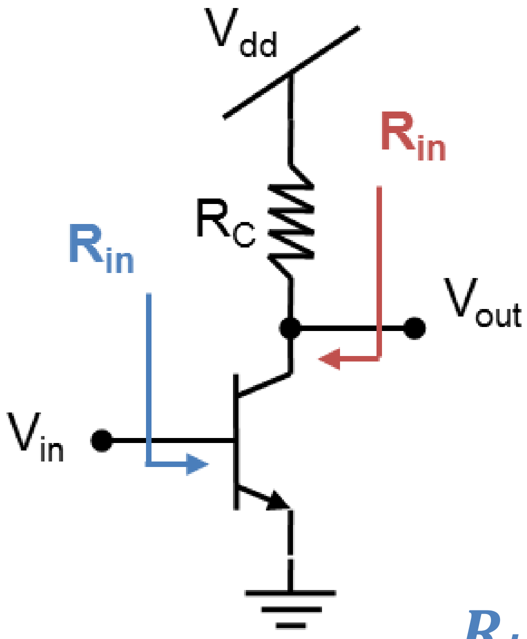
Exam #2 → Wednesday, October 16

BJTs - Chapter #6:

1) Semiconductor Physics
2) Regions of Operation
3) Large Signal Model
4) Large Signal Analysis
5) Small Signal Model
6) Small Signal Analysis

Last Lecture → Common-Emitter Amplifier

- ***npn***



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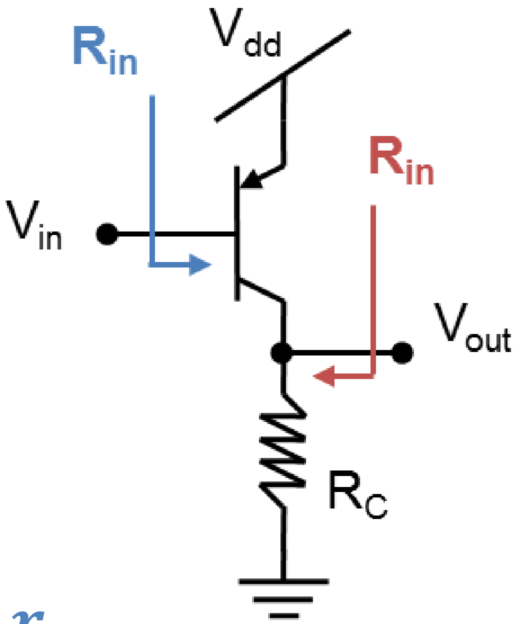
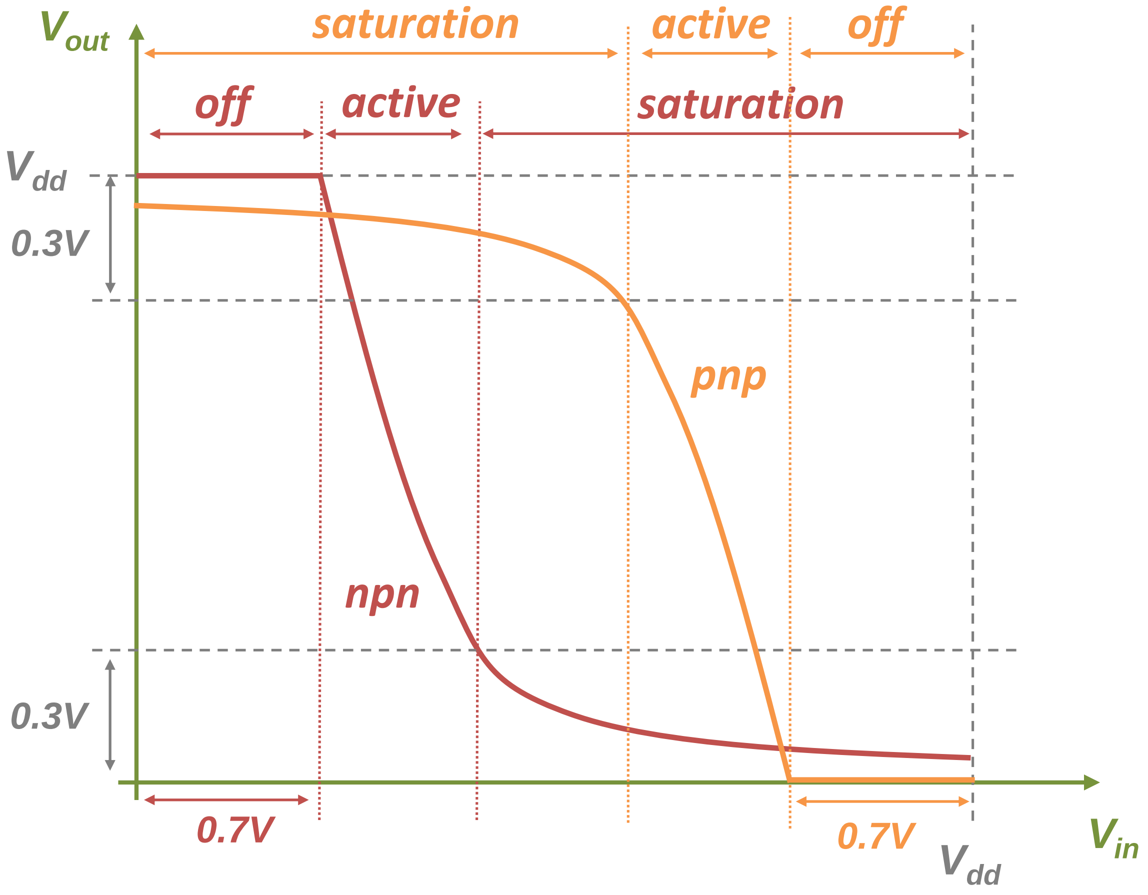


