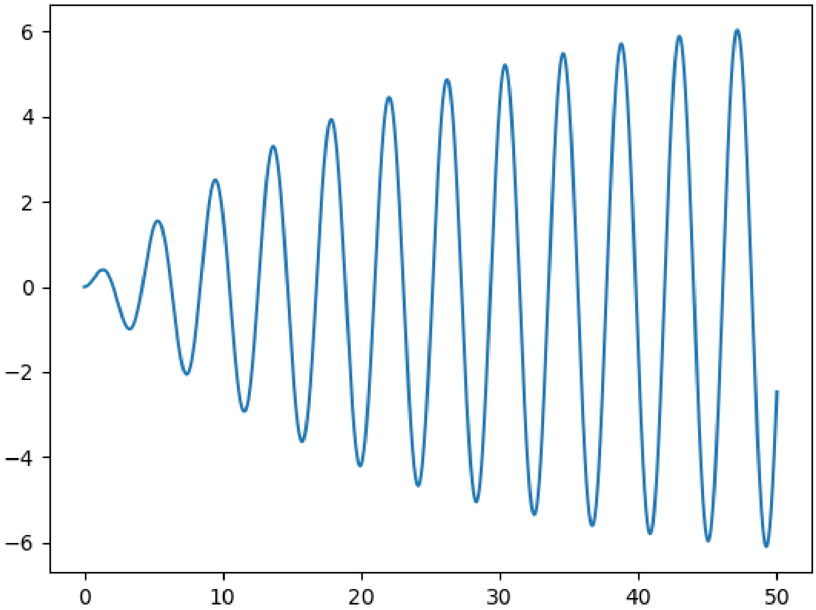

Figure 2: Position of mass under forced oscillation

3.Frequency variation

The same computation is done for force of different frequencies ranging from 1.4 to 1.6 in steps of 0.05. All the obtained responses are plotted.

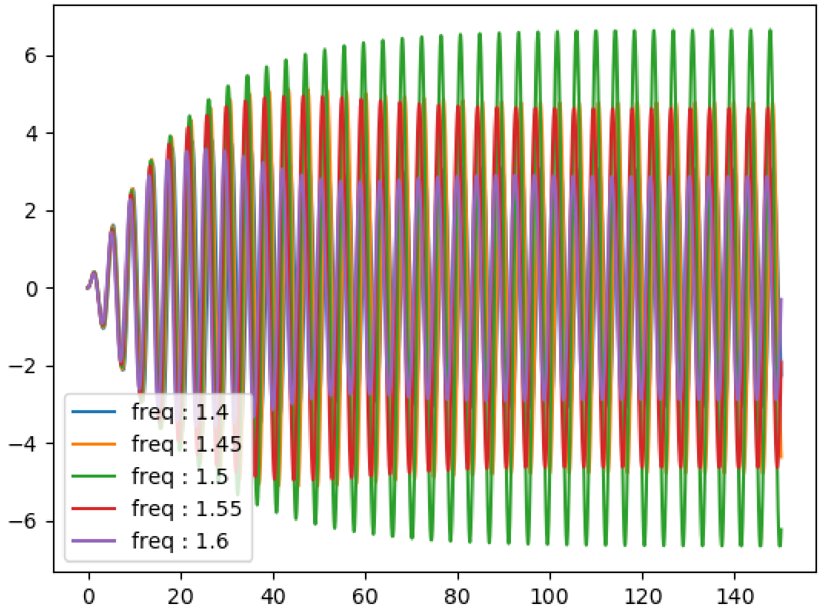

Figure 3: Forces of different frequencies

The natural frequency of the spring system without applying force is 1.5. Therefore when the frequency of the applied force is 1.5, the net resulting amplitude is maximum.

4.Solving coupled equations

The given coupled second order differential equations are decoupled to obtain fourth order differential equation in a single variable. This equation is solved with Laplace transform using initial conditions. The resulting equations are as follows.

$$X(s) = \frac{s^2 + 2}{s^3 + 3s}$$

$$Y(s) = \frac{2}{s^3 + 3s}$$

The time domain solutions of both variables are plotted.

