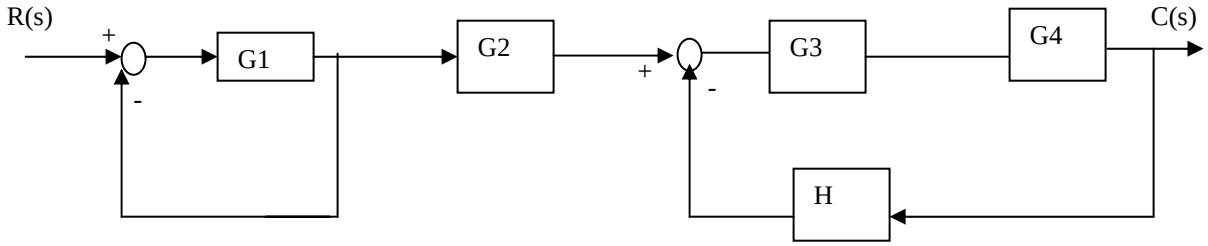
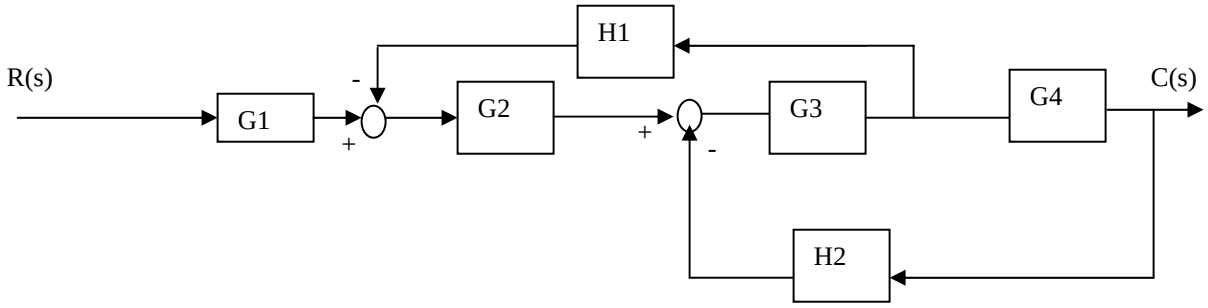
Studio #4: Block Diagrams
ENME462, Spring 2006

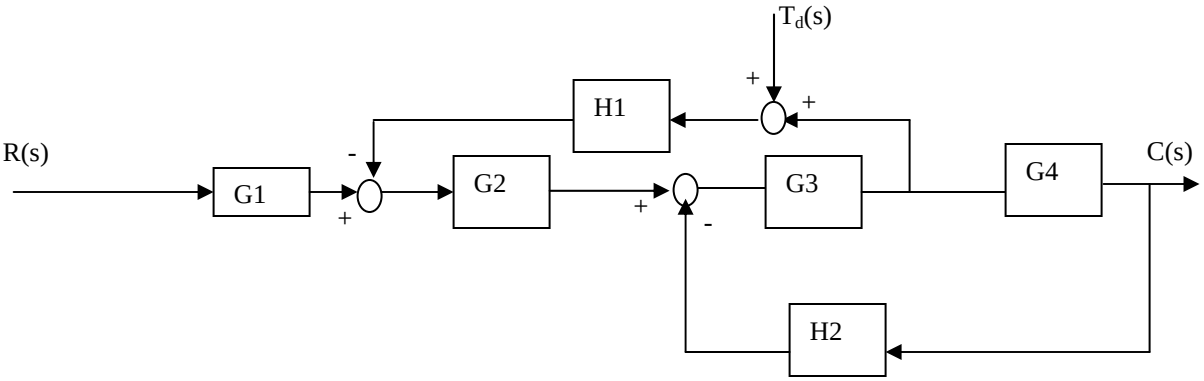
1. Simplify the following block diagram and determine the closed-loop transfer function C(s)/R(s)



2. Simplify the following block diagram and determine the closed-loop transfer function C(s)/R(s)



3. Simplify the following block diagram and determine the closed-loop transfer functions $C(s)/T_d(s)$



4. Simulink is a very powerful tool which allows detailed feedback systems to be modeled and simulated graphically. In this problem you will use Simulink to model the block diagram in problem #1, using the following transfer function values:

$G_1 = 1/(2s^2+s+2)$ $G_2 = (s+1)/(4s+1)$ $G_3 = 1/s$ $G_4 = 3$ $H = 1/(s+1)$

Follow the steps below to create your model:

1. Open a MatLab command window and type *simulink*.

2. From the Simulink Library Browser top menu, select *File -> New -> Model*. This will open up a blank window in which you will create your block diagram.

3. From the left-hand list on the Browser, select *Simulink -> Continuous* to show typical block diagram elements used for continuous systems (as opposed to discrete systems).

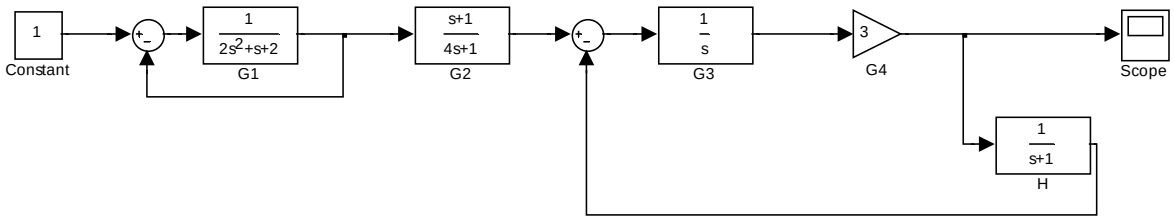
4. Drag four *Transfer Fcn* blocks into your new model window. Label the blocks G_1, G_2, G_3 and H, and arrange the blocks in the order of the block diagram from problem #1, and enter the appropriate transfer functions by double-clicking on each block.

5. Add the transfer function G_4 as a simple gain block:
   Go to *Simulink -> Math Operations* and drag a *Gain* block into your model. Label the block, and change the gain to the correct number.

6. Add a step input source and an output measurement to your system:
   Go to *Simulink -> Sources* and select the *Constant* input block. Place a *Constant* input block on the left side of your model. Next, go to *Simulink -> Sinks* and select the *Scope* block. Add a *Scope* block on the right side of your model.

7. Add summation points:
   Go to *Simulink -> Math Operations* and scroll down until you see the *Sum* element. Drag two *Sum* elements into your model window. Make sure the signs of the summation nodes are correct.

8. Connect the various signal paths by clicking on the output of one element and dragging to the input of another. You can create pickoff points from signal paths by dragging a new signal path from an input or output node of a block onto another signal path. A small black dot will appear at the junction if done correctly. The result should look something like this:



9. Set the simulation time scale:
   From your model window, select *Simulation -> Configuration Parameters*. Set the *Stop time* to 50 (seconds) and hit *OK*.

10. Simulate the system:
    From your model window, select *Simulation -> Start*. The simulation should finish in under a second.

11. View the results:
    Double-click your *Scope* block to show the time-domain response of the system. Right-click the plot and select *Autoscale*.

12. Turn in a printout of:
    (A) Simulink block diagram.
    (B) Output plot c(t).
    (C) Graphically calculate e_{ss} , T_r, T_p, and T_s and label these values on your plot.