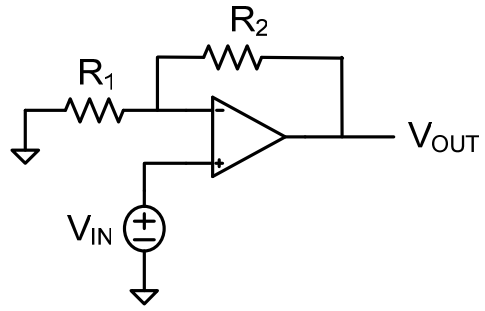
EE 230
Homework Assignment 6
Spring 2010

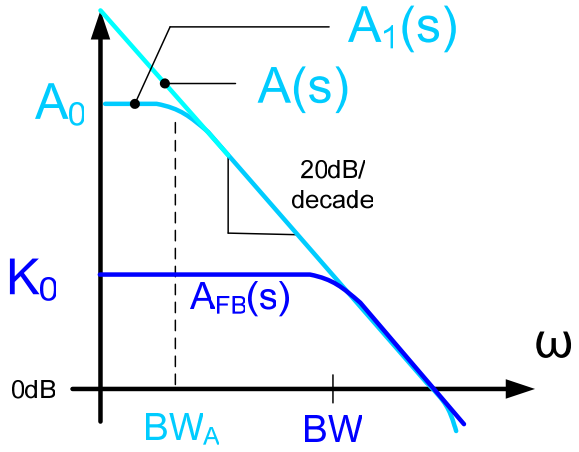
Problem 1 Consider the basic noninverting feedback amplifier circuit where the nominal dc gain is given by the expression $K_0 = 1 + \frac{R_2}{R_1}$.

a) Assuming the gain of the op amp is given by $A_1(s) = \frac{A_0 \cdot BW_A}{s + BW_A}$

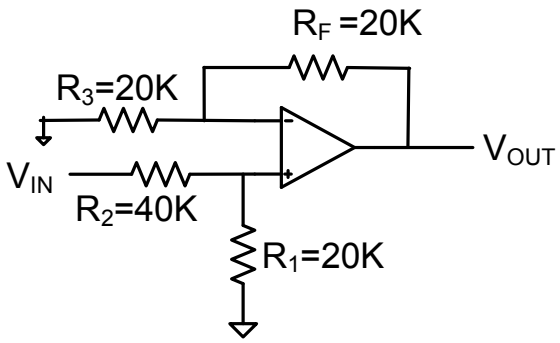
Show that the magnitude of the open-loop gain and the closed-loop gain are as depicted in the figure shown. That is, they both are first-order lowpass, have dc gains of A_0 and K_0 respectively, and that as frequencies enter the stopband, that they are nearly coincident.

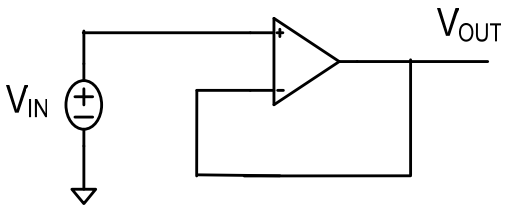
b) Show that there is very little difference in the closed loop response if the simpler open loop gain expression $A(s) = \frac{GB}{s}$ where $GB = A_0 BW_A$

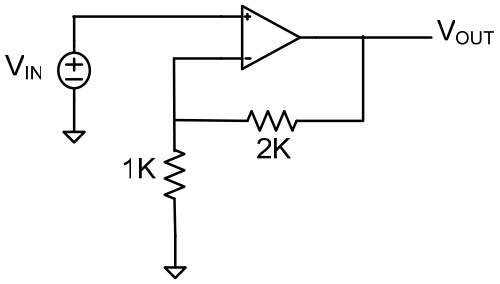


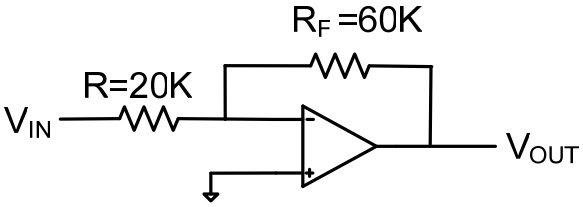


Problem 2 Determine the 3dB bandwidth of the following circuits if the op amp is the National LMP 2231 biased with a single 5V dc power supply.









