Duke University
Department of Physics

Physics 271 Spring Term 2017

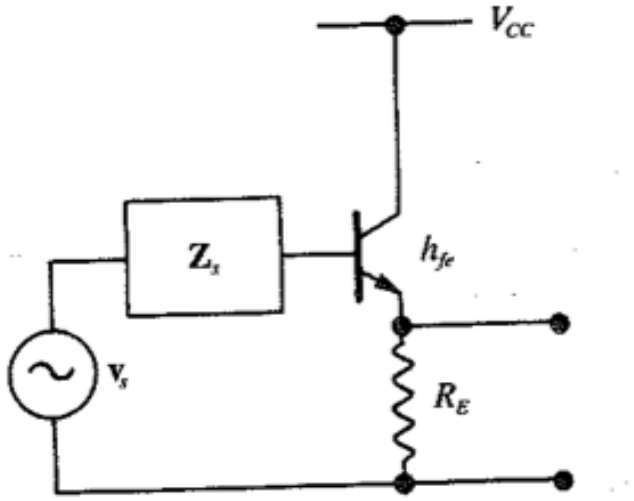
PRACTICE (FINAL) MIDTERM

I will abide by the Duke Community Standard. Name: _____

This is a closed book exam, with two sides of one page cheat sheet allowed. Calculators are allowed, but only for basic calculations: you may not use special memory, graphing etc. functions. You must always show your work for credit; all answers must be justified. **You must hand in your cheat sheet with your test.**

Problem 1: (10 points)

Derive an expression for the output impedance of the simplified CC circuit shown in terms of given quantities. Assume that the transistor works without DC bias resistors. Neglect all hybrid parameters except h_{fe}, but do not assume $h_{fe}R_E >> |\mathbf{Z}_s|$.

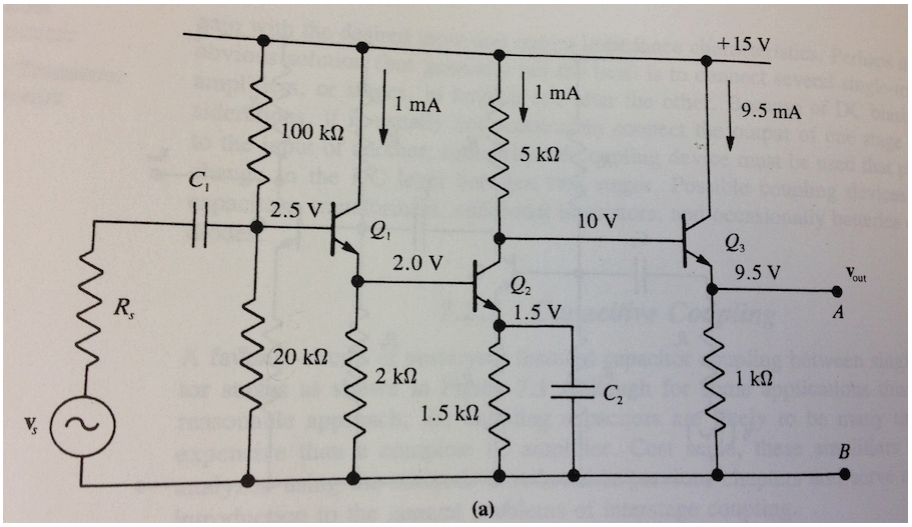


Problem 2: (15 points)

Consider the given circuit.

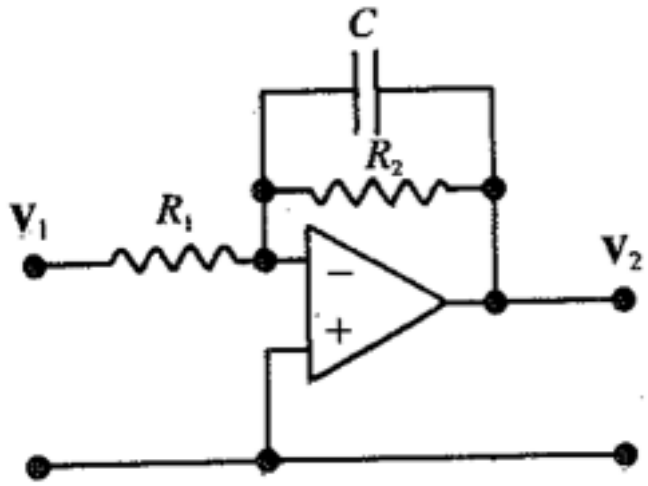
a. Identify the different "components" of the multi-transistor circuit.

b. The DC quiescent voltages of the figure all assume h_{FE} is very large. Work out the voltages exactly if $h_{FE} = 50$ and $V_{PN} = 0.5$ V.



