Helpful Matlab Commands and Information:

num = [a b c d]; Num = as^3+bs^2+cs+d

Transfer function (TF) numerator and denominator polynomials are written as row vectors where each entry is a coefficient of s^x, with x in descending order moving to the right.

G = tf(num, den); G is now a system variable.

Alternatively,
s=tf('s');
G=(a*s^3+b*s^2+c*s+d)/(e*s^3+f*s^2+g*s+h);

G = ss(A,B,C,D); G is now a system variable and A, B, C, and D are SS (state space) matrices.

[A,B,C,D] = tf2ss(num,den); Converts TF to SS, where SS is not unique.

[num,den] = ss2tf(A,B,C,D); Converts SS to TF.

D = eig(A); A is a square matrix and D is a vector of the eigenvalues of A.

[V,D] = eig(A); A is a square matrix, D is a diagonal matrix of eigenvalues, and V is a matrix where the columns are the corresponding eigenvectors.

roots(den); Computes the roots of the polynomial stored in den.

bode(G); Gives the bode plot of system G.

step(G); Shows the unit step response of system G.

controlSystemDesigner(G,H); Opens the Control System Designer where G and H are system variables corresponding to the plant and controller, respectively.

rltool(G,H); Launches the Control System Designer, similar to controlSystemDesigner() command. However, **rltool() only works for MATLAB versions older than R2021a.**

zpk(G); Simplifies system G to a TF separating the zeros, poles, and gain if possible.

pzmap(G); Graphs the poles and zeros of system G.

[w,z] = damp(G); Used to find the damping ratios, z, and natural frequencies, w, of system G.

[K,S,E]=lqr(A,B,Q,R); Used to find Gains using the LQR method.

zeros(rows, cols); Creates a matrix of zeros with the specified size.

eye(size); Creates an identity matrix with the given size.

diag(V); Creates a diagonal matrix using the components of vector V.

The following website from the University of Michigan offers in-depth tutorials and helpful information on Matlab and Simulink. The tabs Basics and Index in the top menu bar are the most relevant.
https://ctms.engin.umich.edu/CTMS/index.php?aux=Basics_Matlab
Another useful resource for Matlab tutorials is as follows.
https://www.tutorialspoint.com/matlab/index.htm

Guidelines for the lab to make your life easier (and your grade better):

1) During Design:

a) If we say something needs to be greater than zero, infinity counts.

b) Know how to convert between the usual TF format and the one used in rltool.

c) For response graphs in rltool and Simulink, the resolution must be high enough that the curves are smooth, and accurate. Adjust this with parameters in Simulink and rltool.

d) When we give you requirements, to get full credit you must meet them completely, close isn't enough. However, close will be enough to get most of the credit if it seems too difficult (this lab isn't always easy) and you should be progressing faster.

e) If you find yourself spending forever on something, just ask the TA's for help. It's better for your time and ours if you just ask (after spending an appropriate amount of time yourself working through the problem), rather than wasting time on something that is actually simple when you're just confused on something small. We will never just give you answers, but we might be able to quickly make you see something you don't already.

f) Always read the manuals and try to understand the concepts before lab. It will make your life so much easier and get you out of lab quicker!

2) Concerning Simulink:

a) Go to the Modeling tab, click the Model Settings icon/option, select Data Import/Export, followed by Additional Parameters, and uncheck the "limit data points to ___" checkbox. Also notice that time is automatically outputted to the workspace as variable 'tout'. Optionally you can use a clock block and output it to a variable yourself.

b) Do not print out scope displays, use the output-to-workspace block instead and use the plot() command to graph variables. In the output-to-workspace block chose the option for "output data as array" to make plotting simple.

c) When using SS, use the mux block for multiple inputs, and demux for multiple outputs.

d) When entering values for Simulink you can use variable names that are in the workspace. So, you can type in "A" instead of the actual matrix A in the SS block.

e) Your Simulink block diagrams should be arranged logically in the conventional fashion (ie. Not completely disorganized but still working.). It's very difficult to trouble shoot a messy diagram, and the TA's won't spend much time if it's not easy to read.