Assignment 2 – Modelling in Matlab

Course code: ***ECEN315*** **-** Will Browne & Daniel Burmester

Coursework description: The aim of this assignment is to assess the student's ability to model systems using MATLAB to simulate system behaviour and understand the system.

Deadline: 15/05/2020 23:59:00 on-line

Work will be marked and returned by 5pm 30.05.20

This piece of coursework is regarded as important.

Working Together and Plagiarism

We encourage you to **discuss the principles** of the course and assignments with other students, to help and seek help with programming details, problems involving the lab machines. However, any work you hand in **must be your own work**.

The School policy on Plagiarism (claiming other people's work as your own) is available from the course home page. Please read it. We will penalise anyone we find plagiarising, whether from students currently doing the course, or from other sources. Students who knowingly allow other students to copy their work may also be penalised. If you have had help from someone else (other than a tutor), it is always safe to state the help that you got. For example, if you had help from someone else in writing a component of your code, it is not plagiarism as long as you state (eg, as a comment in the code) who helped you in writing the method.

This work takes ~6 sides of A4 + Appendix and ~3 Days to complete - do not leave it to the last minute! Presenting the assignment as a full written report is recommended as feedback will be given, although apart from clarity of presentation there will be no marks allocated specifically for the report writing.

System modelling by Matlab

The use of Matlab software, particularly the control toolbox, is a powerful tool in the modeling and simulation of dynamic systems. Work through the handouts on the use of Matlab and then attempt the following problems. Hand in a printout of you Matlab code, answers and figures.

1) For a transfer function given by:

$$\frac{o}{i} = \frac{a}{s^2 + 4s + a}$$

Write a Matlab m-file that will display the step response of this system for values of a = 1, 2, 4, 8. Plot the responses together on one graph. Also plot the poles for each case and calculate the time constant and the settling time.

2) The transfer function of a DC motor is given by:

$$\frac{\theta_L(s)}{E_a(s)} = \frac{0.0425}{s(s+2.45)}$$

(a) Use Matlab to model the output response of the motor to a 5 V step in the input voltage. Comment on the shape of the graph.
(b) For the same motor find the response in angular velocity with time to a 5V step in the input voltage.

3) For each of the systems below, use Matlab to compute the step response. Also find ζ, ω_n, Ts, Tp, TR and %OS. Use the LTI viewer to plot the response of all the systems in order to obtain as much information as possible.

$$G_1(s) = \frac{26}{s^2 + 3s + 16}$$

$$G_2(s) = \frac{0.4}{s^2 + 0.02s + 0.04}$$

$$G_3(s) = \frac{1.07x10^7}{s^2 + 1.6x10^3 s + 1.07x10^7}$$

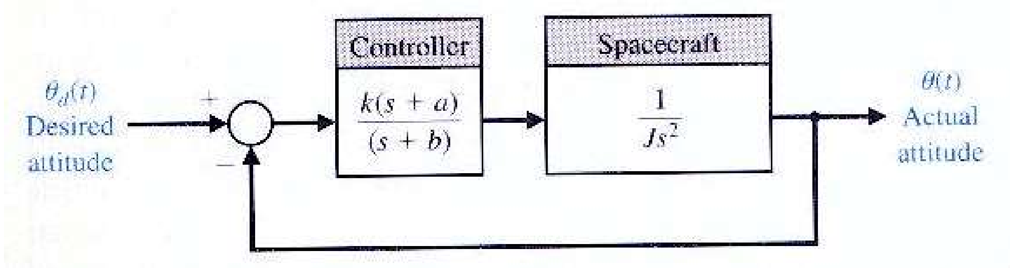
4) A satellite single-axis attitude control is be represented by the block diagram shown below. The variables in the system are as follows: a= 1, b = 8, k = 10.8 x 10^8 and the moment of inertia J = 10.8 x 10^8.

(a) Develop a Matlab script to compute the closed loop transfer function

$$G(s) = \frac{\theta(s)}{\theta_d(s)}$$

(b) Compute and plot the step response for a step demanding a 10º change.

(c) The exact moment of inertia is unknown and may change slowly with time. Compare what the step response will look like if J is 20% and 50% less than initially assumed.



6) For a system with open loop transfer function given by:

$$G(s) = \frac{6}{s(s+6)(s+1)}$$

(a) Determine the minimum value of a series gain controller that causes the closed loop system to become unstable.
(b) Replace the gain controller with a controller that has less steady-state gain than the gain controller found in (a), but still causes the system to become unstable. Explain, using diagrams if necessary, how this occurs.