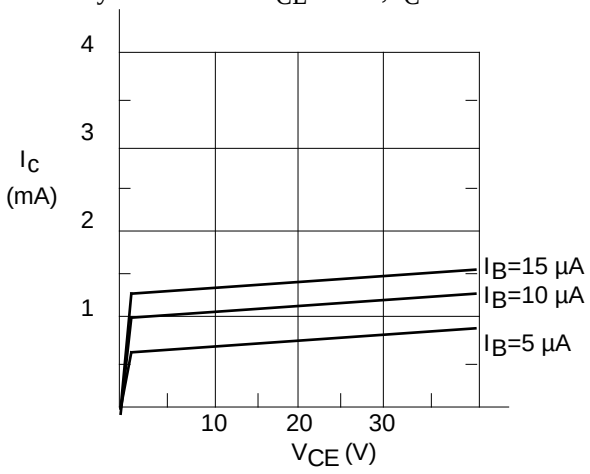
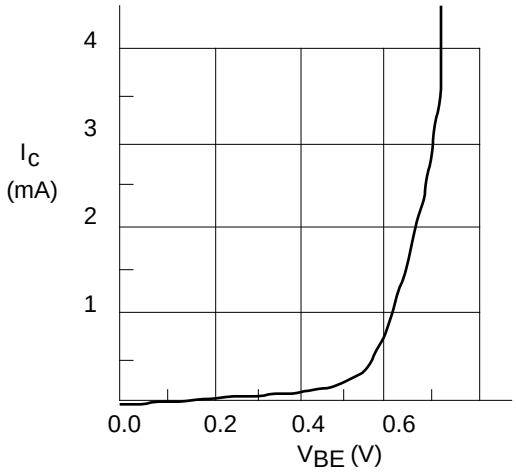
Physics 326 Final Exam
Aug. 4, 1998

Time: 3 hrs.

1. An 1 mH inductor has internal resistance of 5Ω. This inductor is connected to the output of the function generator whose output impedance is 50Ω. The function generator is adjusted so that its output would be 10 V peak-to-peak with a load of infinite impedance.
(a) What peak-to-peak voltage would you predict when the frequency is 1 Hz? [2]
(b) What peak-to-peak voltage would you predict when the frequency is 31.4 kHz? [4]
(c) What peak-to-peak voltage would you predict when the frequency is 3 .14 MHz? [4]

2. Use the following idealized characteristic curves of an npn bipolar junction transistor to estimate h_{FE} (β_{dc}), h_{fe} (β_{ac}), h_{ie} and h_{oe}. Justify your estimates by calculations or graphical analysis. Assume V_{CE} =10 V, I_C = 1.1 mA. [10]

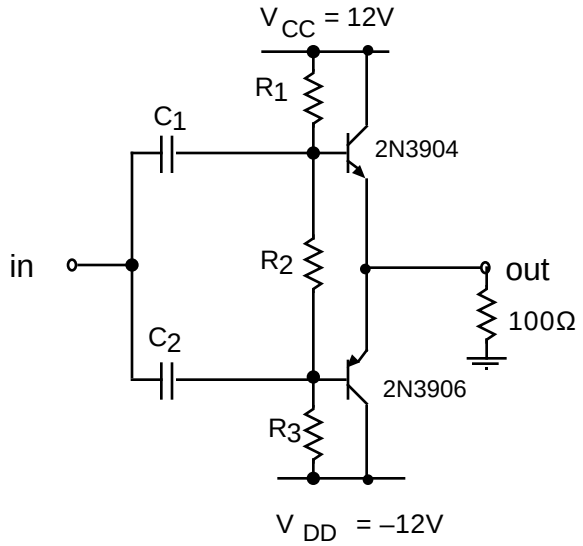




3. Using the transistor of problem 2, design a one-transistor, common-emitter amplifier with the emitter resistor bypassed for maximum gain. Let V_{cc}=20V and make the quiescent collector current about 1 mA. Put the low-frequency roll-off around 20 Hz. Estimate the AC voltage gain. [10]

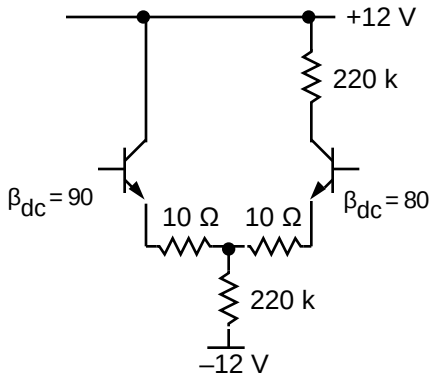
4. (a) Find R_1, R_2 and R_3 which will minimize crossover distortion in the push-pull circuit. [5]

(b) A 1 kHz signal with 20 V peak-to-peak is applied to the input but the output is less than 20 Vpp despite complete elimination of crossover distortion. Why? Estimate the expected attenuation. [5]



5. You have a JFET with $V_{GS(off)}$ = –3.5 V and I_{DSS} = 11 mA. Design a source follower using self bias. What is its amplification? Discuss in what way or ways it is most likely to be useful. [10]

6. Below is the circuit for a differential amplifier using two transistors with (left) $\beta = 90$ and (right) $\beta = 80$.



a) Find the common-mode gain. [2]

b) Find the differential gain. [2]

c) Calculate the common mode rejection ratio in dB. [2]

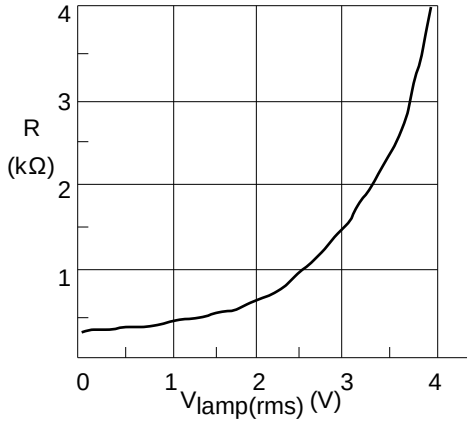
d) What do you expect the input bias current, $I_{in(bias)}$, to be? [2]

e) What do you expect the input offset current, $I_{in(off)}$, to be? [2]

7. a) Design an amplifier with non-inverting voltage feed-back and a 741 or equivalent operational amplifier with a voltage gain of 25. Estimate its input impedance. [5]

b) Design an amplifier with inverting voltage feed-back and a 741 or equivalent operational amplifier with a voltage gain of –25. Estimate its input impedance. [5]

8. Design Wien bridge sine wave oscillator to produce a 3 V peak-to-peak 100 kHz sine wave output. Use a lamp in the feedback circuit with the following resistance characteristics.



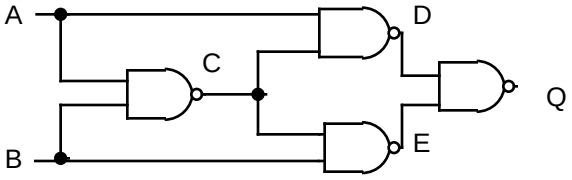
[10]

9. Design an active band pass filter using a pair of two-pole active filters. The pass band should be between 100 Hz and 10 kHz.

a) Specify values for resistors and capacitors conforming to a Butterworth filter design. [5]

b) Sketch the Bode plot (log-log) of output voltage vs. frequency for two decades above and two decades below the critical frequency. (Label axes *quantitatively*) [5]

10. Find the function of the following circuit by making a truth table showing the logic values at C, D, E and Q for all values of A and B inputs. [10]



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