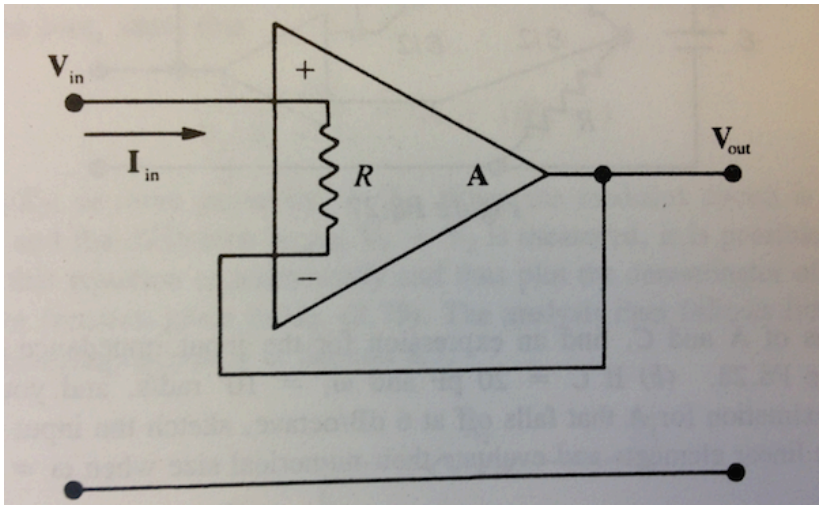
Problem 3: (15 points)

Assuming an ideal op-amp, determine $\mathbf{G}(j\omega)$ for the circuit shown. Sketch the approximation to $|\mathbf{G}|$, labeling magnitudes, corners and slopes.



Problem 4: (10 points)

Find the input impedance of the circuit shown in terms of the open-loop gain **A**.

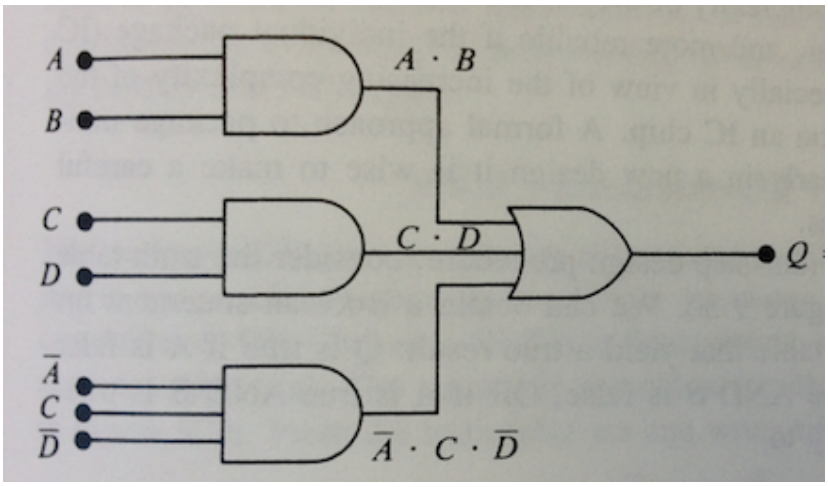


Problem 5: (8 points)

Explain the term "signal race" and describe a common general method of avoiding it in a circuit.

Problem 6: (12 points)

If the input to the given circuit is written as a number $ABCD$, write the nine numbers that will yield a true Q, in binary, decimal and hexadecimal.



Problem 7: (15 points)

Consider the following logical function: $F = (A + \overline{B})C + B\overline{C}$.

a. Make a truth table for the three inputs A, B, C that implements this function.

b. Draw a circuit diagram using logic gates that implements the logic. Do not manipulate the expression mathematically— implement the function exactly as written. You may assume you have both signals and inverted signals available as inputs. Label the output of each logic gate with its value.

c. Now implement the above function with no more than three 2-input gates which are from the set (NOR, NAND, AND, OR, XOR). Use Boolean algebra to reduce the expression. Once again label each gate output.

Problem 8: (15 points)

Design a circuit to create two 100-ns pulses 10 microseconds apart.