$$R_{in} = r_\pi$$

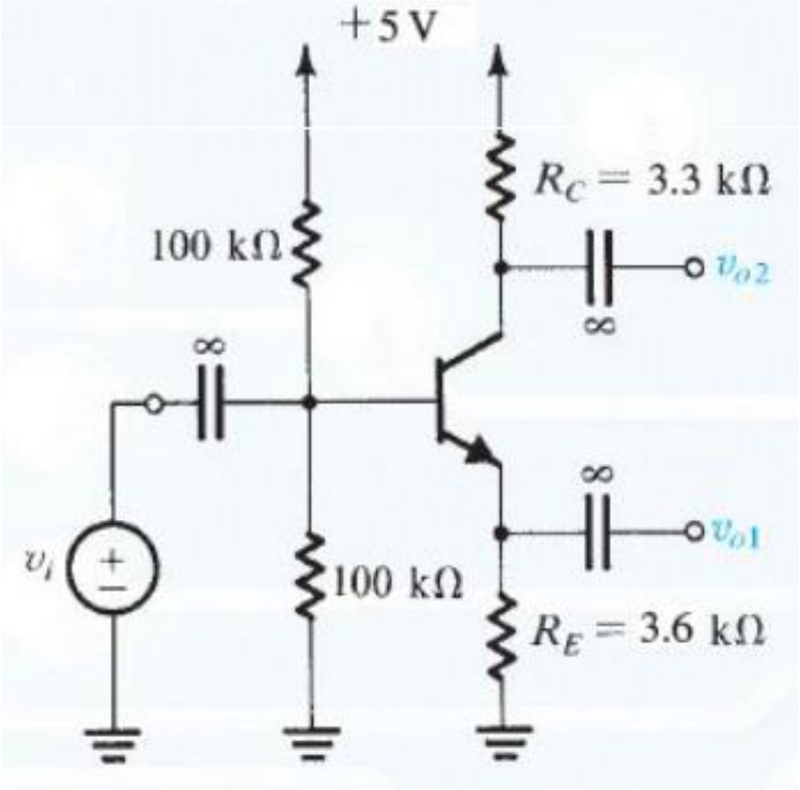
$$R_{out} = R_c // r_0$$

$$A_V = -g_m (R_c // r_0)$$



Problem 6.107

Assuming β is very large and the transistor is operating in active mode, find the collector bias current I_C. Using the small-signal model analyze the circuit to determine v_{01}/v_i and v_{02}/v_i. Determine the resistance seen by the input source ($V_A=\infty$) and the output resistances from v_{01} and v_{02} (V_A=100V).

