IMPORTANT REMINDER: Besides the sheets you use for calculation and your own personal calculator, you are only allowed to use a maximum of two A4 size "copy sheets" prepared with your own personal handwriting during this examination. Notes, problems, and photocopies are not permitted. Be careful with units.

ELE 222E INTRODUCTION TO ELECTRONICS (21604)

Final Exam 22 May 2003 9.00-11.00

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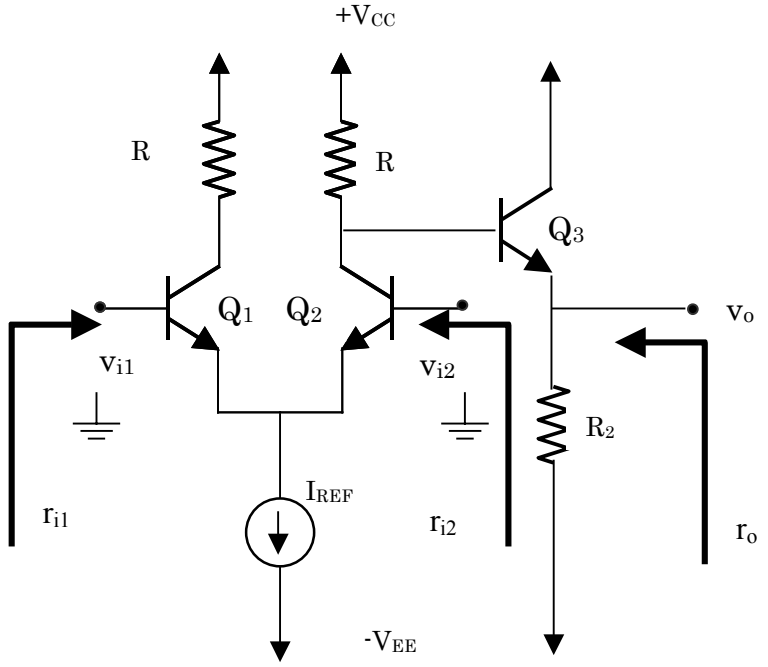
1. What is a semiconductor? How does a semiconductor differ from a conductor? Explain within two sentences. (5 points)

2. What are some of the similarities and differences between MOSFET and BJT transistors. Provide at least 2 of each. (10 points)

3. Using NMOS transistors design a basic current mirror with $-V_{SS} = -5$ V and $I_{REF} = 0{,}4$ mA. Let the two transistors be identical with $V_T = 1$ V, $\mu_n C_{ox} = 20\ \mu A/V^2$, $V_A = 20$ V, W = 40 μm, and L = 10 μm. Find the output resistance and V_{GS}. (25 points)

4. Using the current mirror in Problem (3) as current source connected to the common emitter of the differential amplifier, find



   a. R for $V_{C2}=V_{BE}=0.6$V. (5 points)

   b. R_2 and I_{C3} for $A_{v3}=K_{v3} > 0{,}990$. **HINT:** You have to <u>choose a value</u> either for R_2 or I_{C3}. (15 points)

   c. r_{i1}, r_{i2}, r_o, v_o/v_{i1} and v_o/v_{i2}. (20 points)

   $V_{CC} = V_{EE} = 5$ V,
   $h_{FE} = h_{fe} = 200$,
   $h_{oe} = 0$,
   $V_T = 25$ mV.

5. Design an OPAMP circuit that will realize $v_o = 2v_1 - 3v_2 + v_3$. Please use meaningful resistor values. (30 points)

YOU HAVE 10 BONUS POINTS.... GOOD LUCK!