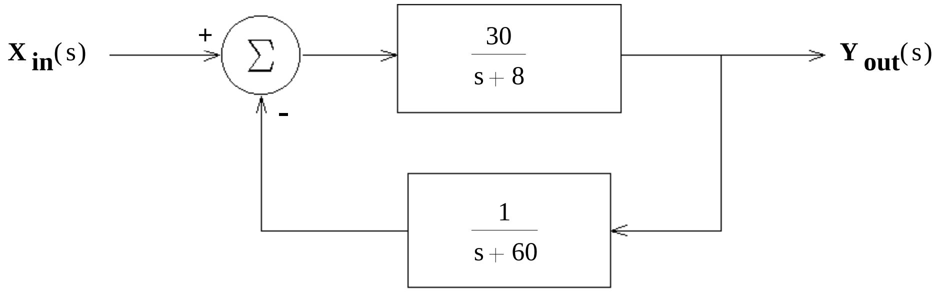
Name: ____________________ ECE 3510 homework 4 Due: Fri, 1/26/24 c

Properly simplify all your expressions for **H**(s). By this I mean that the numerator and denominator should both be simple polynomials or factored polynomials. There should be no $1/s^n$ terms in either the numerator or denominator. Also, there should be no coefficient on the highest-order term in the denominator

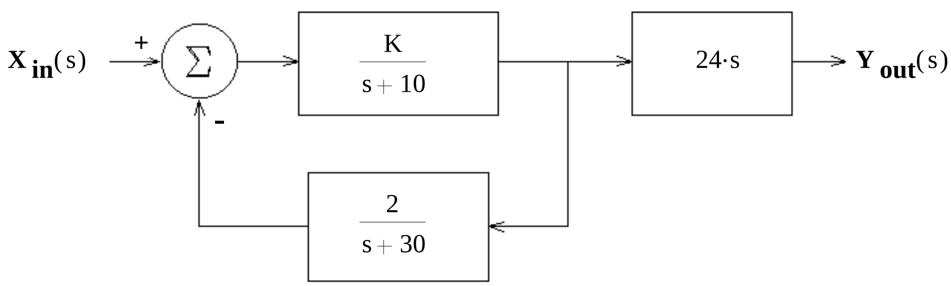
1. For the feedback system shown below, find the transfer function of the whole system, with feedback.

$$\mathbf{H}(s) = \frac{\mathbf{Y}_{\mathbf{out}}(s)}{\mathbf{X}_{\mathbf{in}}(s)}$$



2. a) For the feedback system shown below, find the transfer function of the whole system, with feedback.

$$\mathbf{H}(s) = \frac{\mathbf{Y}_{\mathbf{out}}(s)}{\mathbf{X}_{\mathbf{in}}(s)} = ?$$



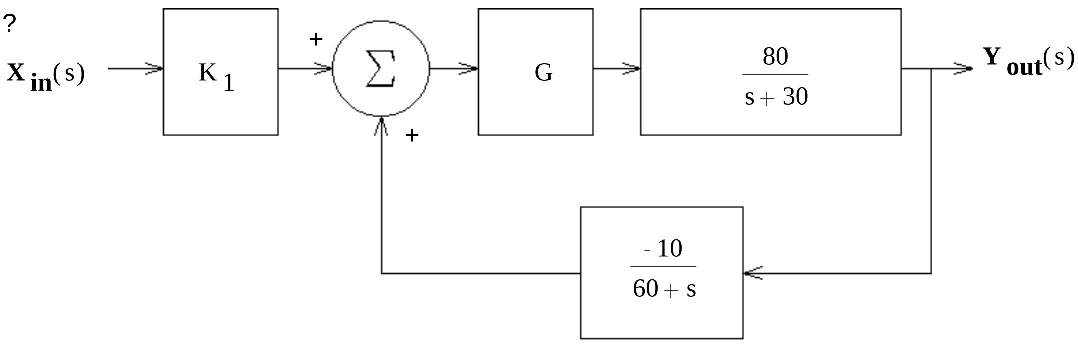
2, continued b) Find the value of K to make the transfer function critically damped.

c) If K is **more** than this value, will the system be underdamped or overdamped?

d) List any zeroes of the transfer function.

3. a) For the feedback system shown below, find the transfer function of the whole system, with feedback.

$$\mathbf{H}(s) = \frac{\mathbf{Y_{out}}(s)}{\mathbf{X_{in}}(s)} = ?$$



b) Find the value of G to make the transfer function critically damped.

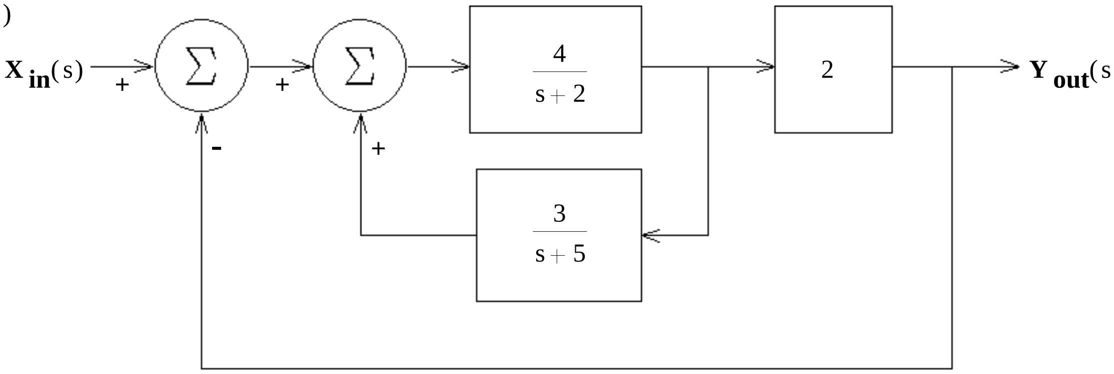
c) If G is **less** than this value, will the system be underdamped or overdamped?

d) List any zeroes of the transfer function.