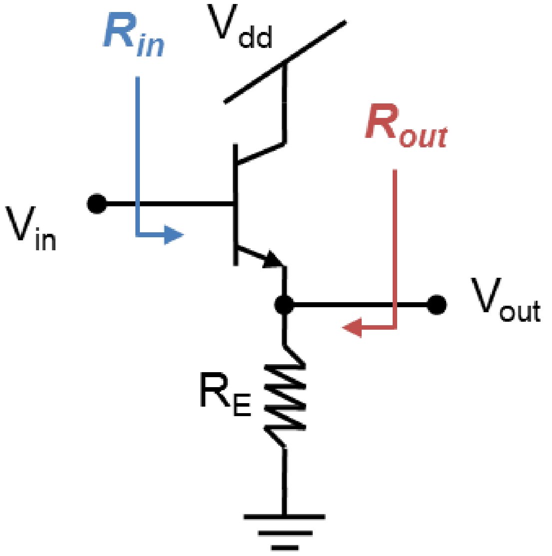


$$V_C = 3.35V$$
$$I_c = 0.5mA$$

$$g_m = 20mS$$
$$r_\pi = \infty$$
$$r_0 = 200k\Omega$$

Common Collector Amplifier

- ***npn***



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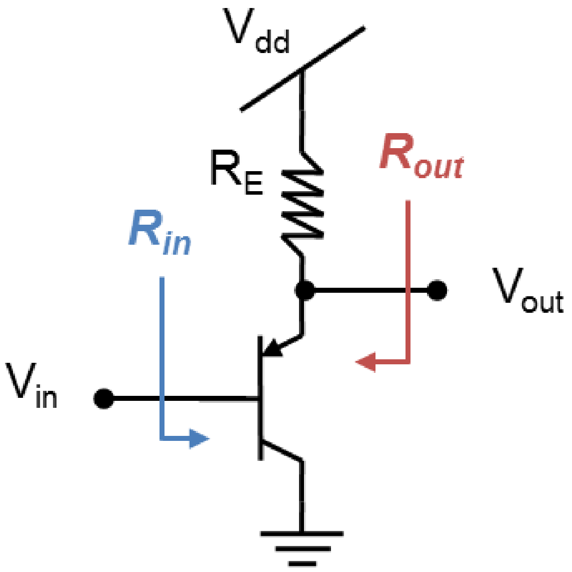
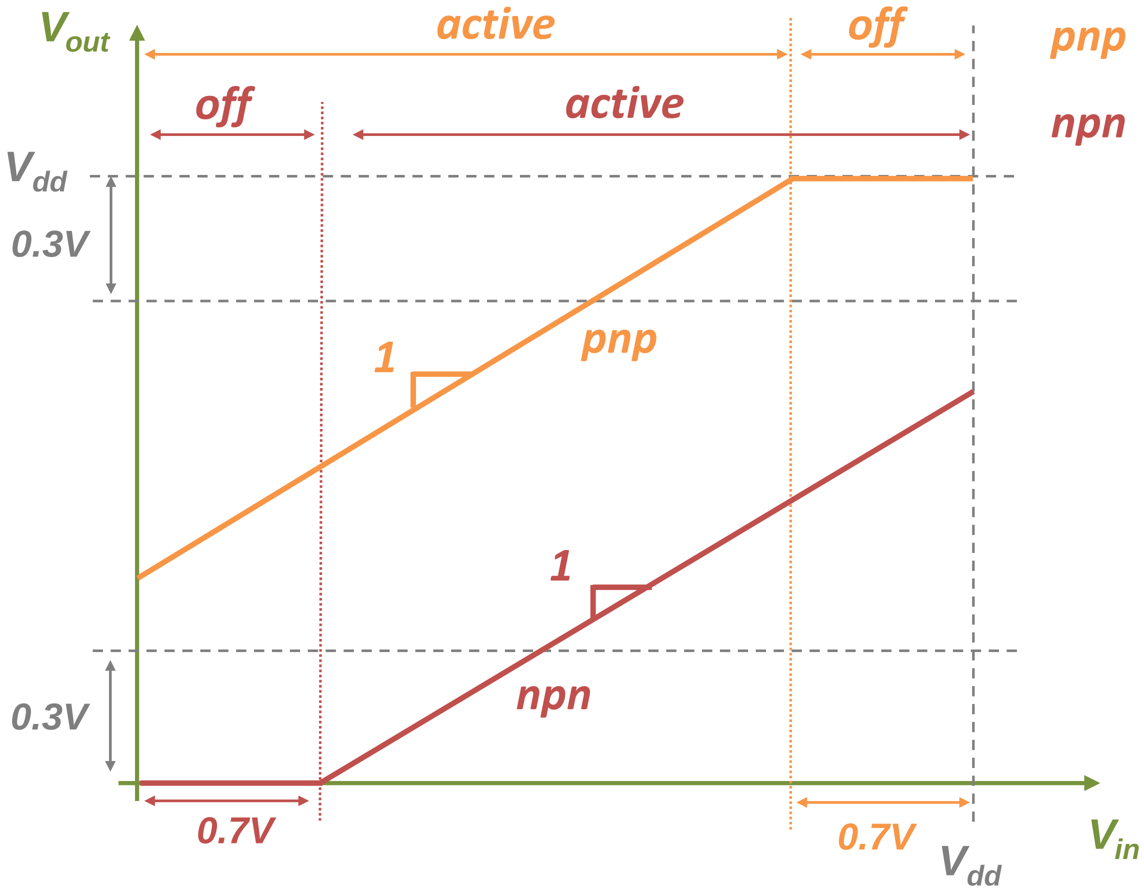


