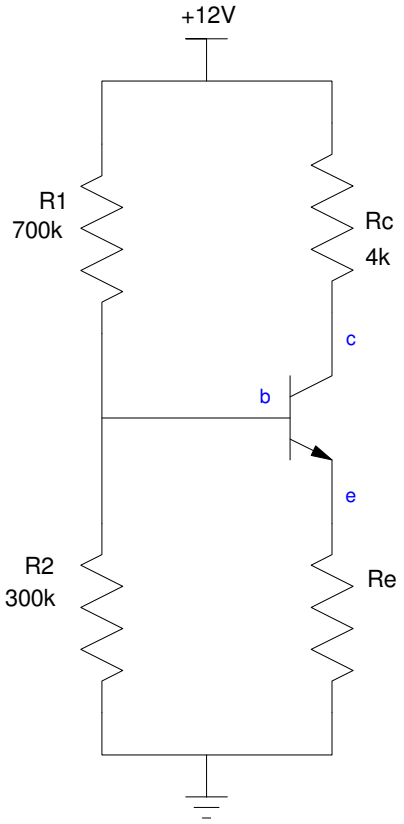
ECE 321 - Quiz #5 - Name _____

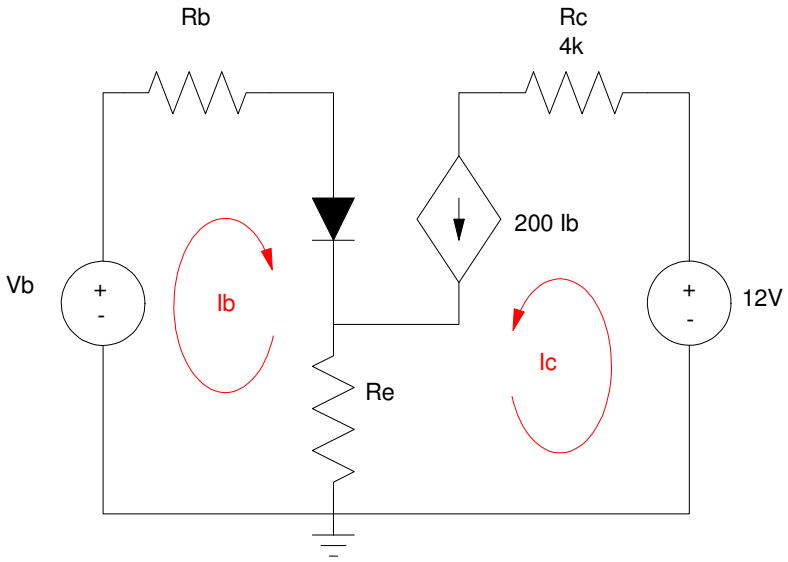
BJT Amplifiers. Due midnight, April 6th

1) BJT Amplifier: DC Analysis. Determine the Thevenin equivalent of R1 and R2 as well as the Q-point. Assume ideal silicon transistors:

- |Vbe| = 0.7V
- β = 200
- Re = 1000 + 100*(your birth month) + (your birth day). May 14th would give R = 1514 Ohms

Re 1000 + 100*mo + day	Vb	Rb	Vce	Ic
1514	**3.6V**	**210k**	**5.773V** varies with Re	**1.128mA** varies with Re





