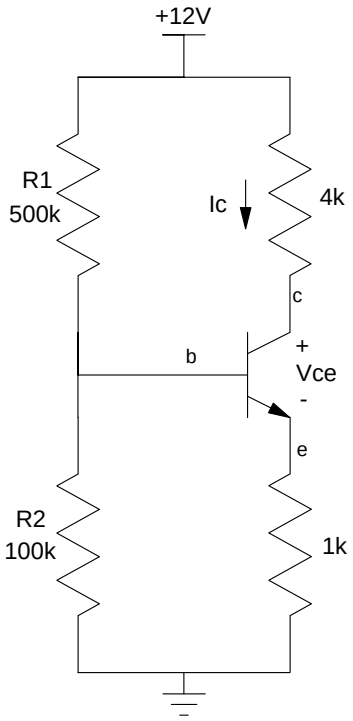
ECE 321 - Quiz #4 - Name _____

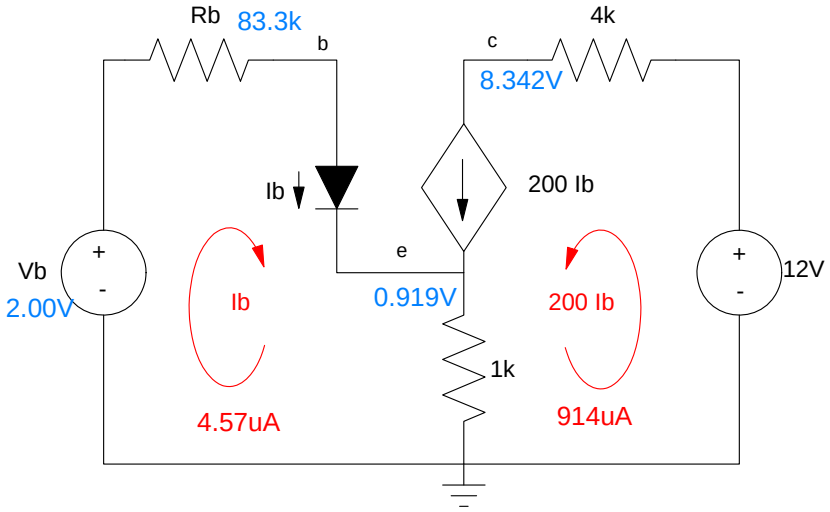
Common Emitter - Common Base - Common Collector Amplifiers. May 2, 2019

1) Q-Point Analysis. Determine the Thevenin equivalent for R1 and R2 (Vb and Rb) and determine the Q-point for the following transistor circuit. Assume ideal silicon transistors:

