Name:____Date:_________________

DEPARTMENT OF ELECTRICAL ENGINEERING AND COMPUTER SCIENCE

MASSACHUSETTS INSTITUTE OF TECHNOLOGY

CAMBRIDGE, MASSACHUSETTS 02139

Spring Term 2007 Quiz 2

6.101 Introductory Analog Electronics Laboratory

NOTE: USE CLOSEST 5% TOLERANCE RESISTOR VALUES FOR ALL RESISTORS.
NOTE: SHOW ALL CALCULATIONS FOR ALL ANSWERS BUT THE MOST OBVIOUS!
[If you want credit for work based on wrong answers!]

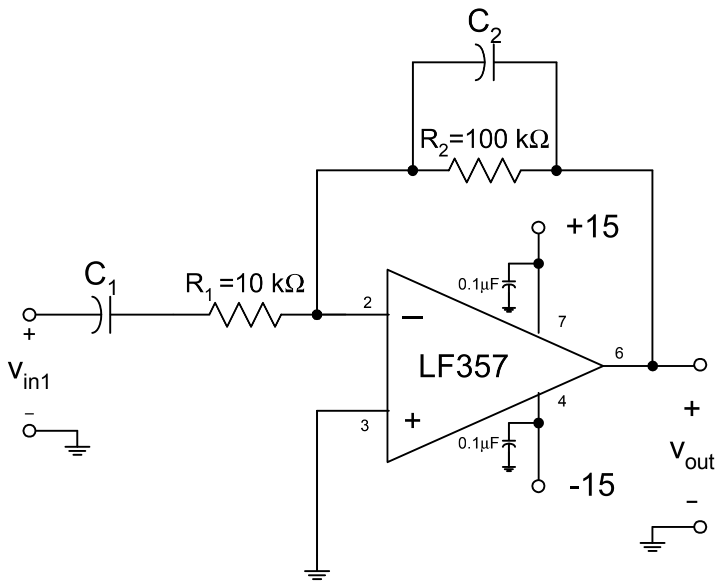
Please look through the whole quiz before beginning. It's always good test-taking procedure to look over the whole quiz before deciding where to start, and so you can plan your time. Also, question 2l on page 5 is only worth 4 points and should not be attempted until you feel confident that the rest of the quiz is done correctly!

Each question is worth 4 points.

Problem 1:_______________ / 52

Problem 2:_______________ / 48

Total:___________________/100



The frequency response for the circuit above is shown on the next page. Please ignore the curve marked “LF356”. Answer the following questions from looking at the next page or the schematic.

1a. What is the high-frequency corner frequency [–3dB point] for this circuit? f_{HI} = _________

1b. What is the low-frequency corner frequency [–3dB point] for this circuit? f_{LO} = ________

1c. What is the midband [1000 Hz] voltage gain for this amplifier in dB? A_v = _________

1d. What is the midband [1000 Hz] voltage gain for this amplifier, expressed as a dimensionless multiplier? A_v = _________

1e. Above what frequency will this circuit make a good integrator? f = __________

1f. Below what frequency will this circuit make a good differentiator? f = __________

1g. In terms of dB per octave, what is the high frequency rolloff above f_{HI}? _____________

1h. Calculate the required value for C_1. [ignore standard values] C_1 =_________

1i. Calculate the required value for C_2. [ignore standard values] C_2 =_________

1j. What is the gain-bandwidth product for the LF357? GBW =______

1k. If we remove C_2, what will be the hf –3dB point for this circuit? f_{HI} = _________

1l. If we had to replace the LF357 with an LM741, which we'll assume has an input DC bias current of 1µA, what change should we make in the circuit? [Either write your answer or draw it on the schematic above.]____

1m. Refer to question 1k. What is no longer operating when frequencies above the frequency in the answer to 1k are sent through this amplifier?____