$$R_b = R_1 || R_2 = 210k$$

$$V_b = \left(\frac{R_2}{R_1+R_2}\right) 12V = 3.6V$$

$$I_b = \left(\frac{V_b - 0.7V}{R_b + (1+\beta)R_e}\right) = 5.638\mu A$$

$$I_c = 200 I_b = 1.128mA$$

$$V_{ce} = 12 - R_c I_c - R_e(I_b + I_c) = 5.773V$$

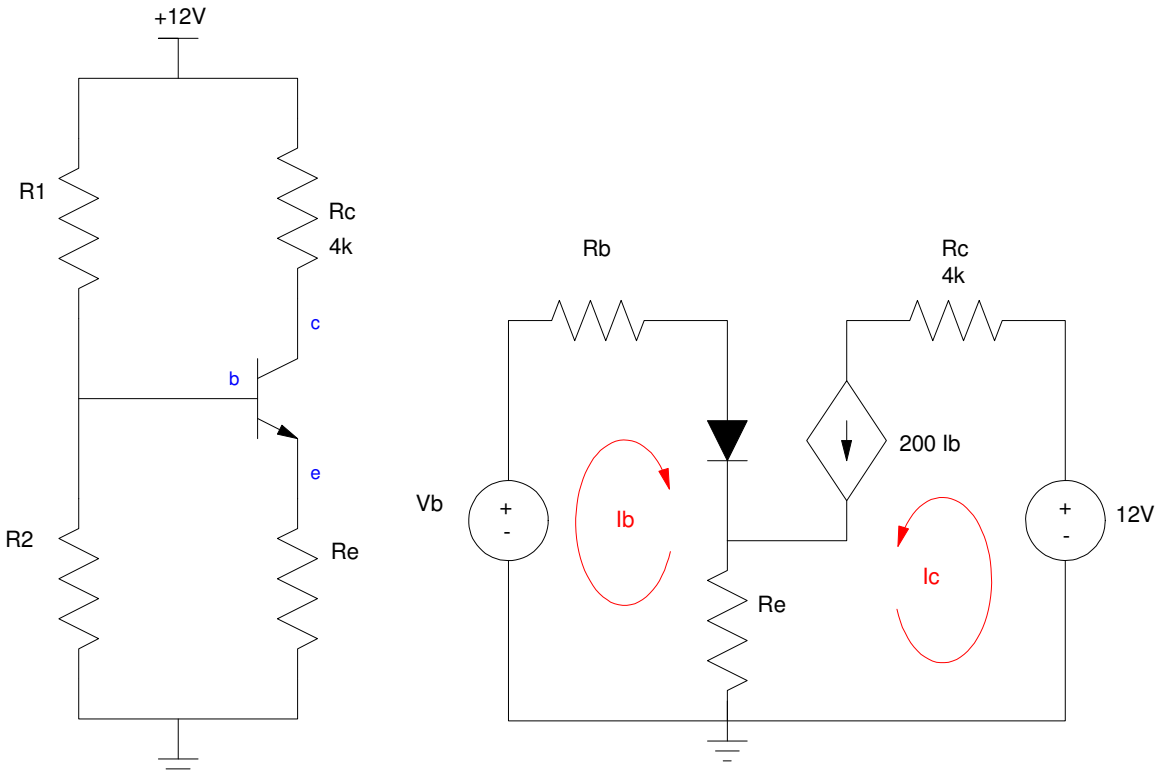
2) BJT Amplifier: DC Design. Determine R1 and R2 so that

- The Q point is Vce = 6.00V and
- The Q point is stabilized for variations in β

Assume

- Ideal silicon transistors (Vbe = 0.7V, $\beta = 200$)
- Re = 1000 + 100*(birth month) + (birth day). May 14th gives R = 1514 Ohms

Re 1000 + 100*mo + day	R1	R2	Vb	Rb
1514	**37.96k** varies with Rb & Vb	**143.1k** varies with Rb & Vb	**2.516V** depends up on Rb	**30k** varies with Re



