MAE3134: Homework 7

Due date: 20 April 2018

Problem 1. A system is defined by the transfer function

$$G(s) = \frac{50}{(s+1)(s+2)(s+10)}.$$

(a) Sketch the Bode diagram for this system using the approximations from class and the semi-log graph paper provided on Blackboard.

(b) Find the analytical expressions for the frequency response, magnitude, and phase response functions.

(c) Using a computer program, find the magnitude and phase of the system for a range of frequencies between $0.1\,\text{Hz} \leq \omega \leq 100\,\text{Hz}$.

(d) Plot these values on your Bode diagram and estimate the maximum error in decibels and degrees between the true response and your approximations. Give the frequencies at which the maximum error occurs.

Problem 2. Consider the system with the transfer function

$$G(s) = \frac{2(s+10)}{(s+1)s+2}.$$

(a) Sketch the Bode diagram for this system using the approximations from class and the semi-log graph paper provided on Blackboard.

(b) Without doing any calculations, find the steady-state output response for an input signal of $u = \cos t$.

(c) Using the Laplace transform, calculate the output response.

(d) Verify your previous solutions using a computer program of your choice.

(e) Use a computer program to generate the true Bode plot and transfer these results to your approximation. Estimate the maximum errors in magnitude and phase and the frequencies at which they occur.

Problem 3. Sketch the Bode diagrams for the following systems using the straightline approximations.

(a)
$$G(s) = \frac{s+10}{s}$$

(b)
$$G(s) = \frac{1}{(s+0.1)(s+1)}$$

(c)
$$G(s) = \frac{s+1}{s^2}$$

(d)
$$G(s) = \frac{100}{s^2(s+1)}$$

Problem 4. Consider the transfer function

$$G(s) = \frac{400\,(s+1)}{s\,(s^2 + 20\zeta s + 100)}.$$

(a) Sketch the approximate Bode plot for $\zeta = 1$ and $\zeta = 0.1$.

(b) Using a computer program find the actual frequency reponse for $\zeta = 0.1$ and transfer this result to your plot.

(c) Indicate the maximum errors and the frequency at which this occurs.