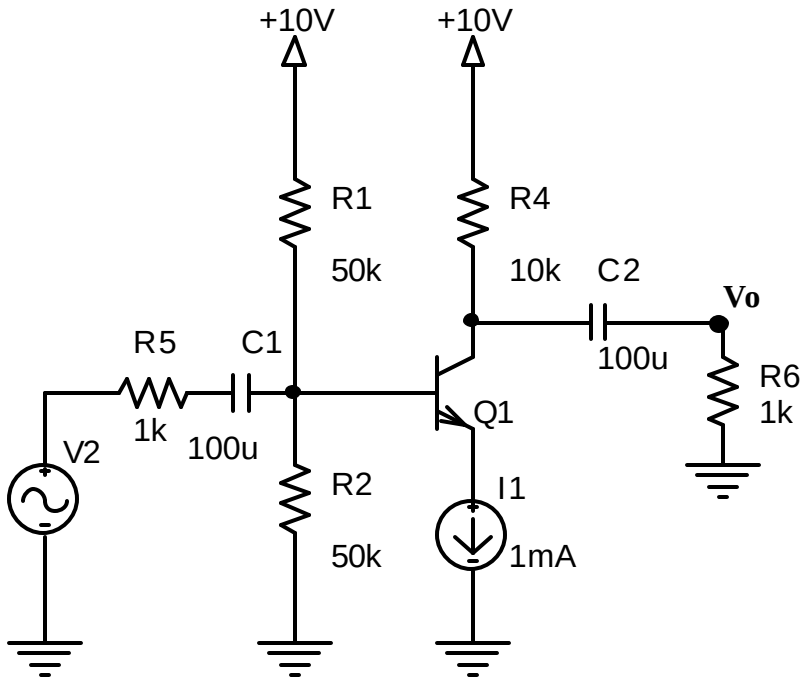
## **Problem 1** (10 points)

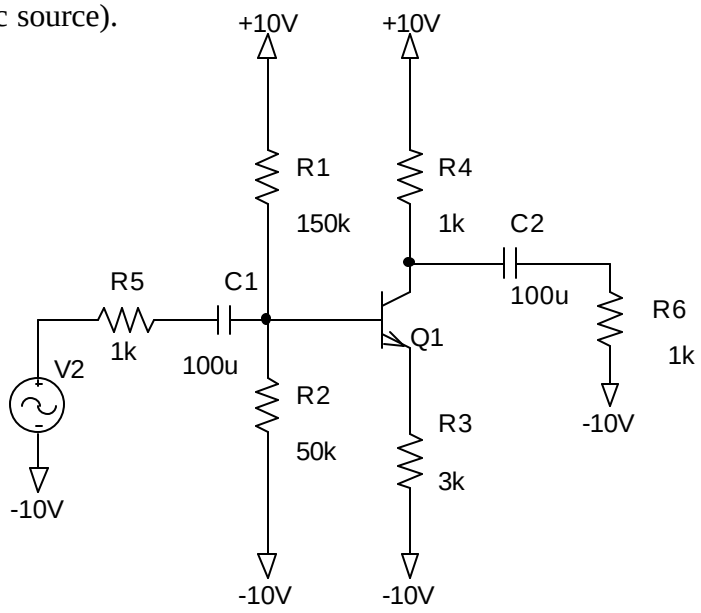
V2 = 0.1m sin(ωt) and β can vary from 20 to 200. The circuit shown below is suppose to amplify but does not. You expect the output at Vo to amplify V2. When you are testing the circuit, you find that it does not amplify. Explain why it does not and what exact resistor can be changed to allow it to amplify. I1 is not an ideal current source and can have a voltage drop across it.



## **Problem 2** (35 points)

Use $|V_{BE}|$=0.7, $\beta$=100, $V_T$=25mV (V2 is an ac source).

- Find the DC values for the following
    a. $I_{E1}$ **(15 points)**
    b. $I_{C1}$ **(3 points)**
    c. $V_{E1}$ **(6 points)**
    d. $V_{C1}$ **(6 points)**
    e. $V_{B1}$ **(5 points)**



## **Problem 3** (55 points)

Use $|V_{BE}|$=0.7, $\beta$=20, $V_T$=25mV (Vs is an ac source), ignore $r_o$.

