Problems:

- **Problem 1:** 9.28

- **Problem 2:** Plot the bode plot for the transfer function:

\[
G(s) = \frac{-100}{(s + 10)(s + 100)} e^{-0.5s}.
\]

1) Plot by hand with the frequency axis on the log scale.

2) Verify by using the Matlab function bode or using the GUI for asymptotic bode plots (see the Useful Links section of course webpage).

- **Problem 3:** The book "Aircraft Control and Simulation" written by Brian L. Stevens and Frank L. Lewis (1992) has the data and corresponding transfer functions from early, declassified wind tunnel test of the General Dynamics F-16 Fighting Falcon. The following transfer function represents the input/output relationship of the elevator angle, \( \delta_e(t) \), in rad, to pitch rate, \( \dot{q}(t) \), in rad/sec, of a model F-16 flying at a Mach 0.6 equivalent under steady flight conditions (see Fig. 1 for a schematic of an elevator control surface and pitch).

\[
\frac{\dot{q}(s)}{\delta_e(s)} = \frac{203.2 (s + 100) (s + 1.029)}{(s + 10.38) (s + 20.13) (s^2 + 1.791s + 2.129)}
\]
The transfer function has the bode plot in Fig. 2.

1) Calculate the F16 pitch rate, \( \dot{q}(t) \), for two different elevator angle profiles: \( \delta_e(t) = 0.0625 \cos 4t \) and \( \delta_e(t) = 0.0625 \cos 500t \). Approximate values read from the bode plot are allowable.

2) Qualitatively, compare the pilot’s level of stomach discomfort for each of the two inputs. With well made systems, low frequencies inputs are typically designed or deliberately applied, in this case \( \delta_e(t) = 0.0625 \cos 4t \) could be the pilot deliberately changing the elevator angle with the controls. With any system, noise dominates the system response at high frequencies. \( \delta_e(t) = 0.0625 \cos 500t \) could be high-frequency chatter in the elevator.

3) On a blank sheet of logscale paper, sketch the bode for the pitch, \( q(t) \), in rad, as a function of elevator angle. You do not need to perform any calculations to get this problem correct. Use your sketched bode plot to evaluate \( q(t) \) for the two different elevator angle profiles. Does your answer match up reasonably well with the integral of \( \dot{q}(t) \) you calculated for each pitch rate in Part 1?
Fig. 2. Bode plot of the transfer function between elevator angle and pitch rate of a scaled model of an F16.