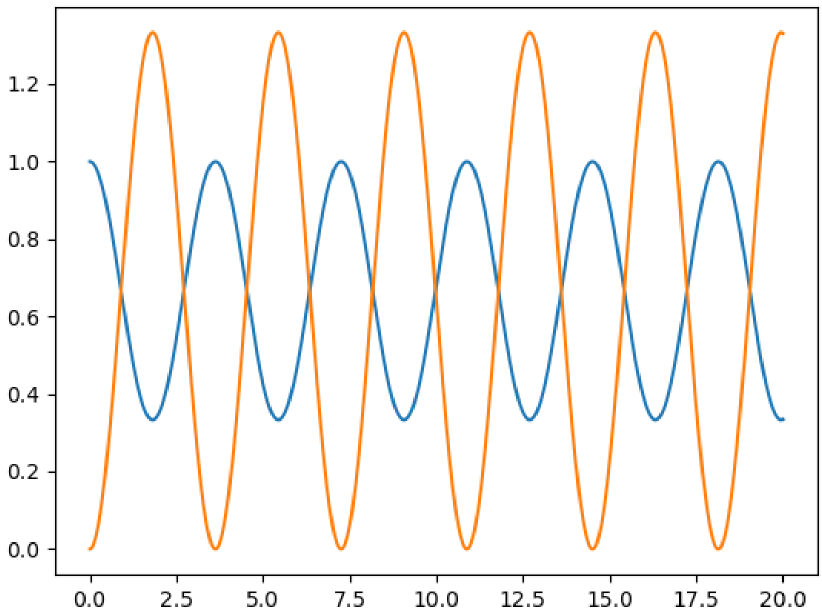

Figure 4: Solution of coupled equations

5.Two port network

The transfer function of the given low-pass filter is as shown below.

$$H(s) = \frac{1}{LCs^2 + RCs + 1}$$

Bode plot of the above function is computed and plotted.

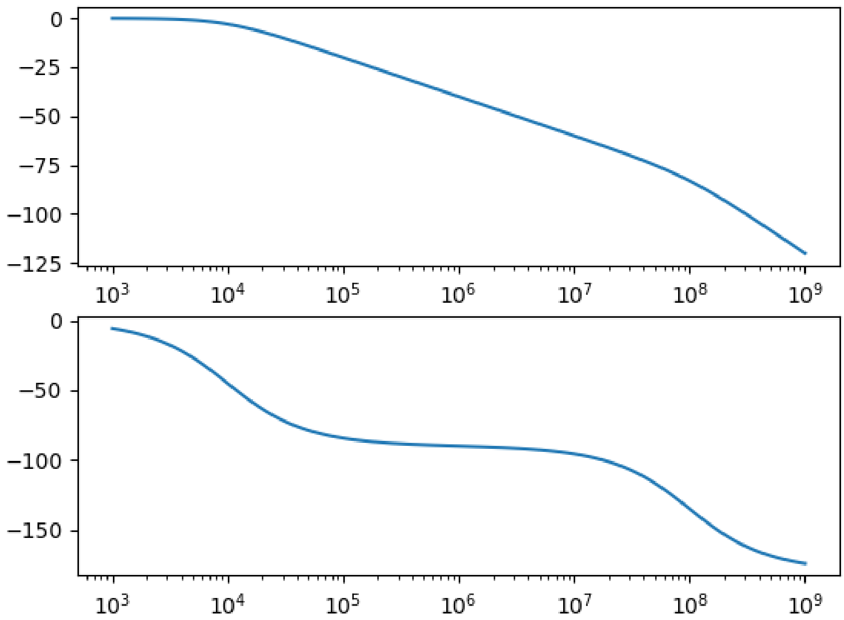

Figure 5: Bode plot of transfer function

6.Response of two port network

The above two port network is supplied with a time dependent voltage source and the response is found at the output port.

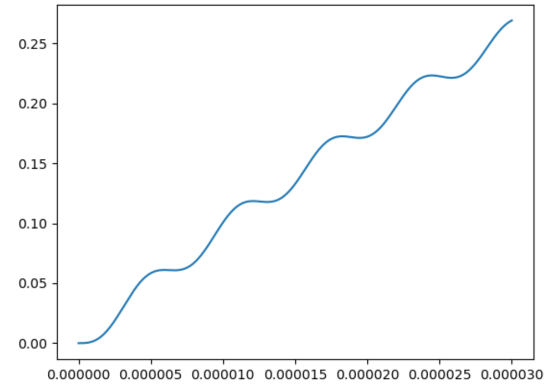

Figure 6: Response over small time scale

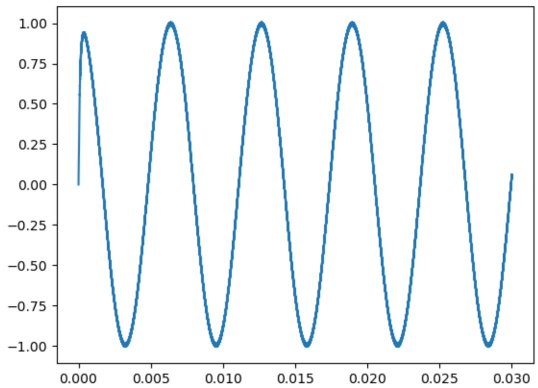

Figure 7: Response over large time scale

We can see that the higher frequency has died out considerably compared to the lower frequency. This is because the system is a non-ideal low-pass filter.

Conclusions

Multiple functions and tools have been utilised to solve for different types of LTI systems.