This small-signal model circuit is drawn below. The original circuit is also shown below. It was found through a DC analysis that $I_{C1}$=50μ and $I_{C2}$=25μ.

(a) Find the ac parameters

a. $r_{\pi 1}$ **(3 points)**

b. $r_{\pi 2}$ **(3 points)**

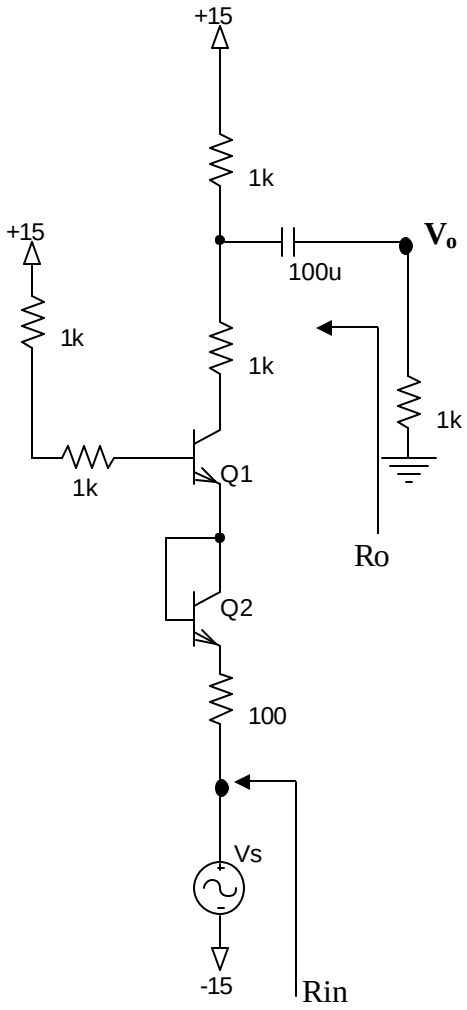
c. $gm_1$ **(3 points)**

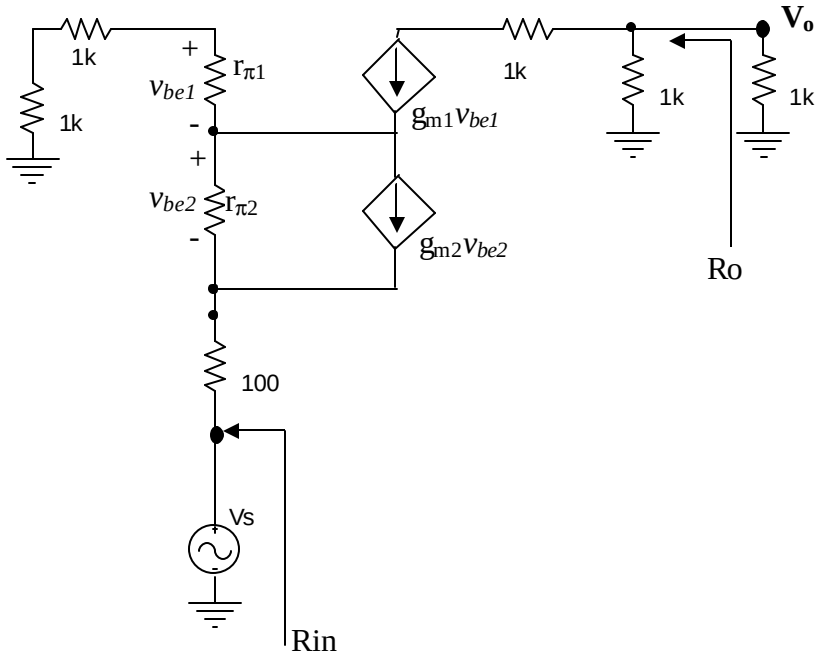
d. $gm_2$ **(3 points)**

(b) Find that input resistance, $R_{in}$. (Ignore the AC input source Vs, include the 100 ohm) **(12 points)**

(c) Find the output resistance, $R_o$. (Ignore the load resistor of 1k to the right of arrow) **(6 points)**

