Session 1. Getting started with MATLAB/ Simulink

Lecture notes for Advanced modeling and Control

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Table 1: Useful functions

General functions:	
`cd`	Change subdirectory
`demo`	Launch the demo (introduction)
`dir (what)`	Listof files in currentdirectory (or only M-files)
`help, helpwin`	Help! Help window
`load`	Load workspace
`lookfor`	Keyword search
`print`	Printgraph; can use pull-down menu
`quit`	Quit!
`save`	Save workspace
`who, whos`	Listof variables in workspace
Calculation functions:	
`conv`	Convolution function to multiply polynomials
`size, length`	Size of an array, length of a vector
Plotting functions:	
`axis`	Override axis defaultof plot
`grid`	Add grid to plot
`hold`	Hold a figure to add more plots (curves)
`legend`	Add legend to plot
`plot`	Make plots
`text (gtext)`	Add text (graphical control) to plot
`title`	Add title to plot
`xlabel, ylabel`	Add axis labels to plot
Partial fraction and transfer functions:	
`poly`	Construct a polynomial from its roots
`residue`	Partial-fraction expansion
`roots`	Find the roots to a polynomial
`tf2zp`	Transfer function to zero-pole form conversion
`zp2tf`	Zero-pole form to transfer function conversion
`tf`	Create a transfer function object
`get`	Listthe objectproperties
`pole`	Find the poles of a transfer function

Activities

1. Explore MATLAB user interface
2. Define a vector `x = [1 2 3 4 5 6 7 8 9 10]`.

   What are different ways you can define x? What happens when you put ; at the end?
3. Convert vector x into a column vector.
4. Create vector `y = [0, 0.1, 0.2, ...., 2.0]`
5. Create a 3 x 3 matrix.
6. Print the size of the matrix and lengths of vectors defined so far.
7. Define 3 polynomials

$$p_1(s) = s^2 - 5s + 4 \tag{1}$$

$$p_2(s) = s^2 + 4 \tag{2}$$

$$p_3(s) = s^2 - 5s \tag{3}$$

8. Calculate $p_1(s)p_2(s)$
9. Perform some mathematical computations on the vectors, matrices, and polynomials defined so far.
10. Solve **Ax** = **b**

    ```
    A = [ 4 -2 -10; 2 10 -12; -4 -6 16];
    ```

    ```
    b = [-10; 32; -16];
    ```
11. Check the solution
12. Calculate eigenvalues and eigenvectors.
13. Consider data:

    ```
    x = [ 0 1 2 4 6 10];
    ```

    ```
    y = [ 1 7 23 109 307 1231];
    ```

    Fit a third-order polynomial. Plot the results
14. Explore MATLAB plotting capabilities
15. Create a MATLAB script, save, and load it to plot data in item 13.
16. Find roots of polynomial defined by `p = [1 5 4]`

17. Search for a function to find roots of a nonlinear equation.
18. Find polynomial for the roots (-4, -1)
19. For the following transfer functions find partial fractions.

$$G(s) = \frac{q(s)}{p(s)} = \frac{2}{s^2 + 5s + 4} \tag{4}$$

$$G(s) == \frac{2}{s(s+1)(s+2)(s+3)} \tag{5}$$

$$G(s) == \frac{s^3 + 4s + 3}{s^4 - 7s^3 + 11s^2 + 7s - 12} \tag{6}$$

20. Have fun with `zp2tf`, `tf2zp`, and `tf` commands
21. Response of first order system: Compute and plot step response of following first order systems

$$y(s) = \frac{1}{5s + 1} \tag{7}$$

$$y(s) = \frac{5e^{-10s}}{2.5s + 1} \tag{8}$$

22. Response of second order system: Compute and plot step response of following second order system. Show effect of ξ on response.

$$G_p(s) = \frac{Y(s)}{U(s)} = \frac{K_p e^{-\theta s}}{\tau^2 s^2 + 2\xi\tau s + 1} \tag{9}$$

$K_p = 1; \tau = 1; \theta = 10$

23. Solve differential equations using Simulink

a) An object falling under gravity

$$\frac{d^2y}{dt^2} = -g \tag{10}$$

Compare the result with analytical solution $y = -gt^2/2$

b) Systems of ODEs

1.

$$\frac{d^2y}{dt^2} + 2\frac{dy}{dt} + 5y = 1 \tag{11}$$

$$\dot{y}(0) = y(0) = 0 \tag{12}$$

2.

$$\begin{bmatrix} \dot{x} \\ \dot{y} \end{bmatrix} = \begin{bmatrix} 1 \\ 0 \end{bmatrix} + \begin{bmatrix} -2 & -5 \\ 1 & 0 \end{bmatrix} \begin{bmatrix} x \\ y \end{bmatrix} \tag{13}$$