ECE 476
Exam #1
Spring 2021

Name:_____

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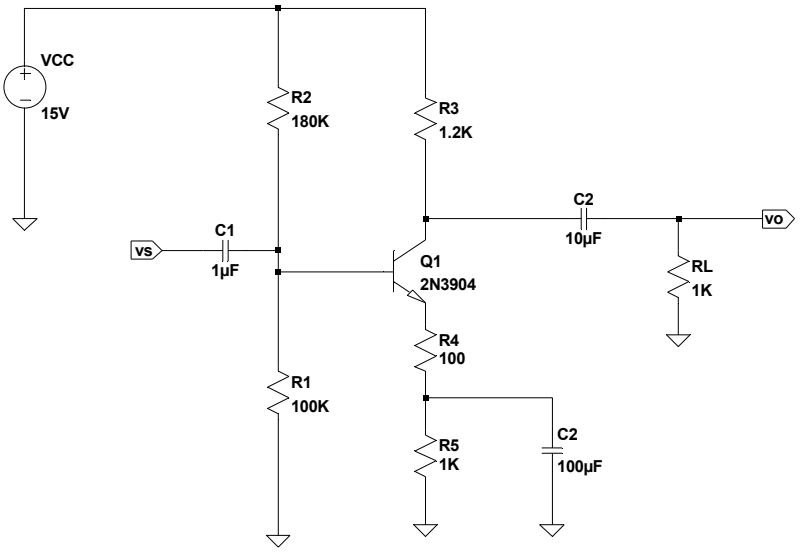
Thursday February 25, 2021

Problem 1. (20 points)

For the circuit shown below the Early voltage and beta are assumed infinite. The DC voltage measured on the collector of Q_1 is 9.72 Volts.



(a) Classify the amplifier. Circle one of the following: common-emitter, common-base, common-collector, common-emitter with emitter degeneration)

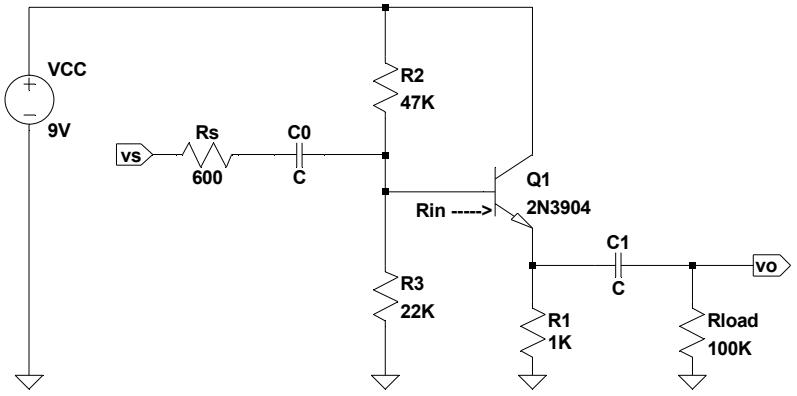
(b) Determine the DC collector current, I_C.

(c) What is the DC voltage on the emitter terminal, V_E?

(d) What is the small-signal mid-band gain, A = $\frac{v_o}{v_s}$?

Problem 2. (20 points)

Answer the following questions for the circuit shown below. Assume the value of C for both capacitors is **infinite**. The transistor has $\beta = 250$ and an Early voltage of 100 Volts. Assume V_{BE} is 700 mV.



(a) Classify the amplifier as either common-emitter, common-emitter with emitter degeneration, or common-collector (a.k.a. emitter follower). Circle one!