$$R_{in} = r_\pi(1 + g_m R_E)$$

$$R_{out} \approx 1/g_m$$

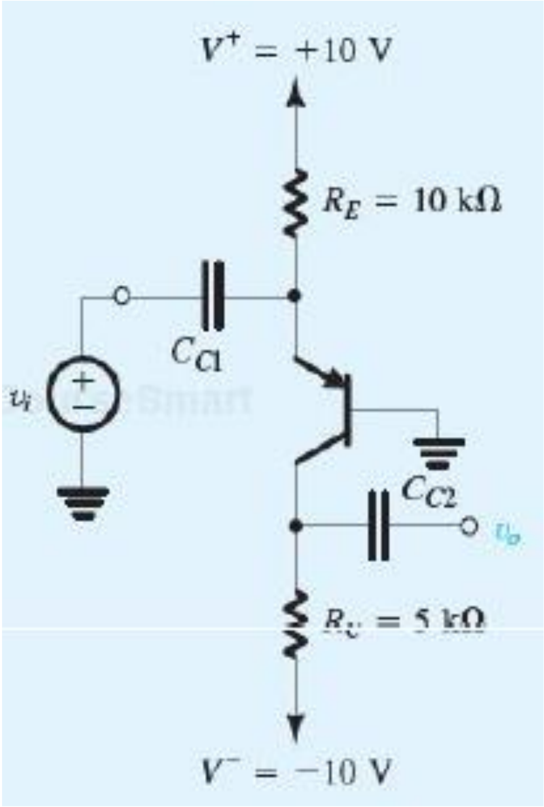
$$A_V = \frac{g_m R_E}{1 + g_m R_E} \approx 1$$



