Tutorial Sheet: Matlab and Simulink Exercises

This sheet is intended to refresh your memory with some basic Matlab commands, and possibly introduce some new ones. Type them into a '.m' and save them so that you have easy access when you do your future tutorials, coursework and TCA. Consider using sections and/or a live script for ease.

1. Enter the matrix $\mathbf{A} = \begin{bmatrix} 0 & 1 & 0 \\ 0 & 0 & 1 \\ -9 & -8 & -7 \end{bmatrix}$

```
% Question 1
'(Question 1)' % Display a label (if you wish)
A = [0 1 0; 0 0 1; -9 -8 -7] % Represent A
A = [0 1 0;
    0 0 1;
    -9 -8 -7]; % An alternative way of entering A: handy for larger
matrices
% Note that a semi-colon after each line prevents the matrix being
% displayed in the command window. This will speed up your computation in
% longer scripts.
```

2. Enter a row vector $\mathbf{C} = \begin{bmatrix} 2 & 3 & 4 \end{bmatrix}$

```
%% Question 2
C = [2 3 4];
```

3. Enter a column vector $\mathbf{B} = \begin{bmatrix} 7 \\ 8 \\ 9 \end{bmatrix}$

```
%% Question 3
B = [7; 8; 9];
B = [7 8 9]'; % An alternative is to enter a row vector and find the
transpose using an apostrophe.
```

4. We can define a state space "object" in matlab using the 'ss' command. You can type 'help ss' or search for ss in the help menu for more information.

```
%% Question 4
A = [0 1 0;
    0 0 1;
    -9 -8 -7]; % Repeated here for completeness, but these may still be in
your workspace.
B = [7 8 9]';
C = [2 3 4];
D = 0; % D is usually (but not always) 0
F = ss(A,B,C,D) % Display F in the command window by not including the
semicolon.
```

5. Last year, you looked a poles and dynamic response of systems. We will revise and expand on this in more detail in future weeks, but for now let's look at how we find a system's response to a **unit step input** using the 'step' command.

```
%% Question 5
close all; % Closes any old windows from previous runs
figure; % Opens a new figure window (prevents your graph being overwritten if you plot more than one graph)
t = 0:0.1:10; % A time vector for your plot. Without it, the software will use default values which may vary between runs.
step(F,t);
grid on; % This places a grid on your graph for ease of reading
```

6. Once you have plotted a graph, you will need to save it and/or put it into your report, coursework assignment, or similar.

To save the figure: Select File > Save As. You can then select a range of formats which can be inserted into your documents later. The menus are shown in Figure 1. Save your graph as a jpeg now.

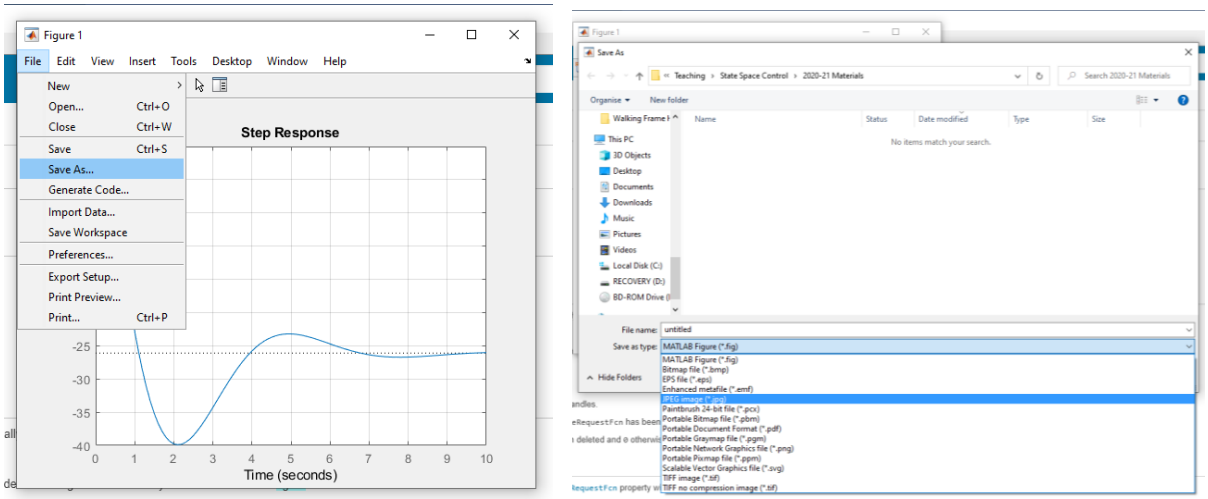

Figure 1: Saving your graph

To copy a figure into a document: Select Edit > Copy Figure. You can then paste it into your document. The menu is shown in Figure 2. Practise doing it now.