- $V_{be} = 0.7V$
- $\beta = 200$

Vb	Rb	Vce	Ic
2.0 V	**83.3k Ohms**	**7.42 V**	**914 uA**





$$R_b = R_1 \,||\, R_2 = 83.3k$$

$$V_b = \left(\frac{100k}{100k+500k}\right)12V = 2.0V$$

$$-2 + 83.3k \cdot I_b + 0.7 + 1k(I_b + 200I_b) = 0$$

$$I_b = \left(\frac{2V-0.7V}{83.3k+(201)1k}\right) = 4.57\mu A$$

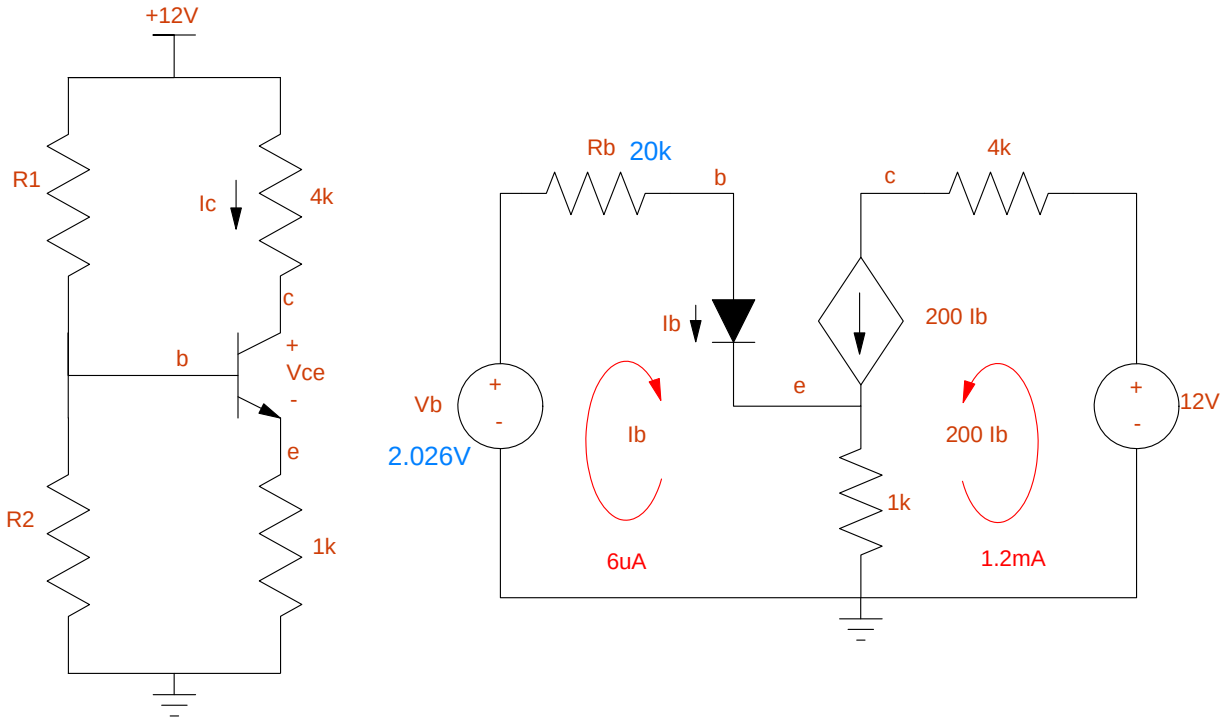
$$I_c = 200I_b = 914\mu A$$

$$V_{ce} = 12 - 4k \cdot I_c - 1k \cdot (I_c + I_b) = 7.42V$$

2) Q-Point Design. Find Rb and Vb and the corresponding R1 and R2 so that

- The Q-point is stabilized for variations in β (i.e. $(1+\beta)R_e >> R_b$)
- $V_{ce} = 6.0V$

R1	R2	Vb	Rb
118.5k	**24.1k**	**2.026V**	**20k**



To stabilize the Q-point

$$R_b << (1+\beta)R_e = 201k$$

Let Rb = 20k.