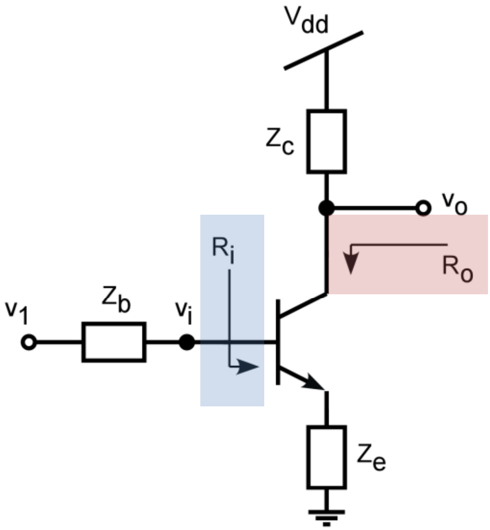
Exercise 6.44

For the following circuit determine

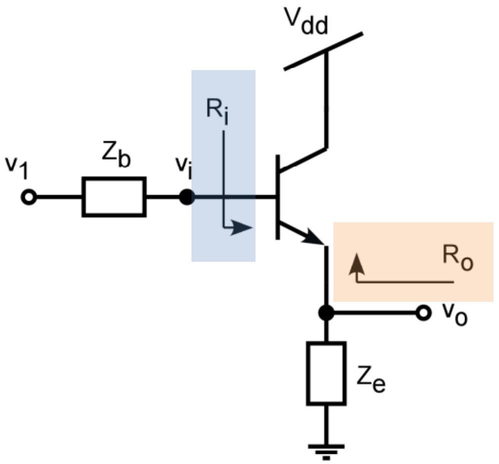
1. the voltage gain v_o/v_i ($r_o=\infty$)
2. the impedance seen by the input source ($r_o=\infty$)
3. the output impedance



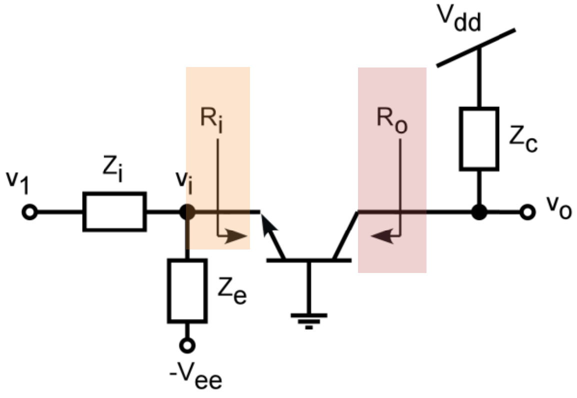
BJT – Single Stage Amplifiers



Common Emitter - CE



Common Collector - CC



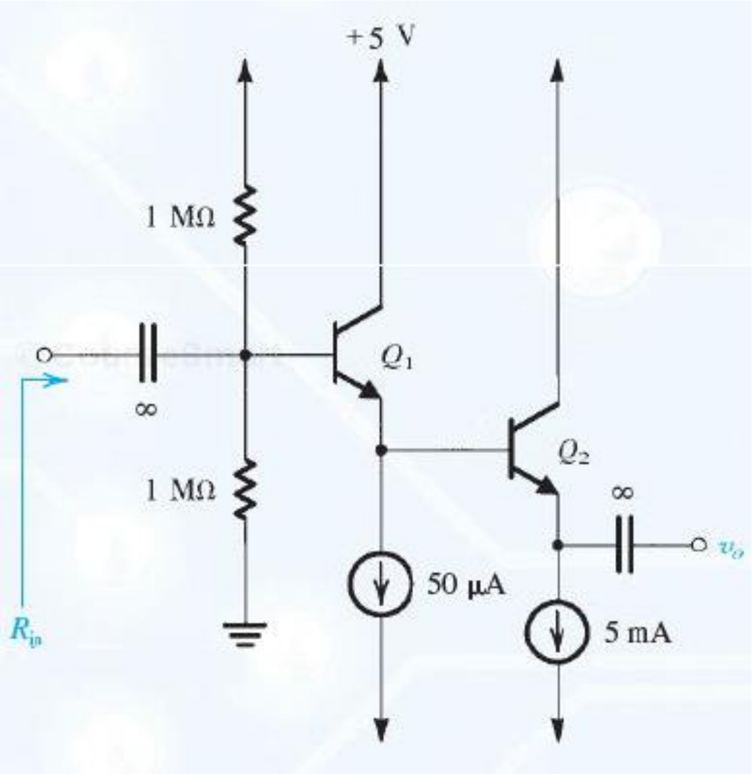
Common Base - CB

Single Transistor Bipolar Amplifier	**Common-Emmitter CE**	**Common-Collector CC**	**Common-Base CB**
Voltage Gain $A_v = \frac{v_o}{v_i}$	$\cong -\frac{g_m}{1+g_m Z_e} \cdot R_o//Z_c$	$\cong +\frac{g_m}{1+g_m Z_e} \cdot Z_e$	$= +g_m \cdot R_o//Z_c$
Input Resistance R_i	$= r_\pi(1+g_m Z_e)$	$= r_\pi\,(1+g_m Z_e)$	$\cong \frac{1}{g_m}$
Output Resistance R_o	$= r_o(1+g_m Z_e)$	$\cong \frac{1}{g_m} + \frac{Z_b}{\beta_o + 1}$	$= r_o[1+g_m(Z_i//Z_e)]$