$$Rb << (1+\beta)R_e = 304k\Omega$$

Let Rb = 30k

$$I_c = \left(\frac{12V-6V}{R_c+R_e+\frac{R_e}{200}}\right) = 1.087mA$$

$$I_b = \frac{I_c}{200} = 5.433\mu A$$

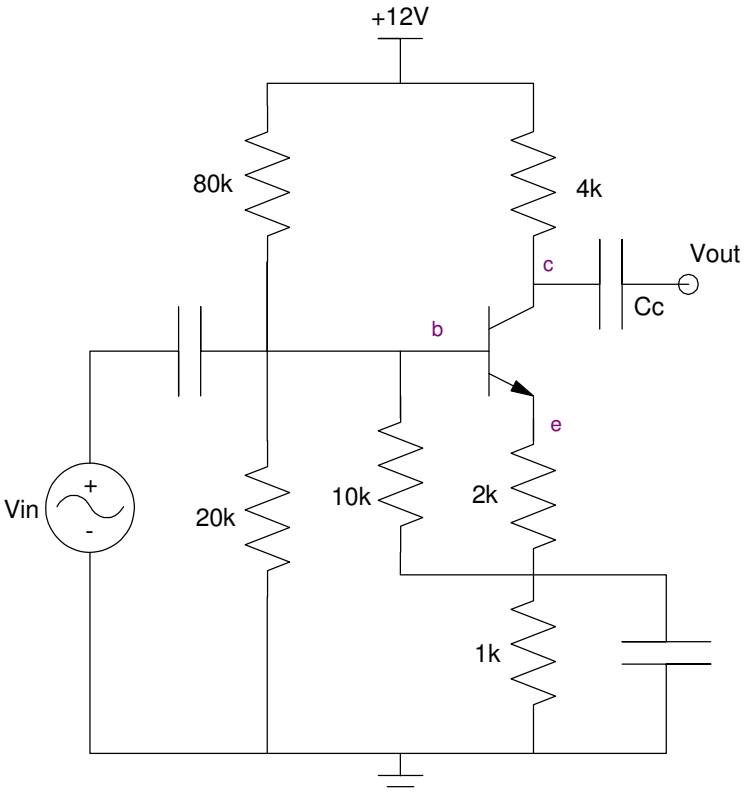
$$V_b = R_e(I_b+I_c)+0.7+R_bI_b = 2.516V$$

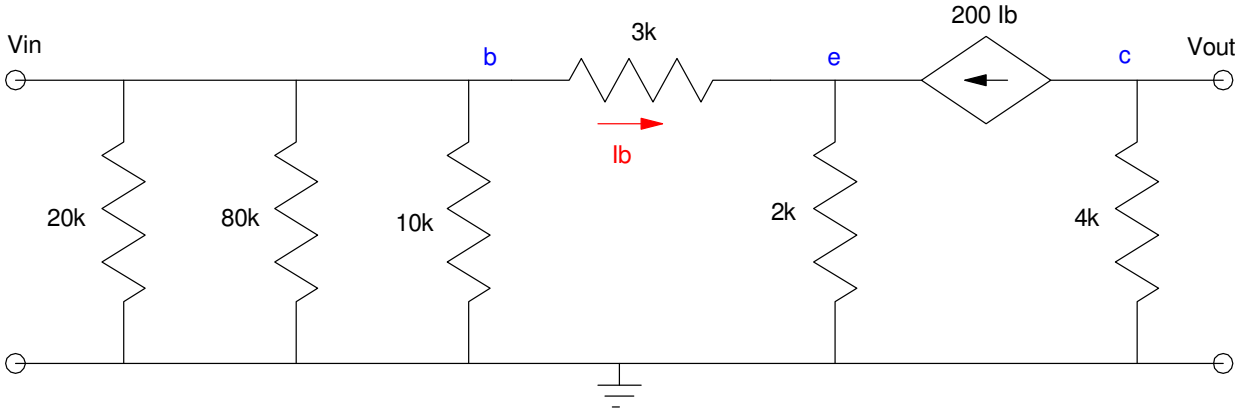
$$R_1 = \left(\frac{12V}{2.516V}\right)R_b = 143.1k\Omega$$

$$R_2 = 37.96k\Omega \qquad \text{R1 || R2 = 30k}$$

3) BJT: AC Analysis: Draw the small signal model for the following BJT amplifier. Assume