(d) Find the overall gain, Vo/Vs. **(25 points)**



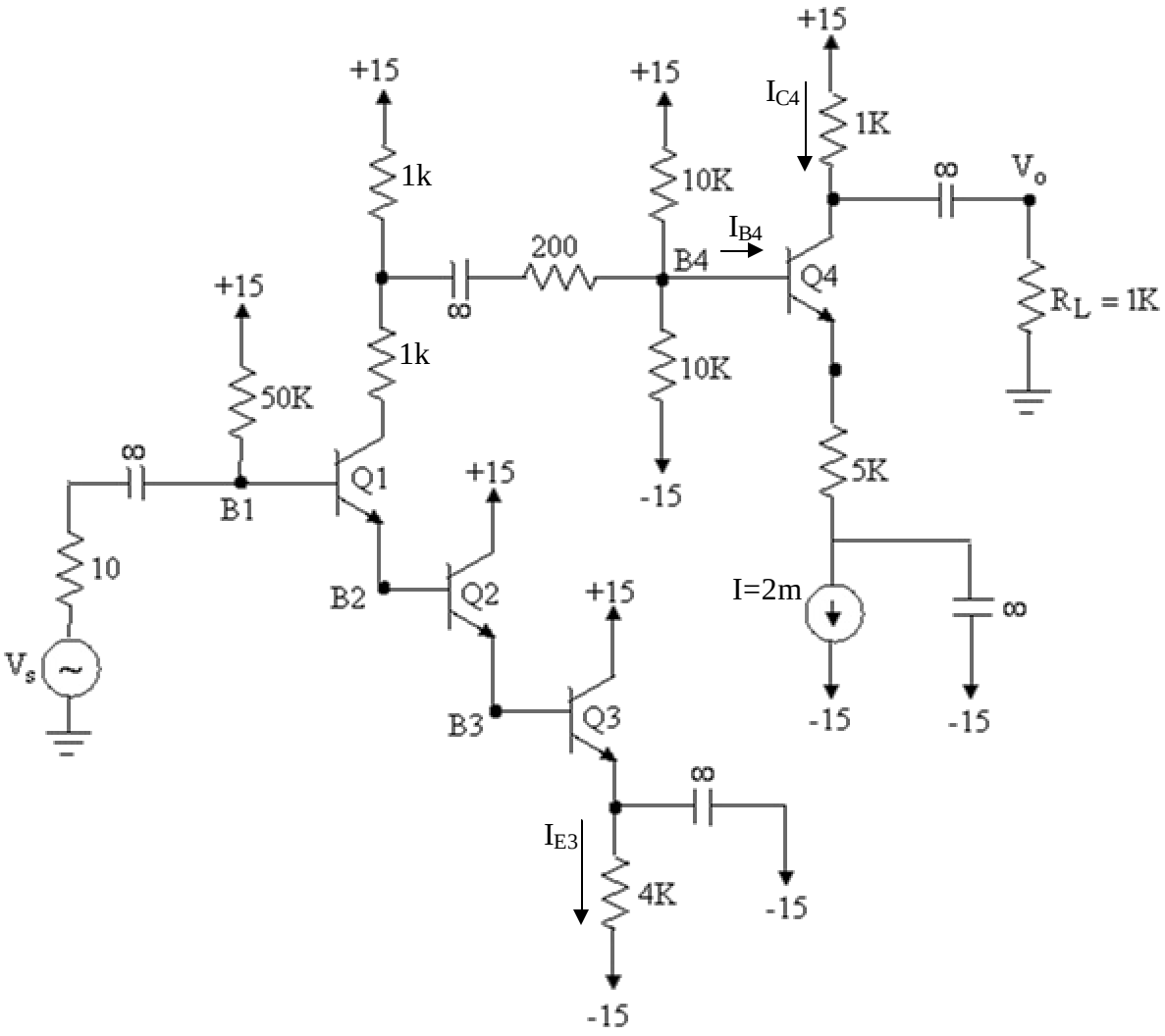
**<u>There are 3 problems total – make sure to show all your work</u>**

## <u>Problem 1</u> – (48 points)

Use $|V_{BE}|$=0.7, $\beta$=100, $V_T$=25mV (Vs is an ac source).

