Master of science-level in Mechanical Engineering
Academic Year 2019-2020, Second Semester

Automatic Control (05LSLQD, 05LSLNE)

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Homework n. 2

Main learning objectives

Upon successful completion of this homework, students will

1. Be able to sketch rough and qualitatively correct bode, polar and nyquist plots, in order to know in advance what the true plots should look like when drawn with Matlab.
2. Be able to draw exact bode, polar and nyquist plots with Matlab.
3. Be able to spot either possible typing errors or software bugs from the mismatch between expected plots and obtained ones.

Problem 1

Consider the following list of transfer functions:

$$H(s) = \frac{1}{s(s+2)(s+4)} \tag{1}$$

$$H(s) = \frac{-0.1(1-2s)}{s(s+0.2)(1+s)} \tag{2}$$

$$H(s) = \frac{1}{s^2(s+3)} \tag{3}$$

$$H(s) = \frac{2(1+0.5s)}{(1+s)(1-s)^2} \tag{4}$$

$$H(s) = \frac{s^2+1}{(s-2)(s+2)(s+4)} \tag{5}$$

$$H(s) = \frac{0.125(1+s^2)}{s(1+0.25s)(1+0.5s)} \tag{6}$$

$$Hs) = \frac{s-2}{(s+2)(s^2+1)} \tag{7}$$

$$H(s) = \frac{0.25}{s(1-0.5s)^2} \tag{8}$$

$$H(s) = \frac{1}{(s^2+1)(s+2)} \tag{9}$$

$$H(s) = \frac{-(1-s)}{s(1+s^2)} \tag{10}$$

$$H(s) = \frac{s+1}{(s+2)(s^2+4s+5)} \tag{11}$$

$$H(s) = \frac{(s+3)(s^2+2s+2)}{s(s-1)(s+2)(s+4)} \tag{12}$$

$$H(s) = \frac{1}{2s^3} \tag{13}$$

$$H(s) = \frac{s^3+4s^2+7s+6}{s^4+5s^3+10s^2+11s+3} \tag{14}$$

$$H(s) = \frac{(s^2-1)}{s^3+s^2+s-3} \tag{15}$$

For each item listed above, do the following

1. Write the transfer function as ratio of polynomials.
2. Write the dc-gain form and evaluate the static gain.
3. Write the zero-pole-gain form and evaluate K_∞.

Problem 2

For each transfer function listed in Problem 1

1. Draw the Bode plot.
2. Draw the polar plot.
3. Draw the Nyquist plot.

Useful Matlab commands

Following is a list of commands which are useful for this homework. If you type `help control`, you get the complete list of commands included in the Control System Toolbox of Matlab. Use `help` in MATLAB for more information on how to use any of these commands.

- `help`: Matlab help documentation.
- `figure`: Create a new figure or redefine the current figure, see also subplot, axis.
- `hold`: Hold the current graph, see also figure.
- `axis`: Set the scale of the current plot, see also plot, figure.
- `plot`: Draw a plot, see also figure, axis, subplot.
- `xlabel/ylabel`: Add a label to the horizontal/vertical axis of the current plot, see also title, text, gtext.
- `title`: Add a title to the current plot.
- `text`: Add a piece of text to the current plot, see also title, xlabel, ylabel, gtext.
- `subplot`: Divide the plot window up into pieces, see also plot, figure.
- `abs`: returns the absolute value of of a complex number.
- `angle`: returns the phase angles, in radians, of a complex number.
- `squeeze`: Remove singleton dimensions.
- `bode`: Draw the Bode plot, see also logspace, margin, nyquist1.
- `polar`: Draw a polar coordinate plot.
- `nyquist`: Draw the Nyquist plot.
- `nyquist1`: Draw the Nyquist plot, see also nyquist. Note this command was written to replace the MATLAB standard command nyquist to get more accurate Nyquist plots.
- `grid`: Draw the grid lines on the current plot.
- `logspace`: Provides logarithmically spaced vector.
- `dcgain`: Computes the steady-state (D.C. or low frequency) gain of LTI models.
- `zpk`: Create zero-pole-gain models or convert to zero-pole-gain format.