Problem 6.155

For the given circuit, assuming β_1=50, β_2=100, $r_o=\infty$ and V_{BE}=0.7V,

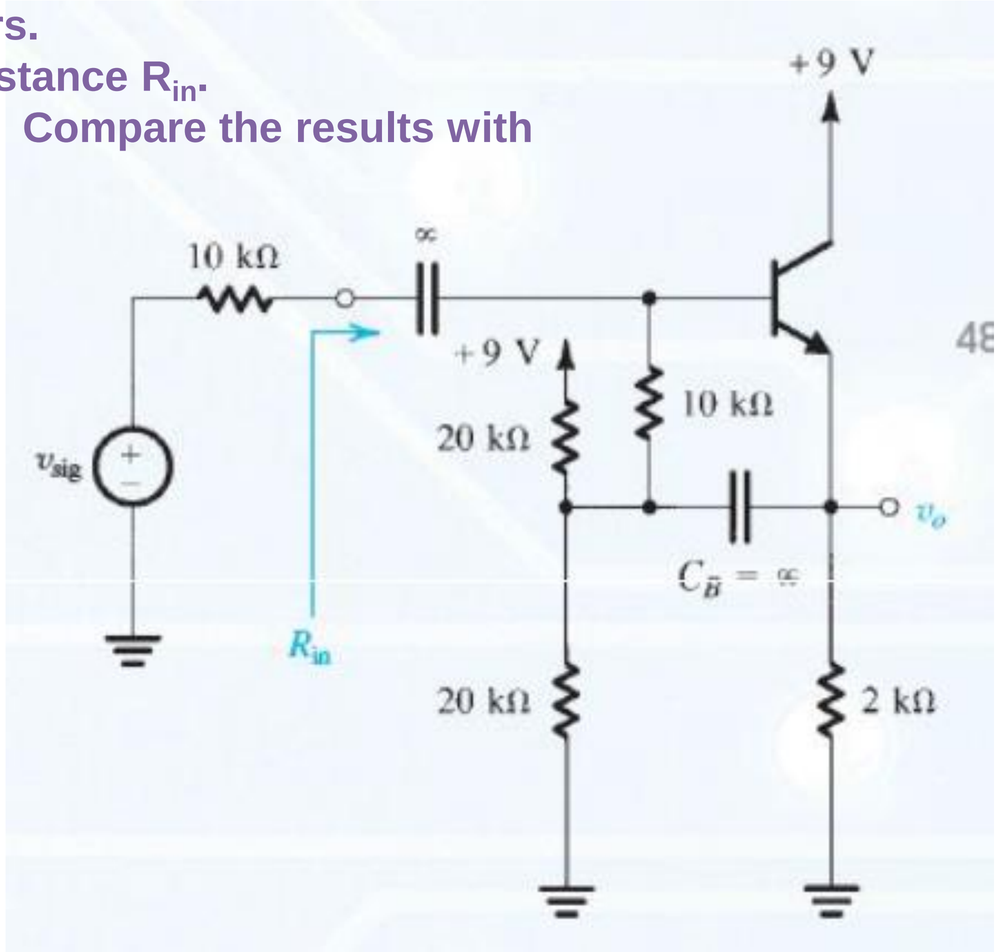
a) find the dc emitter currents of Q_1 and Q_2 along with the dc voltages V_{B1} and V_{B2}.
b) Assuming a load resistance R_L=1kΩ is connected to the output terminal, determine the overall voltage gain v_o/v_{sig} and the input resistance R_{in}.



Problem 6.154

For the given circuit, assume β=100 and V_{BE}=0.7V.

a) **Find the dc emitter currents and the small signal parameters.**
b) **Determine the overall voltage gain v_o/v_{sig} and the input resistance R_{in}.**
c) **Repeat b) for the case when capacitor C_B is open-circuited. Compare the results with those obtained in b).**



Problem 6.147

***6.147** The amplifier of Fig. P6.147 consists of two identical common-emitter amplifiers connected in cascade. Observe that the input resistance of the second stage, R_{in2}, constitutes the load resistance of the first stage.