$$I_c \approx \frac{12V-6V}{4k+1k} = 1.2mA$$

$$I_b = \frac{I_c}{200} = 6\mu A$$

$$V_b = 1k(I_b + I_c) + 0.7 + 20k \cdot I_b = 2.026V$$

To find R1 and R2

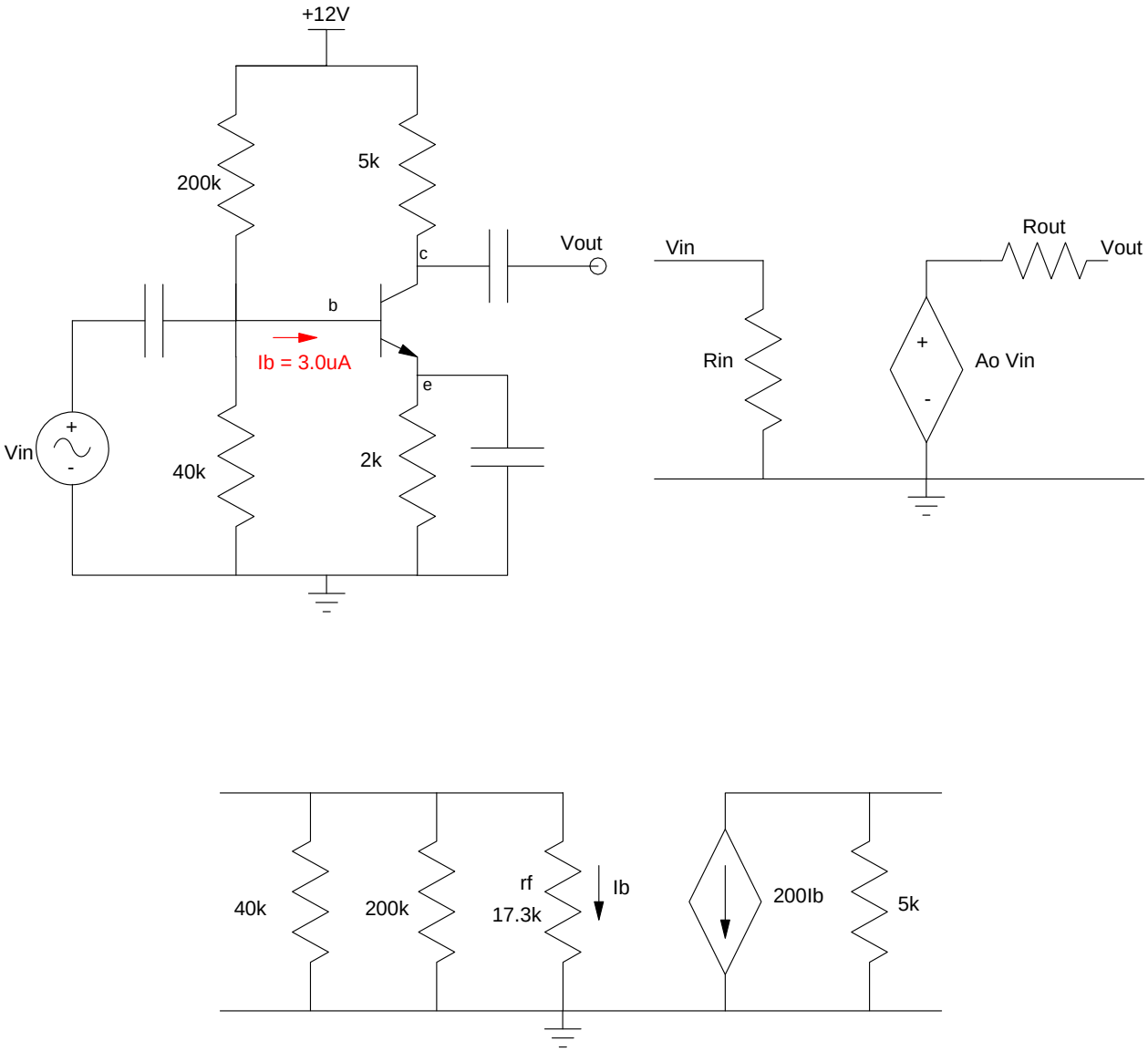
$$\left(\frac{R_1 R_2}{R_1+R_2}\right) = 20k$$

$$\left(\frac{R_2}{R_1+R_2}\right)12V = 2.026V$$

3) AC Anaysis: Common Emitter.

- Draw the small signal model for the following common emitter amplifier. Assume r_f = 17.3k
- Determine the 2-port model for this common emitter amplifier

