

**IMPORTANT:** Besides your **calculator** and the sheets you use for calculations you are only allowed to have an A4 sized “**copy sheet**” during this exam. Notes, problems and alike are not permitted. **Please submit your “copy sheet” along with your solutions.** You may get your “copy sheet” back after your solutions have been graded. **Do not forget to write down units and convert units carefully! Cell phones are not allowed and should be placed on the front desk before the exam.**

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**EEB222E INTRODUCTION TO ELECTRONICS (20727)**

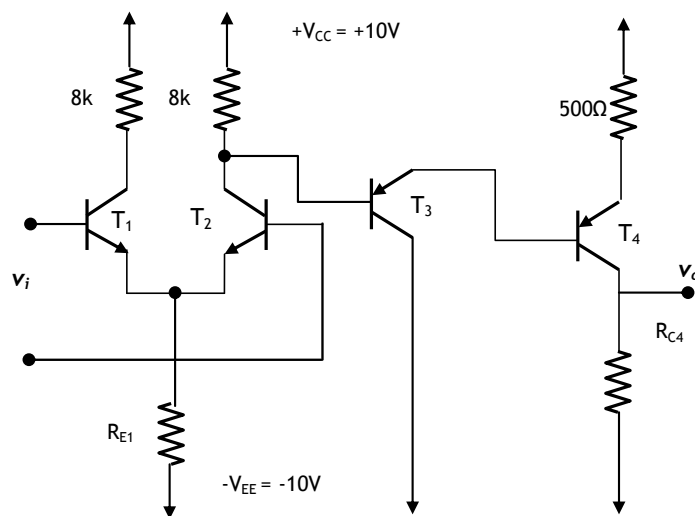
**Midterm Exam #2** ✍️ **20 April 2015** ⌚ **9.30-11.30**

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**EEF 2104**

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1. Analyze the circuit below for  $\beta = h_{FE} = h_{fe} = 100$ ,  $V_T = 25 \text{ mV}$ ,  $h_{oe} = h_{re} = 0$ , and  $|V_{BE}| = 0,6 \text{ V}$ . (60 points)



- Find the value of  $R_{C4}$  such that,  $I_{C1} = I_{C2} = 0,5 \text{ mA}$ , and the voltage swing at the output ( $V_o$ ) is symmetric.
- If you design a current mirror that will provide the current to the first stage you may earn 10 bonus points.

Calculate:

- voltage gain  $v_o/v_{in}$ ,  $r_i$ ,  $r_o$ ,
  - CMRR of the first stage.
2. Design a circuit that will realize the function  $y = ax_1 - bx_2 - cx_3$  using ONE single OPAMP only. Select any a, b, and c with the resistor values selected in kOhm range. (30 points)
3. Name 2 similarities and 2 differences between an n<sup>+</sup>pn and p<sup>+</sup>np transistor. (10 points)

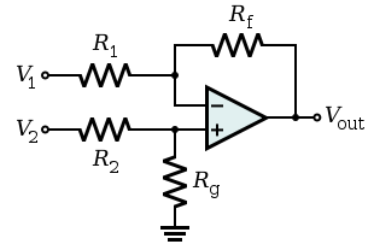
**GOOD LUCK**

SOLUTIONS:

1. Exactly the same problem as Problem 2 in ELE222E INTRODUCTION TO ELECTRONICS (20521) Midterm Exam #2.

2. The circuit should be similar to this, except it should have 2 inputs on the inverting side. Thus the circuit will be like

$$v_o = \frac{R_g}{R_1 + R_g} \left( \frac{R_f}{R_2} + \frac{R_f}{R_3} + 1 \right) v_1 - \frac{R_f}{R_2} v_2 - \frac{R_f}{R_3} v_3$$



3. Similarities

- a. Both are BJT
- b. Both have 3 junctions
- c. Both have 3 electrodes

4. Differences

- a.  $n^+pn$  is faster than  $p^+np$
- b. They can be used complementarily.
- c. They are biased in opposite ways because their  $V_{BE}$ 's have opposite signs.