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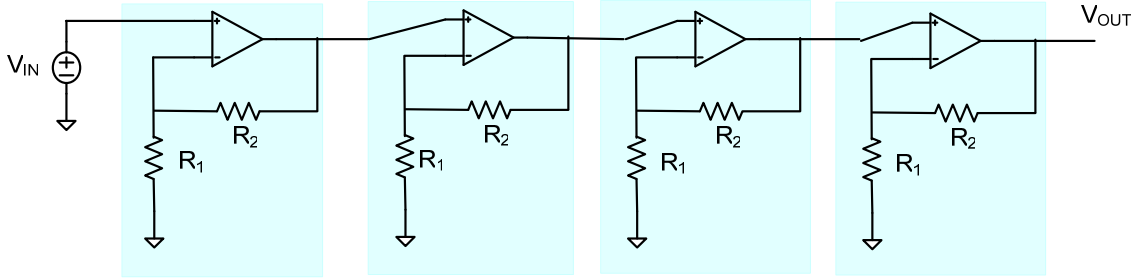
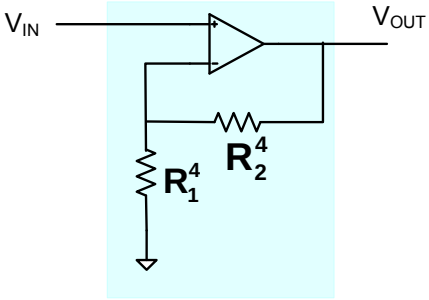
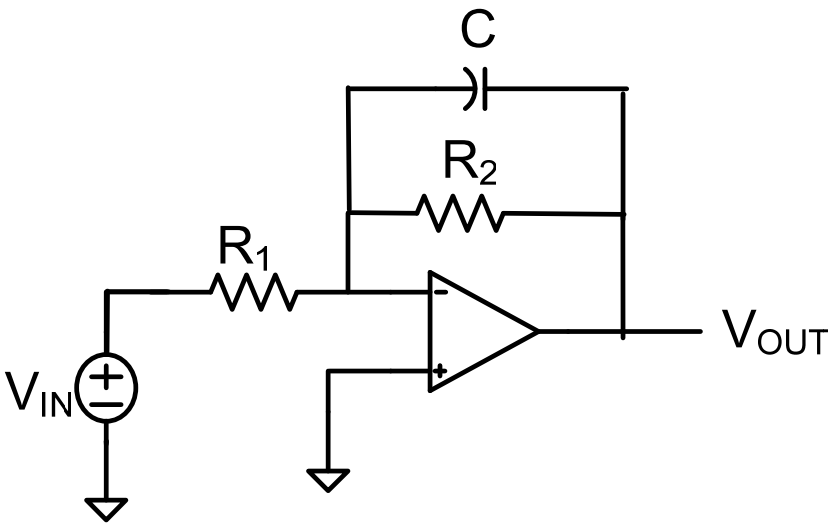
Problem 3 Determine the 3dB bandwidth of the cascade of 4 identical noninverting amplifiers and compare with that of a single noninverting amplifier if both structures are to achieve the same gain. Assume all op amps have a gain bandwidth product of GB.





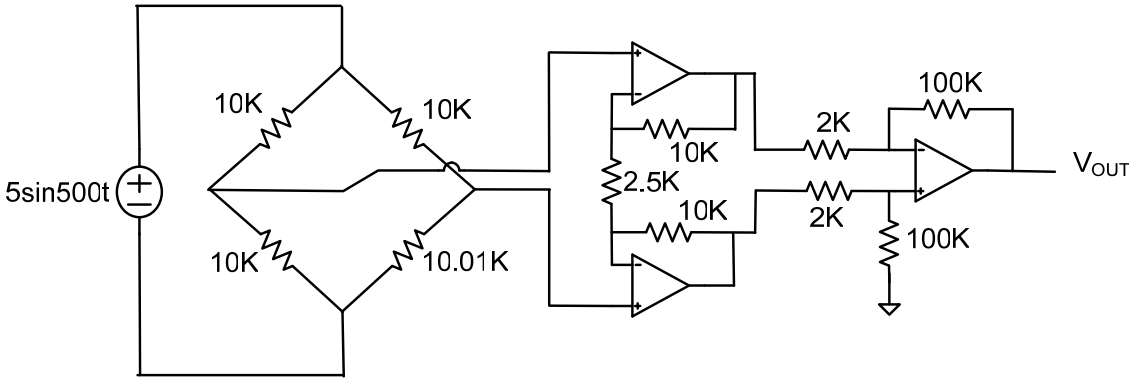
Problem 4 NOTE: YOU MAY OMIT THIS PROBLEM AS IT WAS INCLUDED ON THE PREVIOUS HOMEWORK ASSIGNMENT

