Homework 3: Symbolic Computations and Plotting

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ABSTRACT

The amplitude response of a damped forced vibrating system is solved using symbolic math toolbox. Function to create high quality plots and vector graphics file generation are also covered in this report. To access the code for this homework, please follow the following: GitHub Repository Link.

1 Introduction

The first task is to solve the amplitude response along with the phase angle response of a damped forced vibrating one degree of freedom (DOF) system using symbolic math toolbox. The second task is to form a function that helps to create high quality publication plots. The final task is to import the vector graphics plot in the report with a similar size and typeface as in the rest of the report.

2 Methods

The basic differential equation (equation of motion) that is dealt in this report is as shown:

$$m\ddot{x} + c\dot{x} + kx = F_0 \sin \omega t \tag{1}$$

where, m, c, k are, respectively, the mass, damping coefficient, and stiffness coefficient, F_0, ω, t are, respectively, the amplitude, frequency, and time of applied force. The amplitude and phase angle of the steady state solution is expressed as:

$$X_0 = \frac{F_0}{k\sqrt{(1-\omega^2/\omega_n^2)^2 + (2\zeta\omega/\omega_n)^2}} \tag{2}$$

$$\phi = \tan^{-1}\left(\frac{-2\zeta\omega/\omega_n}{1-\omega^2/\omega_n^2}\right) \tag{3}$$

3 Results and Discussions

The system is symbolically solved using symbolic math toolbox available in Matlab. The following numerical values: A (initial displacement) = -1 m, F_0 = 20 N, k = 10 N/m, ω = 2 rad/s, ω_n (natural frequency) = 2 rad/s, ζ = 0.5 are used to obtain the position response of the system that is compared to the steady state solution response as shown in Figure 1. The amplitude ratio and phase angle response is shown in Figure 2 and 3 respectively. To create high quality plots for publications, a function was created using Matlab. The figures used in this report is ".emf" file imported in the latex document. The size and the typeface are 12 pt. and Times New Roman respectively.

4 Conclusion

The Matlab file for this report is available at the author's GitHub repository. The author was successful in solving the amplitude and phase angle response of a damped forced vibrating system. Also, function to create high quality plots was created. Vector graphics plot are used in this report with similar size and typeface as in the rest of the report.

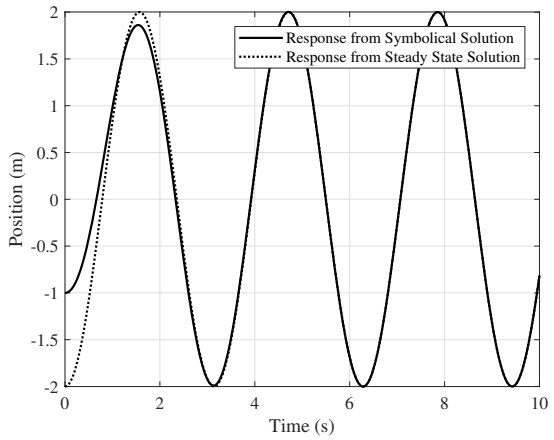

Figure 1. Comparison of responses from symbolic solution and steady state solution

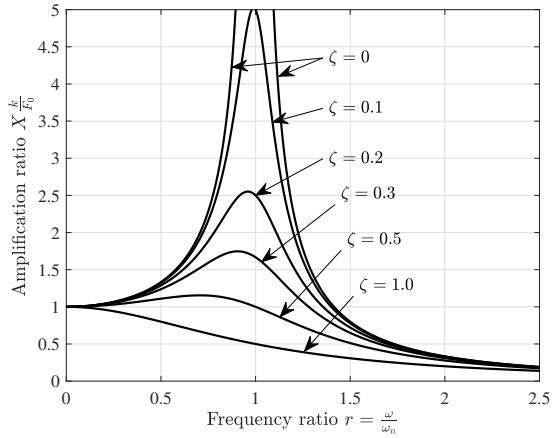

Figure 2. Amplification response of the system

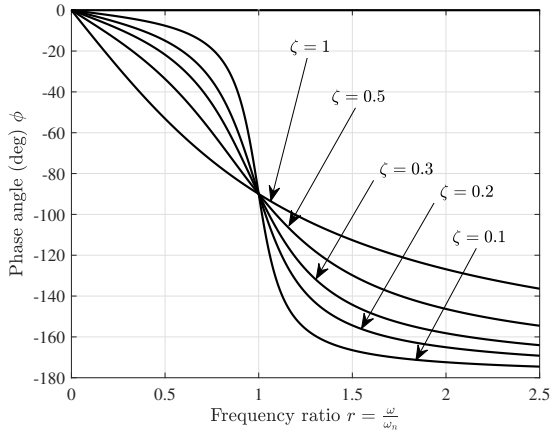

Figure 3. Phase angle response of the system