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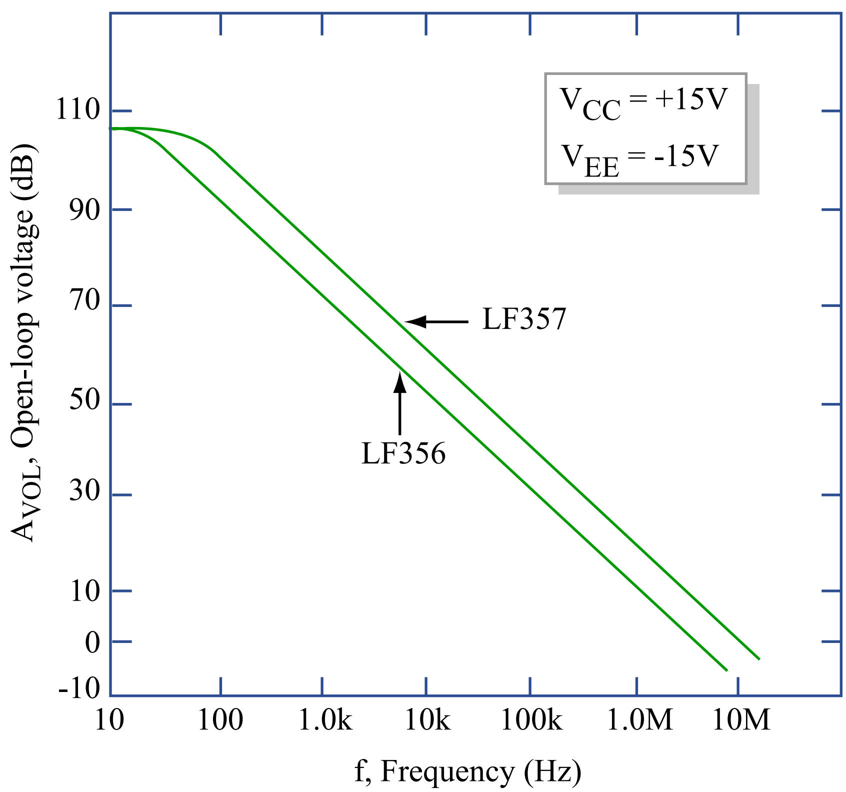
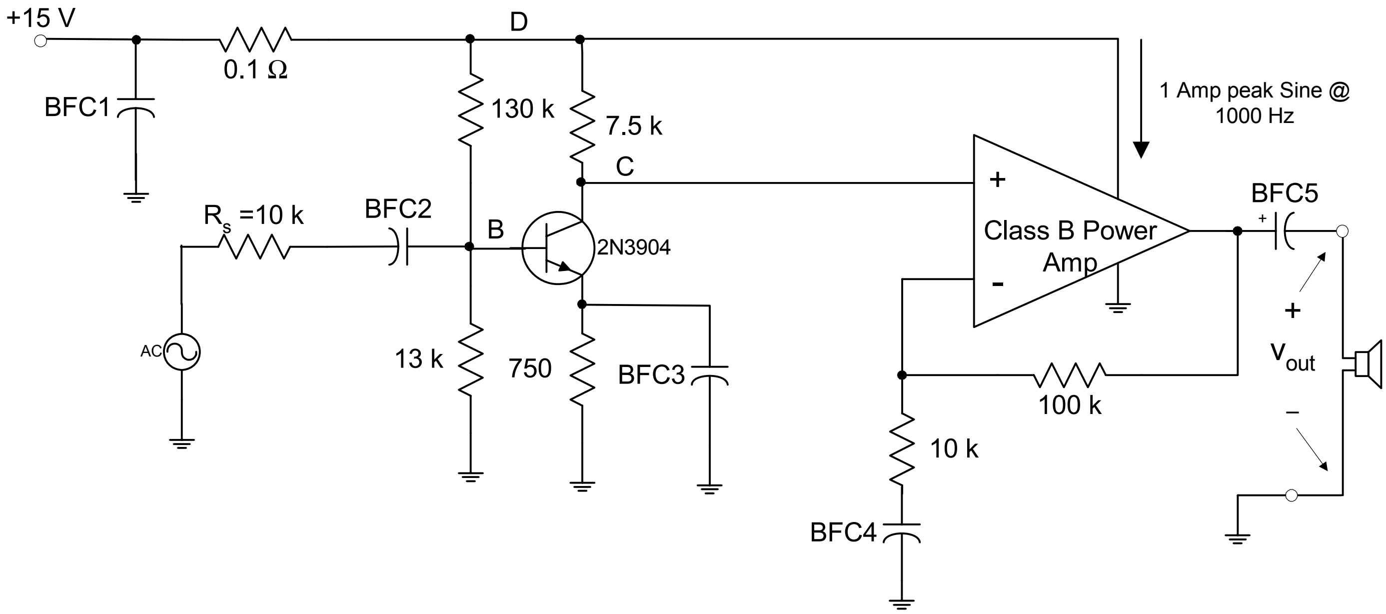


Open-loop frequency response.

Figure by MIT OpenCourseWare.



For the transistor: I_C = 1 mA, $\beta_F = \beta_o$ = 200, r_o = infinity, r_π = 5.0 kΩ, g_m = 40 mmho, V_{be} = 0.6 volts. The 0.1Ω resistance represents the resistance of a long wire. The class B power amplifier is just like the one you designed in lab 5, and the op-amp used is an LF356.

