Session 1. Getting started with MATLAB/ Simulink

Lecture notes for Advanced modeling and Control

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| Table 1: Useful functions

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| **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 |
| zpk | Create a transfer function in pole-zero-gain form |

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# 1. 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?
1. Convert vector x into a column vector.
2. Create vector y = [0, 0.1, 0.2, ...., 2.0]
3. Create a 3 x 3 matrix.
4. Print the size of the matrix and lengths of vectors defined so far.
5. Define 3 polynomials

$$p\_{1}\left(s\right)=s^{2}−5s+4  \left(1\right)$$

$$p\_{2}\left(s\right)=s^{2}+4  \left(2\right)$$

$$p\_{3}\left(s\right)=s^{2}−5s  \left(3\right)$$

1. Calculate $p\_{1}\left(s\right)p\_{2}\left(s\right)$
2. Perform some mathematical computations on the vectors, matrices, and polynomials defined so far.
3. Solve **Ax = b**
* A = [ 4 -2 -10; 2 10 -12; -4 -6 16];
* b = [-10; 32; -16];
1. Check the solution
2. Calculate eigenvalues and eigenvectors.
3. Consider data:
* x = [ 0 1 2 4 6 10];
* y = [ 1 7 23 109 307 1231];
* Fit a third-order polynomial. Plot the results
1. Explore MATLAB plotting capabilities
2. Create a MATLAB script, save, and load it to plot data in item 13.
3. Find roots of polynomial defined by p = [1 5 4]
4. Search for a function to find roots of a nonlinear equation.
5. Find polynomial for the roots (-4, -1)
6. For the following transfer functions find partial fractions.

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

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

$$G\left(s\right)==\frac{s^{3}+4s+3}{s^{4}−7s^{3}+11s^{2}+7s−12}  \left(6\right)$$

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

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

$$y\left(s\right)=\frac{5e^{−10s}}{2.5s+1}  \left(8\right)$$

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

$$G\_{p}\left(s\right)=\frac{Y\left(s\right)}{U\left(s\right)}=\frac{K\_{p}e^{−θs}}{τ^{2}s^{2}+2ξτs+1}  \left(9\right)$$

* $K\_{p}=1$; $τ=1$; $θ=10$
1. Solve differential equations using Simulink
2. An object falling under gravity

$$\frac{d^{2}y}{dt^{2}}=−g  \left(10\right)$$

* Compare the result with analytical solution $y=−gt^{2}/2$
1. Systems of ODEs

$$\frac{d^{2}y}{dt^{2}}+2\frac{dy}{dt}+5y=1  \left(11\right)$$

$$\dot{y}\left(0\right)=y\left(0\right)=0  \left(12\right)$$

$$\left[\begin{matrix}\dot{x}\\\dot{y}\end{matrix}\right]=\left[\begin{matrix}1\\0\end{matrix}\right]+\left[\begin{matrix}−2&−5\\1&0\end{matrix}\right]\left[\begin{matrix}x\\y\end{matrix}\right]  \left(13\right)$$