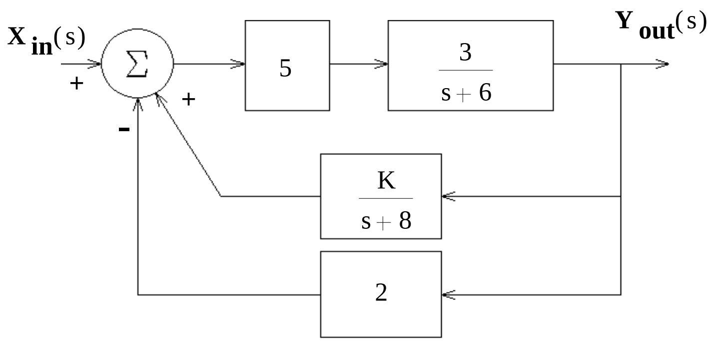
4. For the feedback system shown below, find the transfer function of the whole system, with feedback.

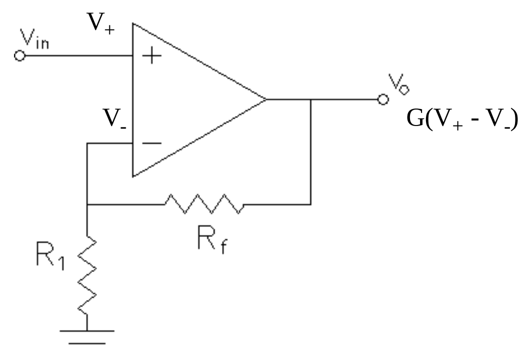
Find $\mathbf{H}(s) = \dfrac{\mathbf{Y}_{\mathbf{out}}(s)}{\mathbf{X}_{\mathbf{in}}(s)}$

Hint: You may use the general feedback relationship twice, it's just a loop inside a loop.



5. Redraw the feedback system below so that it is just one simple loop.



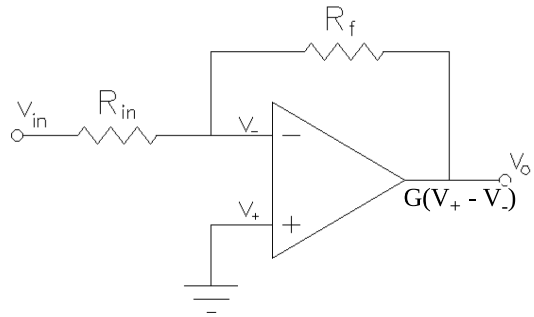


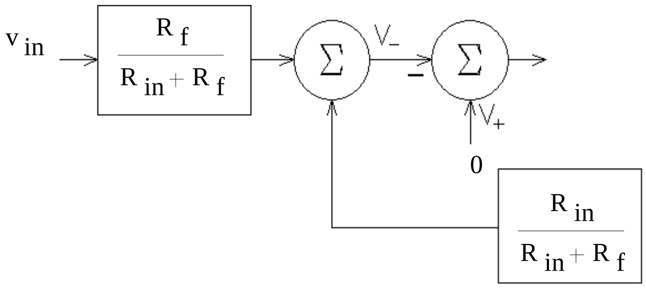
6. a) Draw a standard feedback loop for the noninverting op amp amplifier. Assume no current flows into the op-amp inputs.

   b) Use the standard feedback loop expression to find the transfer function for this amplifier.

   c) Show that this expression simplifies to the standard gain expression for this amplifier if G is very large.

7. a) Draw a standard feedback loop for the inverting op amp amplifier. There also will be an extra block before the loop. This amplifier is trickier than the noninverting amp, so I've done part of the loop for you. The first block determines v_{in}'s contribution to V- (by superposition). The bottom block determines v_O's contribution to V- (by superposition). You will have to combine the summation circles together into one and complete the loop. Assume no current flows into the op-amp inputs.





b) Combine the leading block with the standard feedback loop expression to find the transfer function for this amplifier.

c) Show that this expression simplifies to the standard gain expression for this amplifier if G is very large.

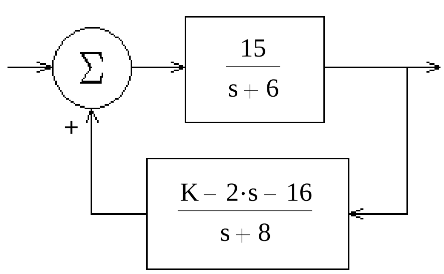
Answers

1\. a) $\dfrac{30\cdot s + 1800}{s^2 + 68\cdot s + 510}$

2\. a) $\dfrac{K\cdot 24\cdot s\cdot(s+30)}{s^2 + 40\cdot s + 300 + 2\cdot K}$ b) 50 c) underdamped d) $0, -30$

3\. a) $K_1\cdot\dfrac{G\cdot 80\cdot s + G\cdot 4800}{s^2 + 90\cdot s + 800\cdot G + 1800}$ b) 0.28125 c) overdamped d) -60

4\. $\dfrac{8\cdot s + 40}{s^2 + 15\cdot s + 38}$

5\. 

6\. b) $\dfrac{G\cdot(R_1 + R_f)}{R_1 + R_f + R_1\cdot G}$ c) $1 + \dfrac{R_f}{R_1}$

7\. b) $-\dfrac{R_f\cdot G}{R_1 + R_f + R_1\cdot G}$ c) $-\dfrac{R_f}{R_1}$