Control Systems - Project 1/Assignment 1

1. The objective of the exercise is to become familiar with writing Matlab programs for control.
   1.1. Product of two polynomials: Let $p_1(s)$ and $p_2(s)$ be two polynomials. Use Matlab to determine the product of these two polynomials.
   1.2. Obtaining the overall transfer function (Block diagram algebra): Let $G_1(s) = \frac{n_1(s)}{d_1(s)}$ and $G_2(s) = \frac{n_2(s)}{d_2(s)}$ be the two given transfer functions, where $G_1(s)$ and $G_2(s)$ are transfer functions of arbitrary order.
      1.2.1. Transfer functions in cascade or series: Write a program that allows the user to input the numerator and denominator polynomials of two transfer functions, and outputs the numerator and denominator polynomials of the overall transfer function.
      1.2.2. Transfer functions in parallel: Write a program that allows the user to input the numerator and denominator polynomials of two transfer functions, and outputs the numerator and denominator polynomials of the overall transfer function.
      1.2.3. *Transfer functions in a feedback loop:* Write a program that allows the user to input the numerator and denominator polynomials of two transfer functions, and outputs the numerator and denominator polynomials of the overall transfer function. Here, $G_1(s)$ is the forward path transfer function, and $G_2(s)$ is the feedback path transfer function.
2. The objective of this exercise is to learn to use Simulink. Consider a circuit with a resistance R, an inductance L, and a capacitance C, all in series with a voltage source.
   2.1. Determine the transfer function from the applied voltage to the voltage across the capacitance. Hence, obtain the differential equation that governs the dynamics of the system.
   2.2. Rewrite this differential equation by expressing the highest derivative of the dependent variable in terms other derivatives of the dependent variable and the input.
   2.3. Implement this in simulink as follows: At the Matlab command prompt type **simulink**. A Simulink library browser opens up. Using the pull-down menu listed under **File** open a new model. Double click on the **Continuous** simulink library. Copy the integrator block onto the new model that you created. Create another copy, and connect the two integrators. (Let these two integrators be named One and Two.) From the **commonly used blocks** get a copy of the summer (**sum**) the **gain** block, and the **scope** block. Connect the output of Two to the scope. Make a

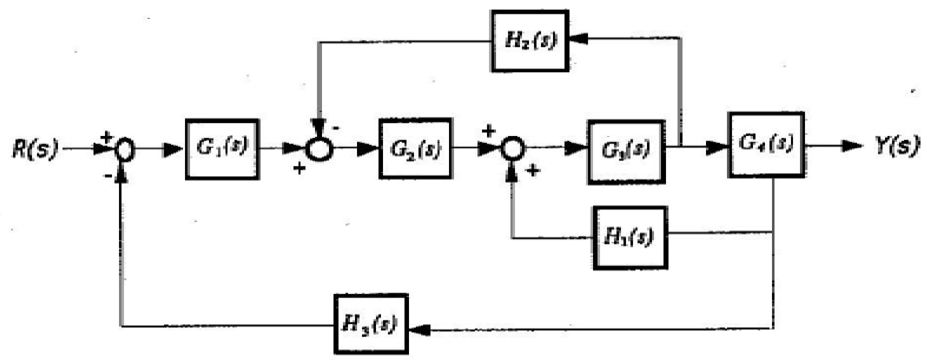
second copy of the gain block, and connect the output of one to one gain block and Two to the other gain block. (For visual correctness, it is possible to flip the direction of the gain block by using Ctrl-r.) Double click on the summer and add one more input to the block. Connect the outputs of the gain blocks to two of these inputs. Connect the **step** block (from the **sources** simulink library) to the first input through an appropriate gain block. For C = 0.01 F, L = 0.1 H, and R = 33 ohms, simulate and observe the response.

3. The objective of this exercise is to use the building blocks for block-diagram algebra for transfer functions developed in question 1., and to perform basic analysis.

   3.1. Using the program/programs developed in question 1., determine the overall transfer function for the figure shown below. The individual transfer functions are as follows:

$$G_1(s)=\frac{1}{s+10};G_2(s)=\frac{1}{s+1};G_3(s)=\frac{s^2+1}{s^2+4s+4};G_4(s)=\frac{s+1}{s+6};$$

$$H_1(s)=\frac{s+1}{s+2};H_2(s)=2;H_3(s)=1$$



   3.2. Generate a pole-zero map of the closed-loop transfer function in graphical form using the **pzmap** function.

4. **P2.17, P2.32, P2.33, P2.34** from *"Modern Control systems"*, R.C. Dorf and R.H. Bishop, 12th Edition, PEARSON Education 2009.