Small-Signal Model	Rin	Ao	Rout
draw	**11.39k**	**-57.8**	**5k**



$$R_{in} = 40k||200k||17.3k = 11.39k$$

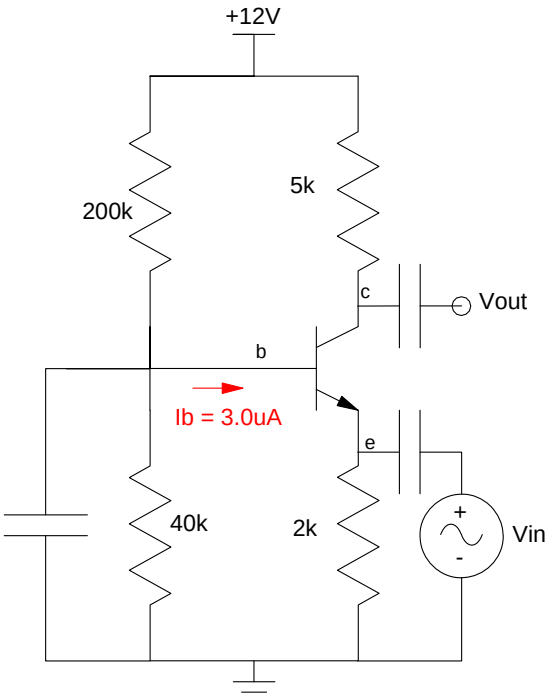
$$R_{out} = 5k$$

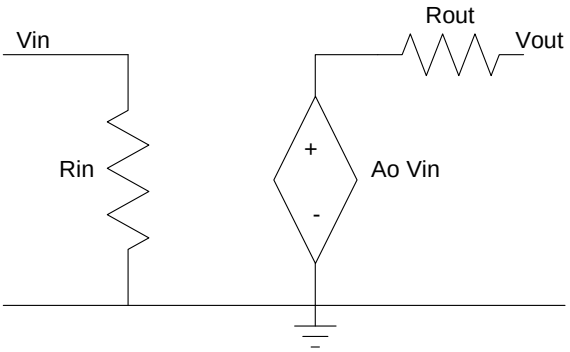
$$A_o = -\left(\frac{200 \cdot 5k}{17.3k}\right) = -57.8$$

3) AC Anaysis: Common Base.

- Draw the small signal model for the following common base amplifier. Assume r_f = 17.3k
- Determine the 2-port model for this common emitter amplifier

Small-Signal Model	Rin	Ao	Rout
draw	**82.52**	**57.8**	**5k**





Rin: Appy 1V at the input, short the output, and compute the resulting current

$$I = \left(\frac{1V}{2k\Omega}\right) + \left(\frac{1V}{17.3k\Omega}\right) + 200\left(\frac{1V}{17.3k\Omega}\right)$$

$$I = 12.12mA$$

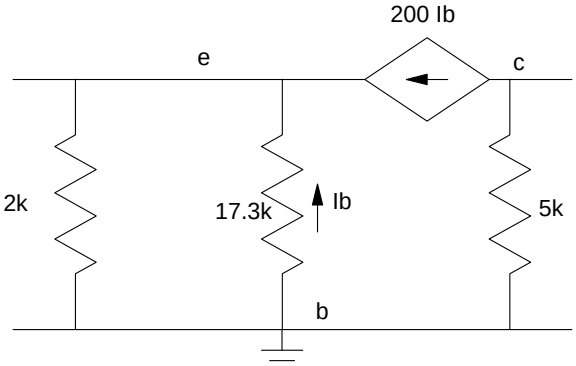
$$R_{in} = \frac{1V}{12.12mA} = 82.52\Omega$$

Rout: Short Vin, measure Rout

Rout = 5k

Ao: Apply 1V at Vin, measure Vout

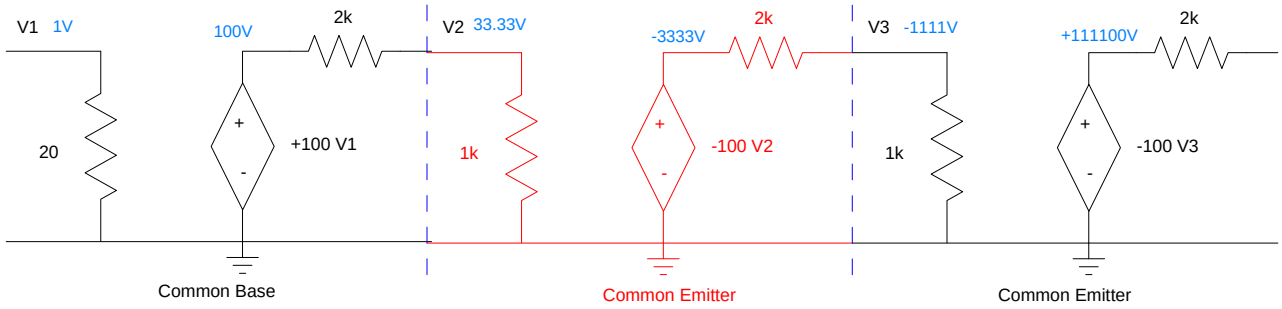
$$A_0 = +\left(\frac{200 \cdot 5k}{17.3k}\right) = +57.8$$



5) Multi-Stage Amplifier: Determine the 2-port model for the following 3-stage amplifier:

CB : CE : CE

Rin	Ai	Rout	Ao
20	**0**	**2k**	**+111,100**



Socialism vs. Capitalism Bonus! What does capitalism say about how wealth is distributed?