(a) For $V_{CC} = 9$ V, $R_1 = 100$ kΩ, $R_2 = 47$ kΩ, $R_E = 3.9$ kΩ, $R_C = 6.8$ kΩ, and $\beta = 100$, determine the dc collector current and dc collector voltage of each transistor.

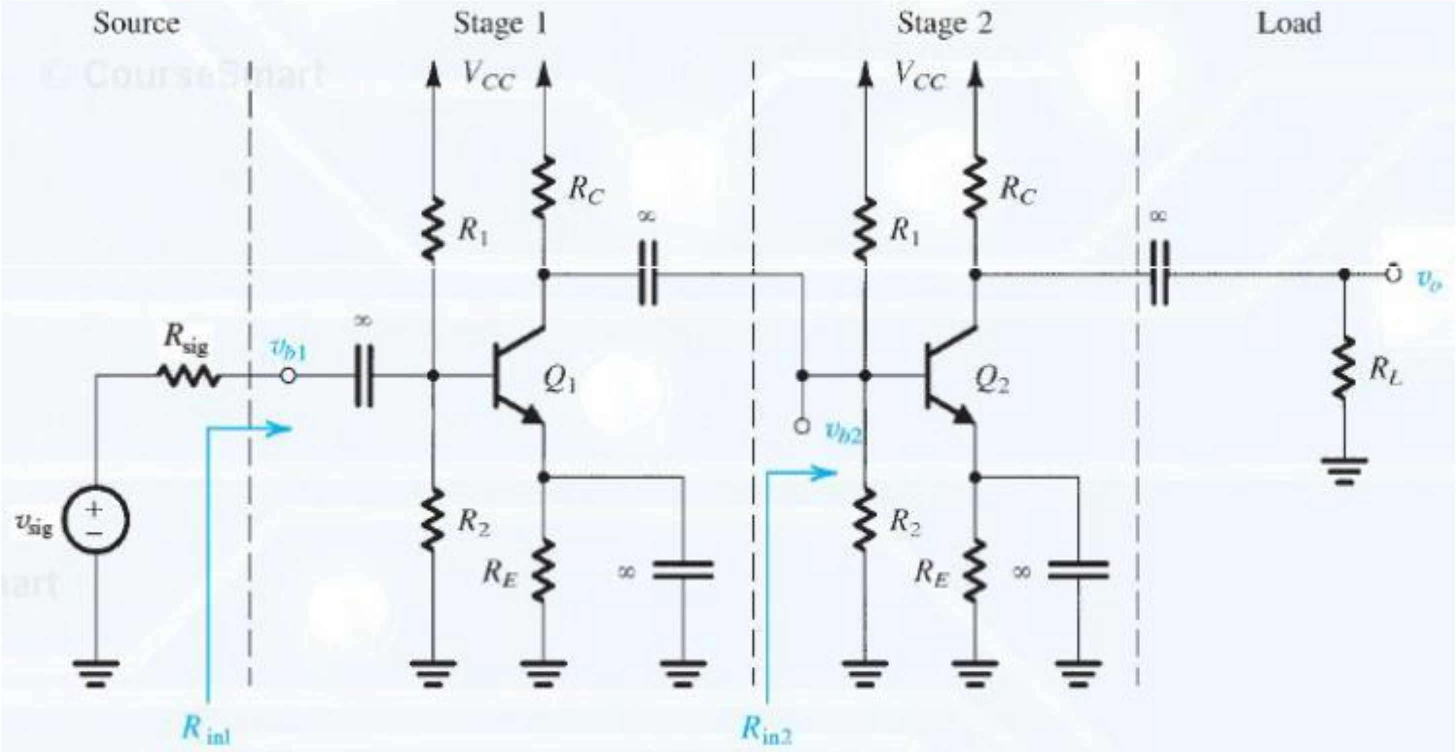
(b) Draw the small-signal equivalent circuit of the entire amplifier and give the values of all its components.

