

1st HOMEWORK (due to 11-15 April 2011)

Open loop transfer function of a unity feedback system is given as *

$$G(s) = \frac{K(s+a)}{s(s+b)(s^2+cs+d)}$$

1. i) By using pencil-and-paper, derive the expressions of the responses of the closed loop system for the following input functions :

- a) Unit Impulse
- b) Unit Step
- c) Unit Ramp
- d) Unit Parabola

ii) Propose a method to plot the responses by hand. Using this method plot the unit step response of the c.l. system roughly.

2. Calculate the steady state errors (e_{ss}) of closed loop system for each input function in (1).

3. Find the poles of the closed loop system. Using the dominant two poles, obtain a second order approximate of the system. According to this approximation, calculate the following specifications for closed loop system when the input is a unit step function.

- a) Percent Overshoot, PO
- b) Rise Time, T_r
- c) Peak Time, T_p
- d) Settling Time (for 2% criterion), T_s

Note: You may probably use MATLAB functions listed in the next page. For more details using these functions type “help *function_name*” in MATLAB commend window.

* Everyone will have a different parameter setting. Your parameters (K, a, b, c, d) will be declared.

TABLE F.7 Matlab Functions

Function Name	Function Description	Function Name	Function Description
abs	Computes the absolute value	minreal	Transfer function pole-zero cancellation
acos	Computes the arccosine	NaN	Representation for Not-a-Number
ans	Variable created for expressions	ngrid	Draws grid lines on a Nichols chart
asin	Computes the arcsine	nichols	Computes a Nichols frequency response plot
atan	Computes the arctangent (2 quadrant)	num2str	Converts numbers to strings
atan2	Computes the arctangent (4 quadrant)	nyquist	Calculates the Nyquist frequency response
axis	Specifies the manual axis scaling on plots	obsv	Computes the observability matrix
bode	Generates Bode frequency response plots	ones	Generates a matrix of integers where all the integers are 1.
c2dm	Converts a continuous-time state variable system representation to a discrete-time system representation	pade	Computes an nth order Padé approximation to a time delay
clear	Clears the workspace	parallel	Computes a parallel system connection
cfig	Clears the graph window	plot	Generates a linear plot
cloop	Computes the closed-loop system with unity feedback	poly	Computes a polynomial from roots
conj	Computes the complex conjugate	polyval	Evaluates a polynomial
conv	Multipplies two polynomials (convolution)	printsys	Prints state variable and transfer function representations of linear systems in a readable form
cos	Computes the cosine	pzmap	Plots the pole-zero map of a linear system
ctfb	Computes the controllability matrix	rank	Calculates the rank of a matrix
diary	Saves the session in a disk file	real	Computes the real part of a complex number
d2cm	Converts a discrete-time state variable system representation to a continuous-time system representation	residue	Computes a partial fraction expansion
dstep	Computes the unit step response of a discrete-time system	rlocfind	Finds the gain associated with a given set of roots on a root locus plot
eig	Computes the eigenvalues and eigenvectors	rlocus	Computes the root locus
end	Terminates control structures	roots	Determines the roots of a polynomial
exp	Computes the exponential with base e	roots1	Same as the roots function, but gives more accurate answers when there are repeated roots
expm	Computes the matrix exponential with base e	semilogx	Generates an x - y plot using semilog scales with the x -axis \log_{10} and the y -axis linear
eye	Generates an identity matrix	semilogy	Generates an x - y plot using semilog scales with the y -axis \log_{10} and the x -axis linear
feedback	Computes the feedback interconnection of two systems	series	Computes a series system connection
for	Generates a loop	shg	Shows graph window
format	Sets the output display format	sin	Computes the sine
grid	Adds a grid to the current graph	sqrt	Computes the square root
help	Prints a list of HELP topics	ss2tf	Converts state variable form to transfer function form
hold	Holds the current graph on the screen	step	Calculates the unit step response of a system
j	$\sqrt{-1}$	subplot	Splits the graph window into subwindows
imag	Computes the imaginary part of a complex number	tan	Computes the tangent
impulse	Computes the unit impulse response of a system	text	Adds text to the current graph
inf	Represents infinity	title	Adds a title to the current graph
j	$\sqrt{-1}$	tf2ss	Converts a transfer function to state variable form
linspace	Generates linearly spaced vectors	who	Lists the variables currently in memory
load	Loads variables saved in a file	whos	Lists the current variables and sizes
log	Computes the natural logarithm	xlabel	Adds a label to the x -axis of the current graph
log10	Computes the logarithm base 10	ylabel	Adds a label to the y -axis of the current graph
loglog	Generates log-log plots	zeros	Generates a matrix of zeros
logspace	Generates logarithmically spaced vectors		
lsim	Computes the time response of a system to an arbitrary input and initial conditions		
margin	Computes the gain margin, phase margin, and associated crossover frequencies from frequency response data		
max	Determines the maximum value		
mesh	Creates three-dimensional mesh surfaces		
meshdom	Generates arrays for use with the mesh function		
min	Determines the minimum value		