(b) Find the DC values for the following **(30 points)**
- a. $I_{E3}$ **(12 points)**
- b. $I_{C4}$ **(3 points)**
- c. $I_{B4}$ **(5 points)**
- d. $V_{C4}$ **(5 points)**
- e. $V_{B2}$ **(5 points)**

(c) Draw the small-signal model for the circuit below. (use hybrid-$\pi$ or Model-T). Make sure to label all the nodes shown in the circuit and mark the difference between each transistor (i.e. use $gm_1$, $gm_2$, $gm_3$, etc.) DO NOT ignore $r_o$. **(18 points)**



## Problem 2 – (47 points)

Use $|V_{BE}|$=0.7, $\beta$=100, $V_T$=25mV (Vs is an ac source), ignore $r_o$.

This small-signal model comes from a circuit that has 2 transistors Q1 and Q2 denoted below as subscripts 1 and 2. It was found that $I_{E1}$=2.525m and $I_{E2}$=1.2625m.

(e) Find the ac parameters **(12 points)**

a. $r_{\pi 1}$ **(3 points)**

b. $r_{\pi 2}$ **(3 points)**

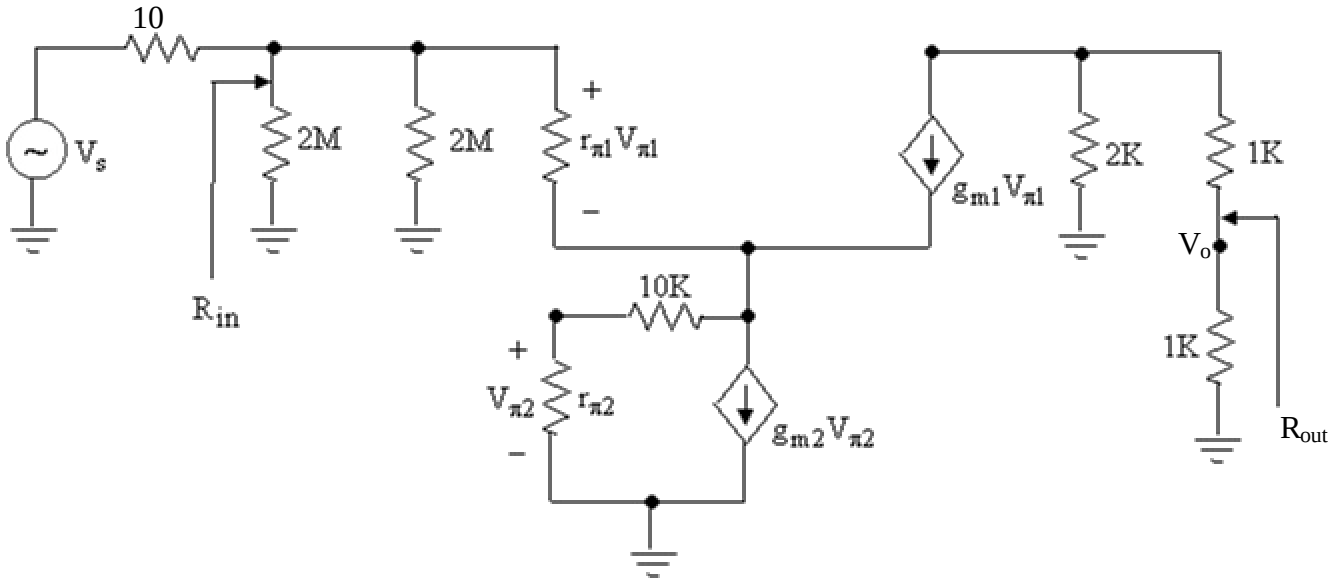
c. $gm_1$ **(3 points)**

d. $gm_2$ **(3 points)**

(f) Find $R_{in}$. **(11 points)**

(g) Find $R_{out}$. **(6 points)**

(h) Find the overall gain, Vo/Vs. **(18 points)**



## Problem 3 – (5 points)

Use $|V_{BE}|$=0.7, $\beta$=100, $V_T$=25mV (Vs is an ac source), ignore $r_o$.

Will this circuit work as an amplifier? Why or why not?