ENGR 232 – Linear Engineering Systems

Lab 9: In Class Assignment Summer 2016-17

Version A: Given a LTI matrix equation: $x' = \begin{bmatrix} 0 & 1 \\ -10 & -2 \end{bmatrix} x + \begin{bmatrix} 0 \\ 1 \end{bmatrix} u \quad x(0) = \begin{bmatrix} 0 \\ 0 \end{bmatrix}$

Perform the following tasks putting work in appropriate cells and then answer the questions in cell 6

1. Find the eigenvalues using the ***eig()*** function in MATLAB. What type of response to a step function do you expect (Overdamped, critically damped or underdamped)?

2. Using Matlab solve the matrix differential equation in the **Laplace domain** and find the two components X1(s) and X2(s). Note this is the zero state response since initial conditions are zero.

    - *For the Input : We consider the model of turning on a switch, waiting a bit (5 seconds) then turning it off . In the Laplace domain the input (Matlab syntax) is*

    *U = 1/s – exp(-5*s)/s*

3. Using Matlab find the inverse Laplace transform (time response) for X1(s), X2(s) and U(s) and then use matlabFunction() to create anonymous functions of time.

4. On a new figure, plot the ***analytical solution*** over the time range: t = ***0:0.01:15***
    - ***Plot x1(t), x2(t) the component plots and the input u(t) in an augmented subplot.*** These should be in a single column.
    - Use titles and labels appropriately.

5. On a separate figure plot the phase plot. Show the initial condition with a black star. From the time plots you should see that the final value is also zero.

After completing the above answer the following questions

6. In a separate cell (called Summary Cell)
    a. Discuss the direction of the phase plot with respect to its starting point, where the pulse turns off and at its final value.
    b. Estimate the time for x1(t) to go to zero after the pulse is removed.
    c. Estimate the time for x2(t) to go to zero after the pulse is removed.