2a. Given I_C = 1 mA, what is the DC **input** voltage at the positive terminal of the power amp [node C]? ____________________

2b. What is the DC voltage at the output of the power amp [V_{out}] ? ____________________

2c. What is the DC voltage gain of the power amplifier [ahead of BFC5] ?______________

2d. What is the DC voltage at the + terminal of BFC5? ____________________

2e. What is the AC voltage gain of the power amplifier? ____________________

2f. What is the reference number of the part that is responsible for the different values for AC and DC voltage gain in the power amplifier? ____________________

2g. What is the voltage drop across the 0.1Ω wire resistance due to the 1A peak current drain from the power amp? [Ignore any current drain from the transistor.] ____________________

2h. What component could be added and where, to prevent/reduce this voltage from being generated and thus coupled into the transistor at its input and output?__________________________________

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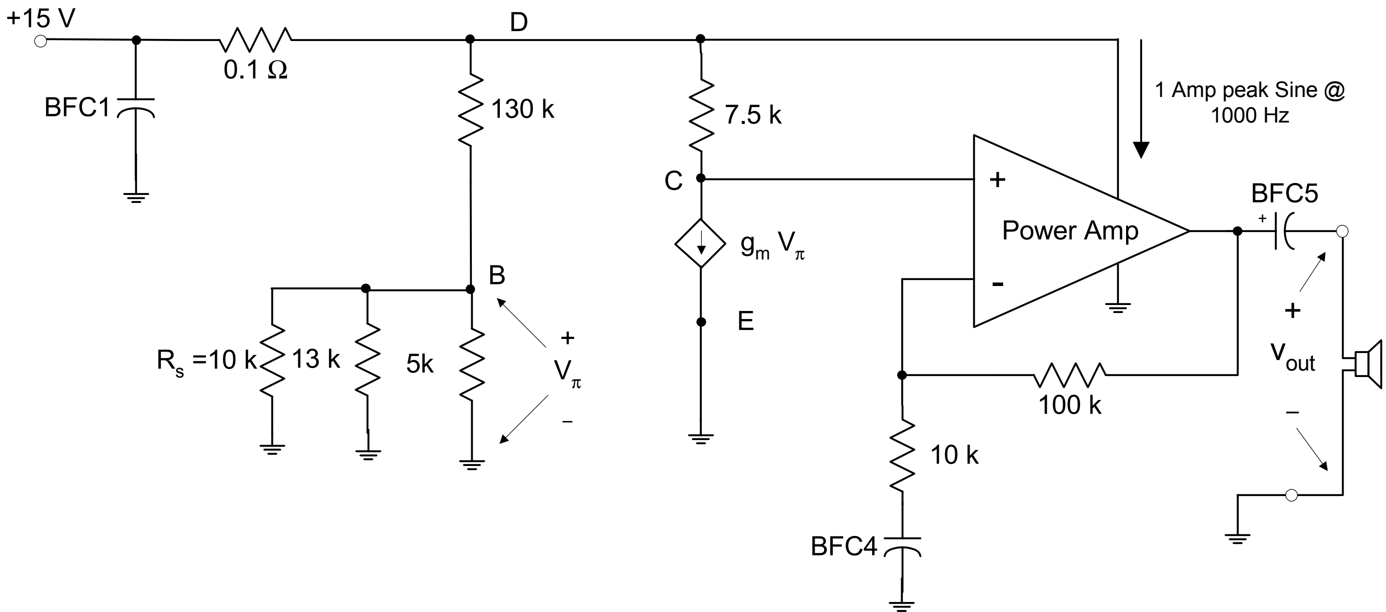
2i. Ignoring BFC5, what value do we need for BFC4 to produce a –3dB point at 10Hz, *for the power amp only*? ______________

2j. [Re: question 2i] The gain below 10 Hz will roll off at 20dB per decade, but at some lower frequency it will stop dropping. Why? What is the approximate lower frequency and what is the gain that we end up with?____

2k. Ignoring BFC4, and assuming we replace the speaker load with a suitable 8Ω power resistor, what value do we need for BFC5 to produce a –3dB point at 10Hz? [pwr amp only]_________



For the transistor: I_C = 1 mA, $\beta_F = \beta_o$ = 200, r_o = infinity, r_π = 5.0 kΩ, g_m = 40 mmho, V_{be} = 0.6 volts

2l. The schematic on the previous page has been modified by replacing the transistor with its hybrid-π equivalent circuit. Since we want to analyze the impact of the power supply bus perturbation previously discussed in question 2g and present at point "D" in the schematic, we have used superposition and turned "off" the signal source in order to analyze the effect of the noise on the power bus. Thus, the input signal source has been replaced by a short circuit to aid analysis. Also, BFC2 has been removed because it is a short circuit at 1000 Hz.

There are two places where the noise will be injected: one at the top of the 130 kΩ biasing resistor, and one at the top of the 7.5 kΩ collector load resistor. Your job in this question is to compute the amplitude of the unwanted signal that appears at the non-inverting input of the power op-amp. Be sure to consider the polarity of the noise signal that appears at point D, as well as the polarity of the noise signal that appears at the collector of the transistor. Also, please state if the unwanted signal at the non-inverting input of the power op-amp would be in-phase or out of phase with the signal coming from the source.____

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