Useful MATLAB Commands

You will be mainly using the MATLAB Control System Toolbox. A great way to get started with the toolbox is to run the demo. This is done by typing `demo('toolbox','control')` at the MATLAB prompt.

Presented here are the most useful MATLAB commands for this class, grouped by topic. For further details, make good use of the `help` command in MATLAB. In general, other than the necessary MATLAB lab tasks, MATLAB should be used as a tool to verify your work, not substitute for it. The exception, of course, is for computationally intensive problems, in which case make sure to note on your assignment that you used MATLAB.

General Matrices:

inv Inverse of a matrix.

conj Returns the complex conjugate of a number, vector, or matrix.

transpose (.') Transpose of a matrix. `transpose(A)` is the same as `A.'`. You can do the complex-conjugate transpose using `A'`.

eig Will return just the eigenvalues of a matrix using `eig(A)`. If used in the form `[v d] = eig(A)`, it will also return a set of eigenvectors (not unique).

rank Returns the rank of a matrix.

Transfer Functions (TFs):

tf Enter transfer functions. The parameters are row vectors of the numerator and denominator coefficients, respectively.

Ex: to enter the TF $H(s) = \frac{s+2}{s^2+5}$, you could type `H = tf([1,2],[1 0 5])`.

conv Convolve two polynomials (represented as row vectors of their coefficients). It is particularly useful for determining the expanded coefficients for factored polynomials.

Ex: enter the TF $H(s) = \frac{s+2}{(s+1)(s-3)}$ by typing `H = tf([1 2],conv([1 1],[1 -3]))`.

series (*) Combine two TFs that are in series.

Ex: if $H(s)$ and $G(s)$ are in series, get the combined TF $T(s)$ with the command `T = G*H` OR `T = series(G,H)`.

feedback Combine two TFs that are in feedback.

Ex: if $G(s)$ is in the forward path and $H(s)$ is in the feedback path, get the overall TF $T(s)$ with the command `T = feedback(G,H)`.

step Plot the step response of a system.

Ex: `step(T)` plots step response of the system $T(s)$.

Stability Plots:

rlocus Plot the root locus. **Keep in mind that this command is used on the loop gain of the system** as opposed to the closed-loop transfer function. For example, consider the standard negative feedback system with forward path G and feedback path H. The loop gain would be $G(s) * H(s)$ whereas the closed-loop TF would be $\frac{G(s)}{1+G(s)H(s)}$.

bode Plots the frequency response.

Ex: `bode(H)` plots the frequency response (both magnitude and phase) for the system $H(s)$.

margin Calculates gain and phase margins and crossover frequencies. If used without return values, plots open-loop Bode with margins marked.

Ex: `[Gm,Pm,Wcg,Wcp] = margin(G)` just returns values for system $G(s)$ while `margin(G)` plots them visually.

nyquist Nyquist frequency response of LTI models. **Does NOT display contour at infinity**. Plot is often misleading because of scale. Make sure to zoom and change axes view to get the complete picture.

State Space:

ss Creates state-space model from argument matrices A, B, C, and D.

Ex: For pre-defined state matrices A, B, C, and D of the proper dimensions, use `H = ss(A,B,C,D)`.

tf2ss
ss2tf Conversion between system representations. `tf2ss` returns the 4 matrices A, B, C, and D. `ss2tf` returns the polynomials (in coefficient vector form) for the numerator and denominator.

ctrb Compute the controllability matrix $\mathcal{C} = [B \quad AB \quad \dots \quad A^{n-1}B]$. Only need to pass it the matrices A and B.

obsv Compute the observability matrix $\mathcal{O} = [C \quad CA \quad \dots \quad CA^{n-1}]^T$. Only need to pass it the matrices A and C.

Plotting:

plot Plots vectors x vs. y. You can add options such as color, line-type, and more as a third argument. See `help plot` for more info.

figure Selects window to plot on.

Ex: To plot into the window titled 'Figure 1', use `figure(1)` before the plot command. To

open a new window, just use `figure` and it will open a new window with the appropriate number.

subplot Similar to `figure`, but splits the current figure into smaller regions.

Ex: To plot x vs. y1 and x vs. y2 on the same plot vertically (so 2 rows and 1 column), use: `subplot(2,1,1), plot(x,y1)` followed by `subplot(2,1,2),plot(x,y2)`.

plotyy Plots two lines on the graph with separate axes for each. One will be displayed on the left, the other on the right.

axis Control axis scaling and appearance. Can be used to return current axes ranges or modify them. There are also a bunch of preset modes. See `help axis` for more information.

title Places a character vector on the top of your figure.

xlabel
ylabel Label your axes. These take a character vector as an argument and places it on the appropriate axis.

legend Adds a legend. You enter strings separated by commas and it will assign them to the graphs in the order they were plotted.

Revision History

Semester and Revision	Author(s)	Comments
Winter 2008 Rev. 1.0	Justin Hsia	Separated 'transfer function' section from Lab 1 and wrote all other groups.