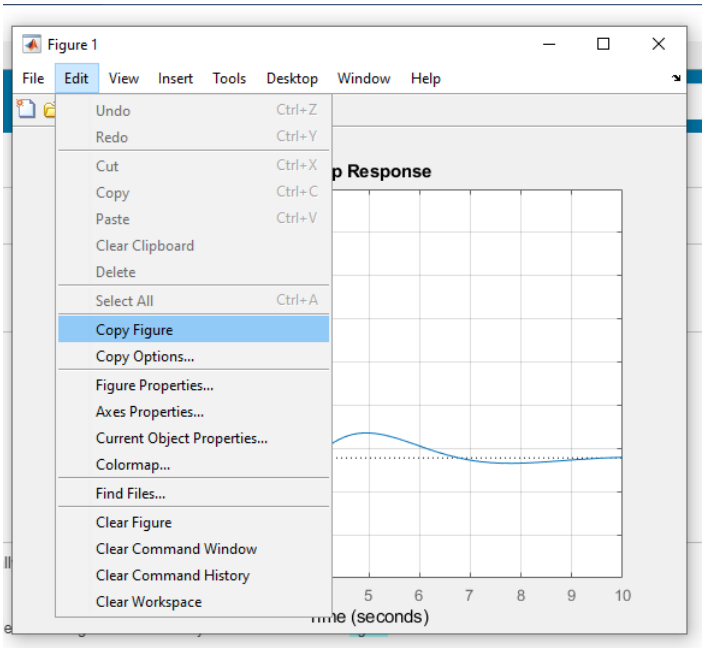

Figure 2: How to copy a Matlab plot into a document

***** Do not ever take a screen shot using the 'PrtScn' key or Snipping Tool *****
Screen shots produce an illegible, poor quality graphic. You will lose marks in this module, and your future work will be of no use, be rejected for publication, and generally reflect poorly on you.

7. Let's check your results in Simulink. Open Simulink, and find the 'State-Space' block. Drag-and-drop it into your workspace, and connect it to a 'Step' source and a 'Scope' sink. Edit the State-Space blocks so that it uses the A, B, C and D matrices already in your workspace. Run the model, and inspect the scope: does it resemble the plot you generated in part 5?

8. Practise copying your model and results to a document. To copy a Simulink model, there is a 'screenshot' option under the Format tab (Figure 3).

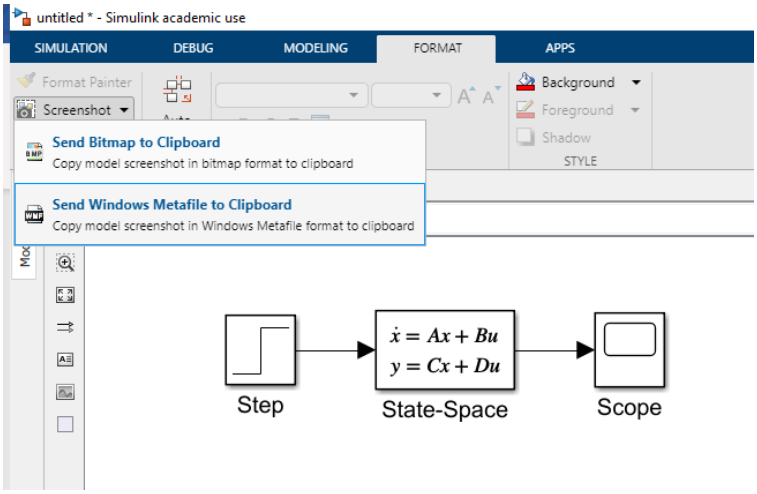

Figure 3: How to copy a Simulink model into a document

The graph plotted in the scope is generally not annotated and can be illegible when copied. You should save your simulation data and plot it in Matlab. Select the View drop-down menu and open 'Configuration Parameters.' Check the box 'Log data to workspace' and change the variable name if you wish (shown in Figure 4). You can also change your preferred save format: select 'Structure plus Time.' When you next run the model, the output data will appear in your workspace.

Alternatively, you could put a 'To Workspace' sink block in your model, connected to the output.

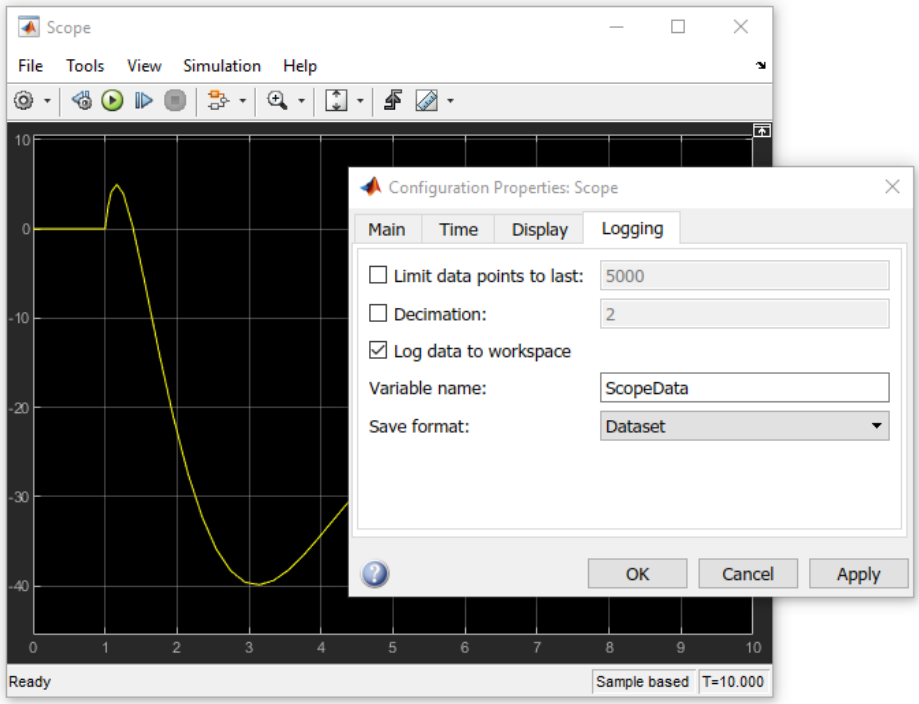

Figure 4: How to save data from a Scope output

Once you have the data in your workspace, practice inspecting and plotting it. The following command (entered in the command window) will plot the output data against time:
`plot(out.ScopeData.time,out.ScopeData.signals.values)`

Make sure you annotate the graph. You can insert X and Y Labels, Title, Legend, etc. from the 'Insert' drop-down menu. When it is finished, save it just like the graphs you generated in question 6.