MASSACHUSETTS INSTITUTE OF TECHNOLOGY

Department of Electrical Engineering and Computer Science

6.301 Solid State Circuits

Spring Term 2006

Midterm Quiz 3/21/06

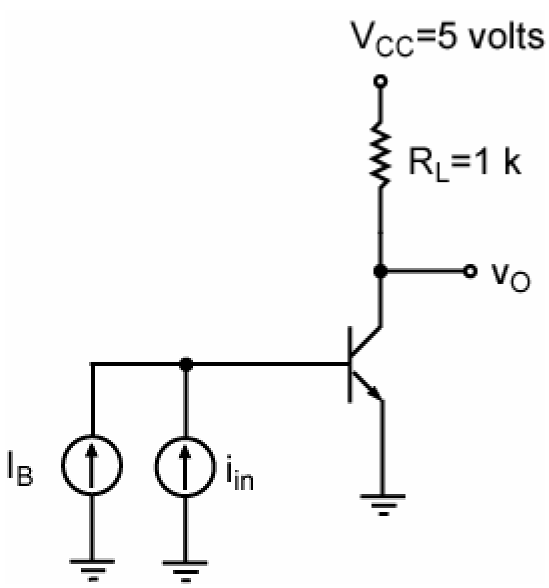
This is an **open book** test. You are allowed a 1-page cheat sheet. Make sure to show your work on the exam booklet as partial credits are given. Don't forget to put your name on the exam booklet. You will have to make reasonable approximations to do the problems quickly. You only need to calculate about **within about 5%** of an accurate value. Failing to make such approximations will result in unnecessarily complicated equations, so you may not be able to complete all the problems in 90 minutes.

Problem 1(10 points):

The circuit in Fig. 1 is intended to be used as a transresistance amplifer. In other words, at low frequencies, the incremental output voltage v_o is given by:

$v_o=R_m i_{in}$

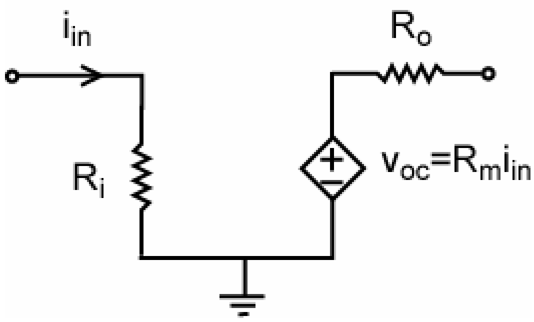
Where i_{in} is the incremental input current and R_m is the transimpedance.



Assume $\beta_F=\beta_o=100$, $r_o=\infty$ ($V_A=\infty$), and $r_b=0$, $C_\pi=20pF$, $C_\mu=1pF$, $C_{CS}=0$ for the transistor. Ignore any other transistor parasitic resistance or capacitance.

a. Find the value of the bias current I_B to make the quiescent output voltage $V_O=2.5$ volts

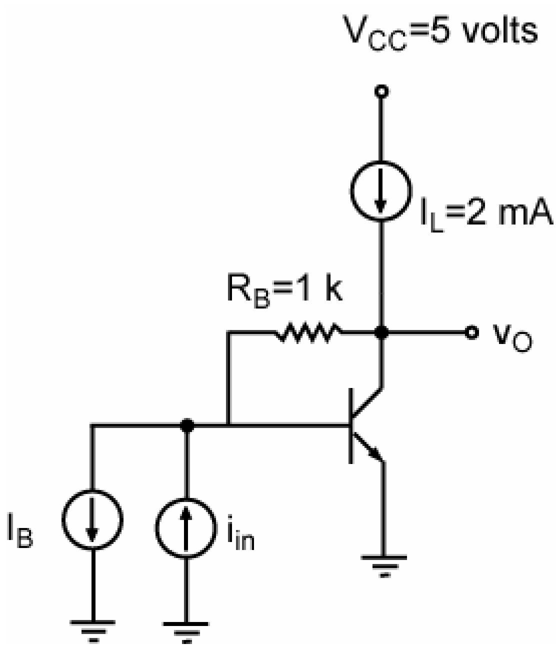
b. The following is the incremental model of the amplifier. Find the values of the input resistance R_{in}, the transresistance R_m, and the output resistnace R_o.



c. Compute open-circuit time constants.

Problem 2(15 points):

The circuit in Fig. 2 is another transresistance amplifer.



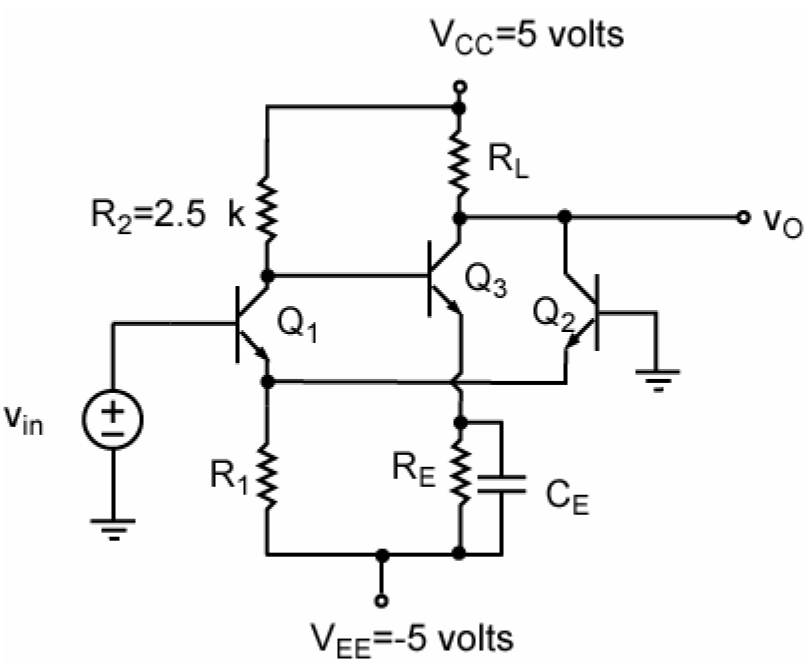
Assume $\beta_F=\beta_o=100$, $r_o=\infty$ ($V_A=\infty$), and $r_b=0$, $C_\pi=20pF$, $C_\mu=1pF$, $C_{CS}=0$ for the transistor. Ignore any other transistor parasitic resistance or capacitance.

a. Find the value of the bias current I_B to make the quiescent output voltage V_O=2.5 volts. Assume V_{BE}=0.6 volt

b. Find the transresistance R_m of the amplifier

c. Calculate open-circuit time constants.

Problem 3(25 points): Consider the following amplifier circuit.



β_F=β_o=100, r_o= ∞ (V_A = ∞), and r_b=0 for both transistors. Also, C_μ=1pF, C_π=20pF for all transistors. Ignore any other transistor parasitic resistance or capacitance. V_{BE}=0.6 volt.

a. With v_{in}=0, calculate values of R_1, R_E, and R_L such that I_{C1}=I_{C2}=I_{C3}=1mA, and V_O=3.5 volts.

b. What is the midband gain of the amplifier? For this part, assume C_E is large.

c. Determine the value of C_E for the lower 3dB frequency f_l=100Hz.

d. Compute open circuit time constants.

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