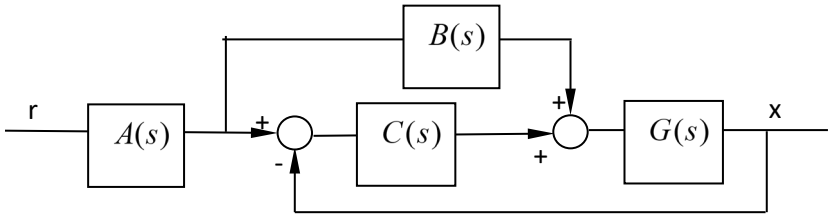
HW #4 (3/1/2023)

1) Chapter 6: 6.4b, 6.5c, 6.7b, 6.11-6.12, 6.16(a-b), 6.17b, 6.18-6.21, 6.23(b and e), 6.26-27, Chapter 6: 6.32-6.40, 6.45-6.54 (as with last time select a few to be comfortable or ones you are most interested in looking at)
2) Consider the plant, G(s) shown below. Derive the closed-loop block diagram from reference (r) to output (x) for the various control strategies. Comment on the similarity and differences. $G(s) = \frac{1}{s+10}$

   I) A=11, B=0, C=1
   II) A=1, B=10, C=1
   III) A=1, B=0, C=1/s



3) Write a controller (matlab or Simulink) for a simple *1/s* plant. Assume a unit step input for the reference, *r(t)*.
   a. What type of controller did you use. Provide the Gain Margin, Phase Margin, closed-loop eigenvalues, and steady state error
   b. What is the steady state error if the reference *r(t)* is a unit ramp input and parabolic input?
   c. Redesign the controller to track the ramp input and repeat part (a-b).
   d. Redesign the controller to track a parabolic input and repeat part (a-b)
4) Write a proportional controller for a simple 1/s plant.
   a. What value of positive gains does the system become unstable?
   b. Simulate the controller at 10 Hz control updates (no saturation and no noise). Note that you will need a higher update rate for the numerical integration (or you can use closed form solution or ode45). What value of positive gains does it become unstable? Repeat with 100 Hz control update. Why does the control update rate make a difference compared to your answer to part a?
5) Plot the Body and Nyquist plots for the following system $\frac{x}{u} = \frac{50}{s^3+2s^2+100s}$
   a. What values of K will it be stable?
   b. For K=1, what is the Gain Margin and Phase Margin? K=2?
6) Redesign your controller for the Inverted Pendulum using frequency based design techniques.
   a. State your controller
   b. Provide a response of the controller using the system on the website and compare to your previous designs. Are you able to improve your performance? Why?
7) OPTIONAL: Redesign any of the vehicle controllers or ball on beam controller using frequency based design techniques.