(c) Find R_{in1} and v_{b1}/v_{sig} for $R_{sig} = 5$ kΩ

(d) Find R_{in2} and v_{b2}/v_{b1}.

(e) For $R_L = 2$ kΩ, find v_o/v_{b2}.

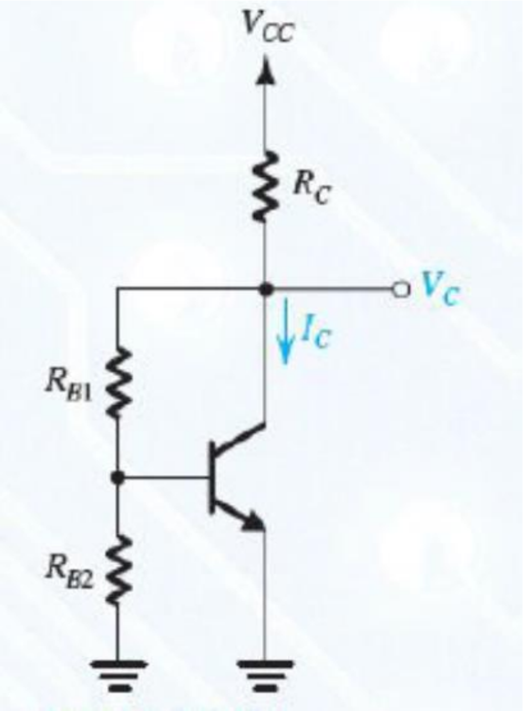
(f) Find the overall voltage gain v_o/v_{sig}.



Problem 6.136

For the given circuit, using a 3-V power supply,

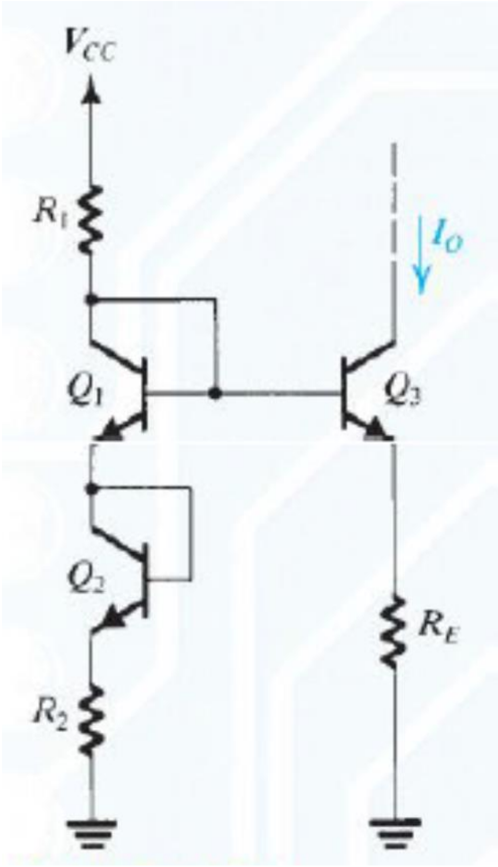
a) **and assuming $R_{b2}=\infty$, design R_c and R_{b1} to provide I_c=3mA and $V_c=V_{cc}/2$ for β=90.**
b) **Find V_c and I_c for $\beta=\infty$.**
c) **Re design R_c, R_{b1} and R_{b2} for β=90 and using a current through R_{b2} equal to the base current.**
d) **Find V_c and I_c for $\beta=\infty$.**



Problem 6.140

For the given circuit, assuming all transistors to be identical with β infinite,

a) derive an expression for the output current I_0, and show that by selecting $R_1=R_2$ and keeping the current in each junction the same, the current I_0 will be $I_0=V_{CC}/(2R_E)$
b) What must be the relationship of R_E to R_1 and R_2 be?
c) For V_{cc}=10V and V_{BE}=0.7V, design the circuit to obtain an output current of 0.5mA.
d) What is the lowest voltage that can be applied to the collector of Q_3?



Problem 6.68

Assuming β=infinite, design the given circuit so that the bias currents in Q_1, Q_2, and Q_3 are 1mA, 1mA, and 2mA, respectively, and V_3=0, V_5=-2V, and V_7=1V.