

Go to ME Design day in the Union on Thursday, 4/20 sometime from 11:00 to 3:00.
See <http://mech.utah.edu/newsroom/design-day/>

Write **several paragraphs** about what you see there. Especially:

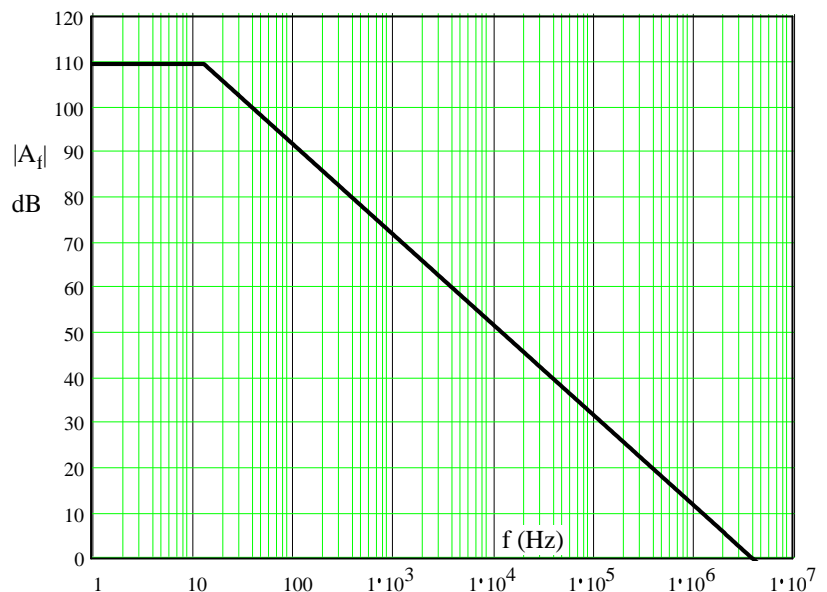
1. Note control systems and/or systems with feedback.
2. Tell which senior project most impressed you and why.
3. Observe at least part of one of the competitions (main mechatronics robot competition, 1:00 - 3:00) and write at least one paragraph about it (suggest improvements).

Name: _____ ECE 3510 homework AF2 Due: Wed, 4/17/24

Find your textbook from your electronics class (ECE 2280 here at the U). Find the chapter or section which covers feedback in amplifiers. Read the sections covering bandwidth or frequency response, noise reduction, distortion reduction and gain reduction.

Amplifier Compensation

1. The plot at right shows the frequency response of an LF353 op amp.
 - a) Find the gain-bandwidth product (GBW).
 - b) Find A_o in both dB and as a factor.
 - c) Find the open-loop roll-off point and the compensation pole location.



- d) A voltage (series-shunt) feedback network is used to feed back 0.1% of the output back to the input in a negative manner. Find the closed-loop gain (as a factor and in dB) and the closed-loop roll-off point. Draw the closed-loop frequency response on the drawing above.
- e) Now use two equal amplifier stages (two op amps) to achieve the same gain as part in d), Find the closed-loop roll-off point of a single stage. Draw the closed-loop frequency response of a single stage on the drawing above.

Would this also be the 3dB roll-off point of the entire two-stage amplifier? If not, why not?

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2. Show that the low-frequency 3dB roll-off point = $\omega_{Lf} = \frac{\omega_L}{1 + A_o \cdot B}$

Note: To do this, you'll take the basic open-loop amplifier transfer function and use it to write the closed-loop transfer function. Unfortunately the result is pretty messy and it can be hard to see what you can reasonably leave out to approximate the closed-loop transfer function.

A much easier approach is to pretend the basic amplifier doesn't have a high-frequency roll-off and eliminate the high-frequency pole from it's transfer function before you write the closed-loop transfer function. This is reasonable to do because the high-frequency roll-off will have very little effect on the low-frequency roll-off point.

where:

A_o = Midband gain of basic amplifier

B = the feedback factor

ω_L = Low-frequency 3dB roll-off point of basic amplifier

ω_{Lf} = Low-frequency 3dB roll-off point with feedback

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3. Draw the ideal series-shunt feedback topology. You may leave out the output impedance (or source resistance) of the input voltage and the input impedance of the feedback network. By "leave out" you may consider them to be zero and ∞ , respectively.

4. Show that the input resistance with feedback is: $R_{if} = (1 + A_o \cdot B) \cdot R_i$

where:

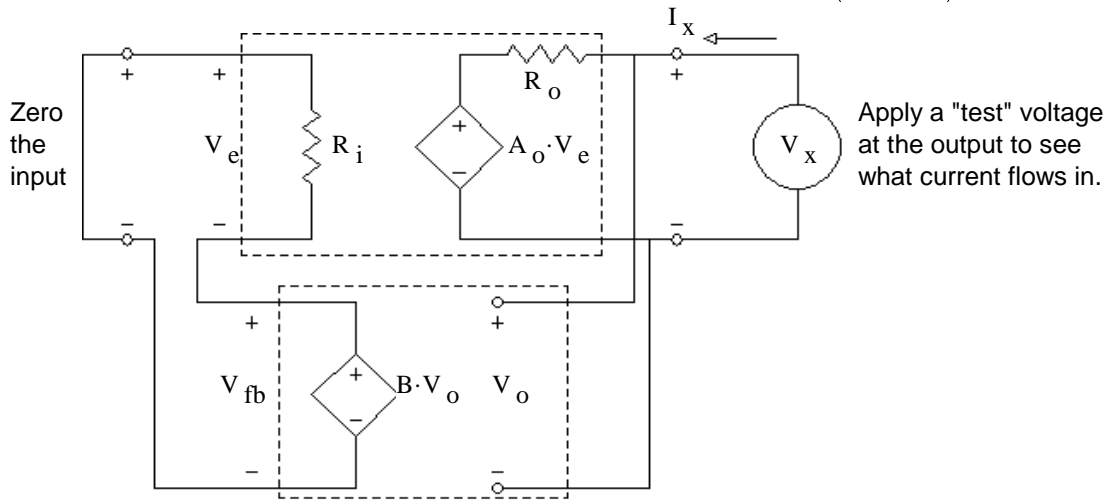
A_o = the open-loop amplifier gain

R_i = the open-loop input resistance

B = the feedback factor

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5. Show that the output resistance with feedback is: $R_{of} = R_o = \frac{R_o}{(1 + A_o \cdot B)}$ $R_o =$ the open-loop output resistance



Answers

1. a) 4·MHz b) 110·dB $3.162 \cdot 10^5$ c) 12.65·Hz
 c) pole: $\frac{1}{s + 79.5}$ d) 1000 60·dB 4·kHz e) 126.5·kHz
 e) The 3dB roll-off point of the entire two-stage amplifier is a bit less than 126.5kHz because that would actually be a 6dB roll-off point.