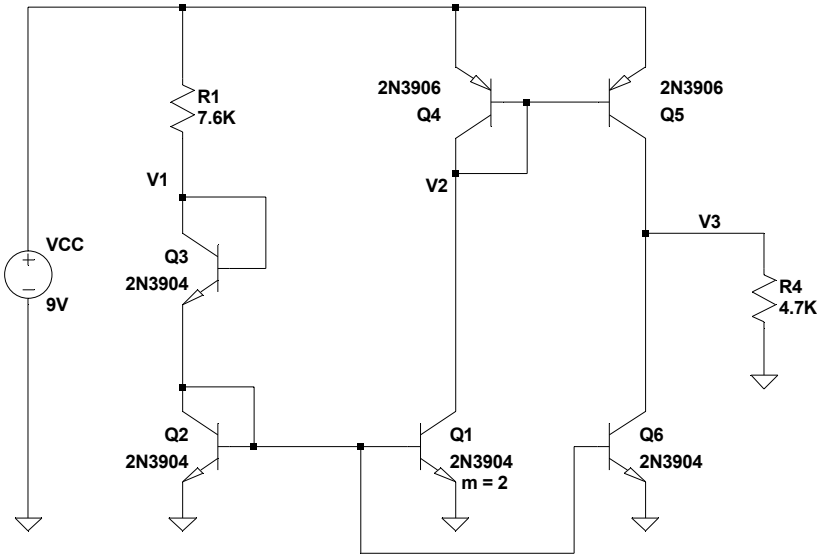
(b) Determine the DC collector current, I_C, You may assume infinite β for this calculation.

(c) Determine the r_0 of the transistor.

(d) Determine the small signal input resistance, R_{in} for the circuit.

Problem 3. (20 points)

Answer the following questions for the circuit shown below. Assume **infinite** β and Early Voltage, V_A, for all transistors. Also, assume that all transistors are in the active region and assume that the base-emitter voltage (for NPNs), V_{BE}, and emitter-base voltage (for PNPs), V_{EB}, is 700 mV.



(a) Determine the DC voltage, V_1.

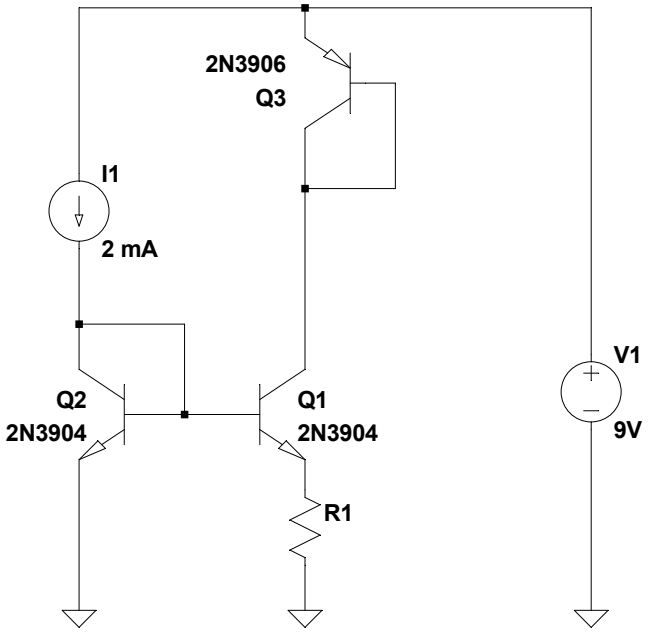
(b) Determine the DC voltage, V_2.

(c) Determine the DC current collector current for Q_5.

(d) Determine the DC voltage, V_3.

Problem 4. (15 points)

For the circuit shown below assume the transistors are matched. Moreover, assume the β of the transistors is infinite and that the Early voltage is 125 V.



(a) Transistors Q_1, Q_2, and resistor R_1 implement what type of current mirror? Please CIRCLE one of the followng: simple, Widlar, cascoded, or Wilson.

(b) Find the value of R_1 so that the output current of the mirror is 0.5 mA.

(c) Determine the small-signal output resistance, R_o, of the resulting current mirror.

Problem 5. (15 points)

A diode-connected BJT has an emitter current of 400 μA. The transistor I_{ES} is 4 fA. The base-emitter voltage temperature coefficient for the device is -2 $\frac{mV}{C}$.

(a) Compute the base-emitter voltage at room temperature?

(b) If the current is reduced to 50 μA, then what is the new base-emitter voltage?

(c) If the the emitter current is returned to 400 μA, then what is the base-emitter voltage if the temperature of the device is raised by 50 degrees Celsius?

Problem 6. (10 points) GRADUATE STUDENTS ONLY

For the circuit shown below, you may make the following simplifying assumptions: V_{BE} is 700 mV, β is infinite, V_A is infinite, and the capacitors can be treated as shorts for the small-signal analysis. Please determine the voltage gain, $\frac{v_o}{v_s}$.