IMPORTANT: Besides your calculator and the sheets you use for calculations you are only allowed to have two A4 sized "copy sheets" during this exam. Notes, problems and alike are not permitted. Please submit your "copy sheets" along with your solutions. You may get your "copy sheets" back after your solutions have been graded. **Do not forget to write down units!**

ELE222E INTRODUCTION TO ELECTRONICS (21271)

Final Exam ✎ 3 May 2004 🕑 14.00-16.00

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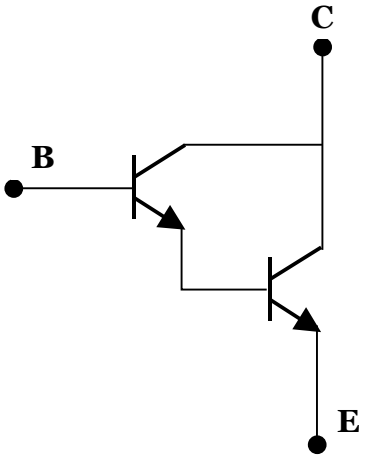
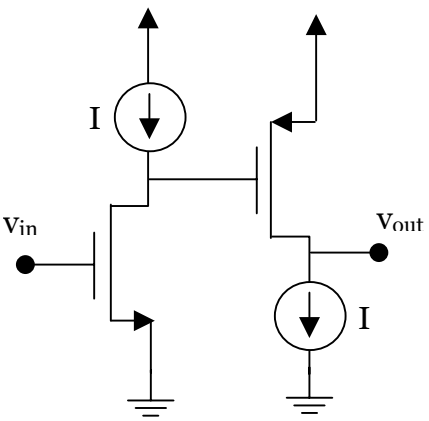
1. Explain the mechanisms by which charged carriers move through a silicon crystal. (5 sentences max, plus accompanying equations; 20 points)

2. A diode rectifier forms an essential building block of a DC power supply as you have experienced while working on your project. Now, draw a simplified diagram of your power supply and explain how the different components of your power supply work. (20 points)



3. On the right you see the *Darlington Configuration* of two BJTs. Analyze this configuration. Find the base-emitter voltage $V_{BE\text{-}D}$ and $h_{FE\text{-}D} = h_{fe\text{-}D}$ for this specific configuration in terms of V_{BE} and $h_{FE} = h_{fe}$ of individual BJTs. (20 points)

$V_{BE\text{-}D} = 2\ V_{BE}$ and $h_{FE\text{-}D} = h_{fe\text{-}D} \approx h_{FE}^2 = h_{fe}^2$



4. On the left is an IC MOS amplifier. Assuming the biasing current sources have very high output resistance, find an expression for the overall voltage gain in terms of g_m and r_o of individual MOS transistors.
How does the overall gain change when a signal source with internal resistance R_s is used and a load resistor R_L is connected to the output? (20 points)

$v_{in}/v_{out} = g_{m1}g_{m2}r_{o1}r_{o2}$
$v_{in}/v_{out} = g_{m1}g_{m2}r_{o1}[r_{o2}//R_L]$

5. Design an OPAMP circuit that will satisfy $v_o = a_1v_1 + a_2v_2 + a_3v_3 + a_4v_4$ for $a_i>0$, and $i = 1, 2, 3, 4$. Find the resistor values for $a_1 = 5$, $a_2 = 3$, $a_3 = 4$, $a_4 = 2$ considering $R_{max} = 100k$.

GOOD LUCK!