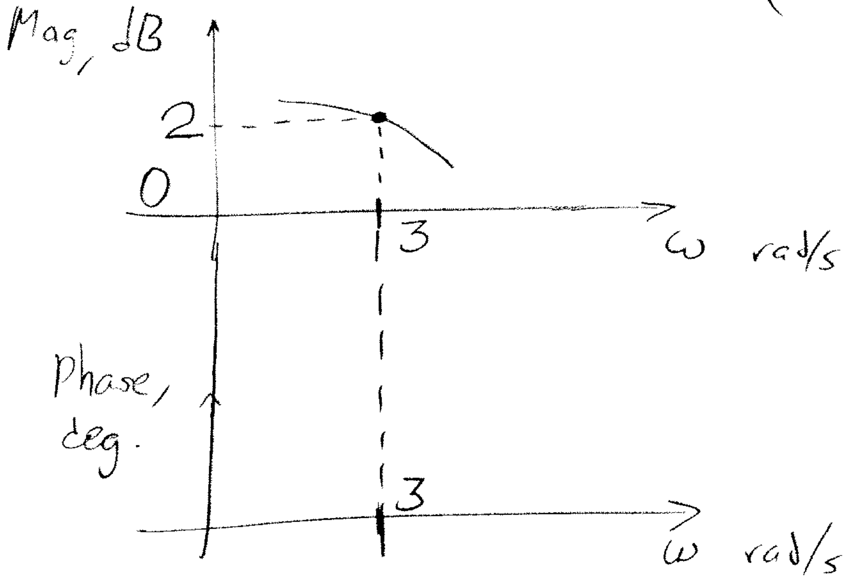
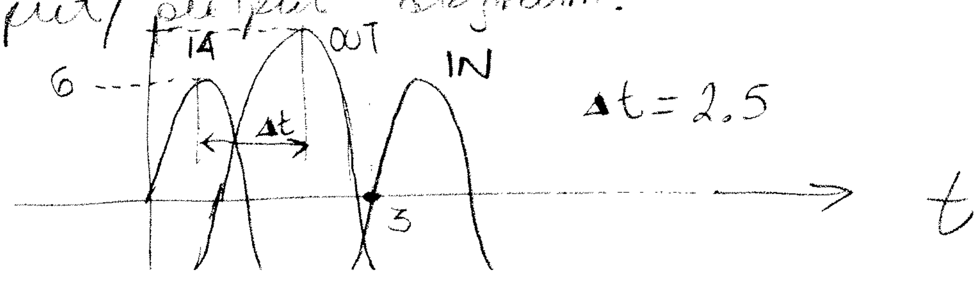
MCE541/441 – Exercises for the final exam Fall 201

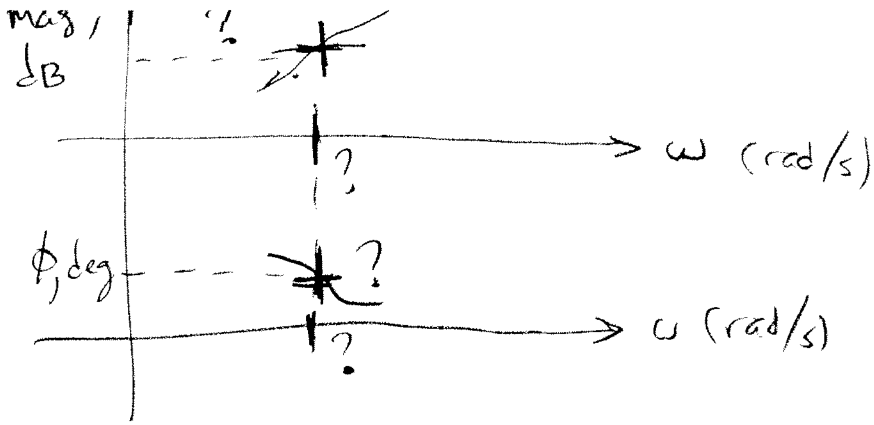
1. Find K from the given transfer function and Bode sketch: $G(s) = \frac{K(s+1)}{(s+2)}$. Then find the phase margi[n] using the value of K.



2. The input $u(t) = 3\sin 4t$ is applied to $G(s) = \frac{1}{s+1}$. Sketch the input and output finding the time lead/lag, the output amplitude and the period.

3. Complete the coordinates of the Bode plot based on the input/output diagram:





4. Sketch the Bode plot for

$$G(s) = \frac{10(s+0.1)}{s^2+0.1s+100}$$

label resonant peak heights, slopes and final phase.

5. Sketch the Bode plot for

$$G(s) = \frac{s^2+0.1s+1}{s^2+0.2s+10}$$

label resonant peaks, slopes and final phase

6. Find the phase margin:

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

7. (MCE541) Find the allowable time delay so that the phase margin is at least 30°:

$$G(s)K(s) = \frac{2e^{-Ts}}{s(s+1)}$$

8) Find the gain margin:

$$G(s)K(s) = \frac{2}{s(s+2)}$$

9) Find phase and gain margins knowing that the phase crossover frequency is 3.32 rad/s

$$G(s)K(s) = \frac{e^{-0.01s}}{s^2+0.1s+1}$$

10) Convert the following design requirements to the frequency domain and represent them in a target Bode plot:

i) 0 sse for ramps
ii) PO% to step inputs < 10%
iii) Tset to step inputs < 1 sec
iv) −60 dB roll-off rate

11) Find a state-space representation for the transfer function:
$$G(s) = \frac{s+1}{s(s^2+s+2)}$$
(give matrices A, B, C, D)

12) Find a state-space representation for
$$G(s) = \frac{10}{s^4 - s^3 + 2s^2 + 3s + 3}$$
(give A, B, C, D)

13) (MCE541)

Find the transfer function corresponding to the state-space system
$$\begin{cases} \dot{x} = Ax + Bu \\ y = Cx + Du \end{cases}$$

with
$$A = \begin{bmatrix} 3 & 2 \\ -1 & -2 \end{bmatrix}, \quad B = \begin{bmatrix} 0 \\ 1 \end{bmatrix}$$

$$C = \begin{bmatrix} 1 & 0 \end{bmatrix}, \quad D = 1$$

14) (MCE 541) Find the equilibrium points of the nonlinear system and linearize about a point of your choice: (give A, B, C, D of the linearized system). Take $u_0 = 1$

$$\begin{cases} \dot{x}_1 = x_1 - x_1 x_2 + u \\ \dot{x}_2 = x_2 \cos(x_1) - x_1 u \end{cases}$$

$$y = 2x_1 x_2 + x_1^2$$

15) (MCE 541) Linearize the following system about the origin:

$$\begin{pmatrix} u_0 = 0 \\ x_{10} = 0 \\ x_{20} = 0 \end{pmatrix} \qquad \begin{cases} \dot{x}_1 = x_1 x_2 + u \\ \dot{x}_2 = 2x_1 - x_2 \end{cases}$$