Matlab Exercise

Experiment No 1 EE371 Instrumentation &Control and Laboratory IIT Patna
Prepared by Shovan Bhaumik Duration: 3 hours

1.1 Objective:

(i) Familiarisation with Matlab software from control system engineer point of view.

1.2 Exercise Problems:

Background

1. Learn entering and displaying constants and expressions.
2. Entering and displaying vector and matrix. Also learn the addition, multiplication, transpose, eigenvalue, trace and inverse of a matrix.
3. Note the function of following command from help:
   ‘abs’, pi, ‘sin’, ‘cos’, ‘tan’, ‘asin’, ‘acos’, ‘atan’, ‘exp’, ‘imag’, ‘log10’, ‘log’, ‘real’, ‘imag’, ‘diag’, ‘conj’, ‘poly’,
4. Note the function of following command from help:
   ‘clc’, ‘dir’, ‘info’, ‘lookfor’, ‘what’, ‘clear’, ‘size’, ‘who’, ‘home’, ‘quit’, ‘ans’, ‘eps’, ‘flops’, ‘clear all’.
5. Note the features of the function ‘plot’. Also note the functionality of the auxiliary function ‘axis’ and ‘grid’. Try the command sequence
   x = -pi:pi/300:pi; y = tan (sin(x)) – sin (tan(x)); plot (x,y);
   (a) Change the line type and colour, (b) Toggle the grids on and off, (c) zoom the graph to view interesting parts of the graph closely, (d) Superimpose 2cos(x) on the graph.
6. Note the function of following command from help:
   ‘for’, ‘end’, ‘if’, ‘while’, ‘switch’, ‘break’, ‘continue’, ‘end’, ‘tic’, ‘toc’.

State Space method

7. Given the state transition matrix, $\phi(t) = \begin{bmatrix} 2e^{-t} - e^{-2t} & e^{-t} - e^{-2t} \\ -2e^{-t} + 2e^{-2t} & -e^{-t} + 2e^{-2t} \end{bmatrix}$ find out
   a. $\phi(0)$; $\phi^{-1}(t)$ and $\phi(-t)$ for ant t>0
   b. $\phi(t_2 - t_1)$, $\phi(t_1 - t_0)$ and $\phi(t_2 - t_0)$ for any t_2, t_1 and t_0.
   c. $[\phi(t)]^k$ and $\phi(kt)$ for t>0 and any positive integer k.
8. Note the utility of the function ‘ctrb’ and ‘obsv’ from help.
9. Try to find out the controllability matrix of the system described by A=[1 2 1;2 -1 3;1 1 2]; and B=$[2\ 1\ {-1}]^T$. Compare the rank of the controllability matrix and the order of the system.
10. Consider the system described by A=[2 -1 3;1 2 -1;0 1 1]; B=[1 2 -1]T , C=[1 0 0]T. Find the observability matrix for the system. Find the rank and compare it with the order of the system.

Transfer Function Method

11. Enter the system transfer functions G1(s) = 10/ s(s + 5) and G2(s) = (s+1)/ s.
    a. Find the resultant transfer function of the system when G2(s) is connected in series with G1(s).
    b. Find the transfer function of the resultant system when G1(s) is connected in the forward path and G2(s) is in the feedback path with both positive and negative feedback.
    c. Find the closed loop TF of G1(s) = 10/ s(s + 5) with unity feedback.
12. Know the utility of the functions ‘ss2tf’ and ‘tf2ss’ from Matlab Help. Take a system with TF $G(s) = \frac{s+1}{s^3 + 2s^2 + 3s + 1}$. Convert the TF to state space form and reconvert it. Compare both the results.
13. Obtain the pole-zero mapping of the system $G(s) = \frac{s+2}{s(s+1)(s+3)}$.

14. Look up the function 'minreal' from help. Obtain the minimal realization of the system $G(s) = \frac{s^2 + 4s + 3}{s^3 + 5s^2 + 6s}$, after pole-zero cancellation.

15. Obtain the bode plot of the system $G(s) = \frac{10}{s(1+0.2s)(1+0.02s)}$. Modify the axis so that the plot is in the frequency range of range of 1rad/s to 10 rad/s. and note the gain crossover frequency, phase crossover frequency, gain margin and phase margin. Use 'margin' command to obtain the above values. Compare both the results.

16. Obtain the nyquist plot of the system $G(s) = \frac{11(s+2)}{s^3 + 3s^2 + 10}$. Find out whether the critical point has been encircled by obtaining a closer view of that point. From the graph find out gain margin.

17. Obtain the rootlocus plot of the following system $G(s) = \frac{K}{s(s+5)(s+10)}$. Find the value of K at points where the locus crosses over to the right half of the s- plane and at the breakaway points.

1.3 Hints to solve the above problems:

Whenever in need of help please

(i) Type help <command> at the prompt in the MATLAB Command Window or

(ii) Go to Helpdesk by clicking on the question mark (?) at the top-most right corner of the MATLAB Command Window

That way you achieve two things

(i) Really get some help about the instruction you are about to use

(ii) Prevent producing noise in the lab

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