Plot the poles and zeros of the following circuit. Assume the op amp is modeled by the frequency dependent gain $A(s) = \dfrac{A_0}{\dfrac{s}{p}+1}$ where A_0 is the dc gain of the op amp and the parameter p is positive.



Problem 5 Design a circuit that has in input impedance of an inductor of value 3mH if all that is available is resistors, capacitors, and ideal op amps.

Problem 6 Determine V_{OUT} for the following circuit. Assume the op amps are ideal.

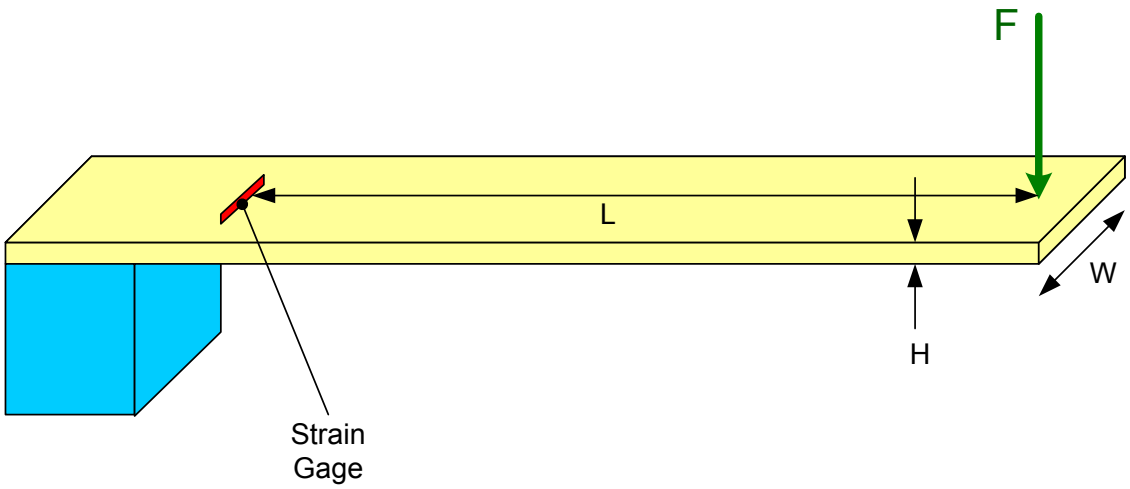


Problem 7 Design a circuit that has an input impedance of -10K. Assume you have available op amps, resistors, and capacitors.

Problem 8 A beam fixed on the left and loaded with a force F is shown below. A strain gage is mounted on the top of the beam at the location shown. A second strain gage is mounted directly below the top strain gage on the bottom side of the beam. The distance from the beam to the strain gage, the thickness, and the width of the beam are all indicated. Assume the strain gages have a nominal resistance of 300Ω and a gage factor of 1.5.

Design an instrumentation amplifier that will provide an output voltage of 5V when a force of F=1 pound is applied to the aluminum beam using the two strain gages as transducers. Assume the beam is aluminum and the length L is 1m, the width is 1 inch, and the thickness is 0.2 inches.

Some characteristics of the stress and strain on the beam are summarized below.



The strain on a bar is given by the equation

$$\in = \frac{\Delta L}{L} = \frac{6FL}{YWH^2}$$

where Y is Young's Modulus and where F, L, W, and H are in standard units (N and m).

Young's Modulus for aluminum is 6.9E10 N/m^2. The change in resistance of a strain gage is related to the strain by the equation

$$\frac{\Delta R}{R} = \frac{\in}{K}$$

Problem 9 The maximum acceptable strain on aluminum is 8E-4. What would be the output voltage of the instrumentation amplifier designed in the previous problem when the load produces the maximum acceptable strain.

Problem 10 Determine the worst case magnitude of the output offset voltage of the following circuits if the magnitude of the input offset voltage is 3mV.