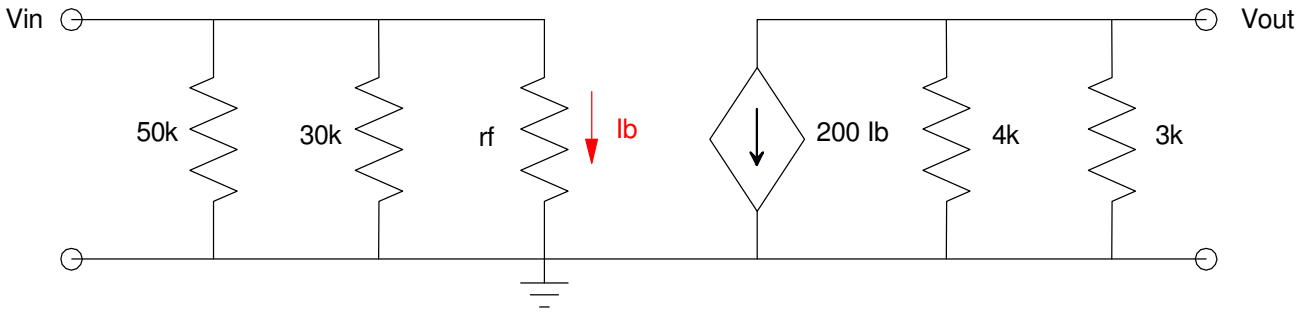
- $r_f = 3000\Omega$
- $\beta = 200$





4) BJT: AC Analysis: Determine the 2-port model for the following CE amplifer.

rf 1000 + 100*mo + day	Rin	Ain	Rout	Ao
1514	**1401** varies with rf	**0**	**1714**	**-226.4** varies with rf7



$$R_{in} = 50k||30k||1514 = 1401\Omega$$

$$A_{in} = 0$$

$$R_{out} = 3k||4k = 1714\Omega$$

$$A_o = -\left(\frac{200 \cdot 1714}{1514}\right) = -226.4$$

5) 2-Port model (experimental): Determine the 2-port parameters based upon the following experimental data:

Case 1:
- Vin = 1mV @ 1kHz
- R1 = 0 Ohms
- R2 = 10M Ohms

results in Vout = 173mV

Case 2:
- Vin = 1mV @ 1kHz
- R1 = X Ohms
- R2 = 10M Ohms

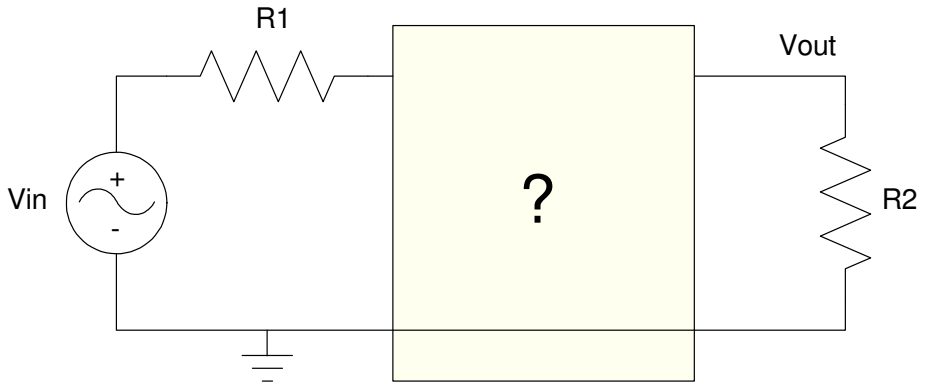
results in Vout = 100mV

Case 3
- Vin = 1mV @ 1kHz
- R1 = 0 Ohms
- R2 = X Ohms

results in Vout = 50mV

Assume
- X = 1000 + 100*(your birth month) + (your birth date) Ohms
- Ai = 0

X 1000 + 100*mo + day	Rin	Ai	Rout	Ao
1514	**2047** varies with X	**0**	**3723** varies with X	**173**



Case 1: This tells you Ao

$$A_o = \frac{173mV}{1mV} = 173$$

Case 2: This tells you Rin

$$\left(\frac{R_{in}}{R_{in}+1514}\right) 173mV = 100mV$$

$$R_{in} = \left(\frac{100mV}{173mV-100mV}\right) 1514\Omega = 2074\Omega$$

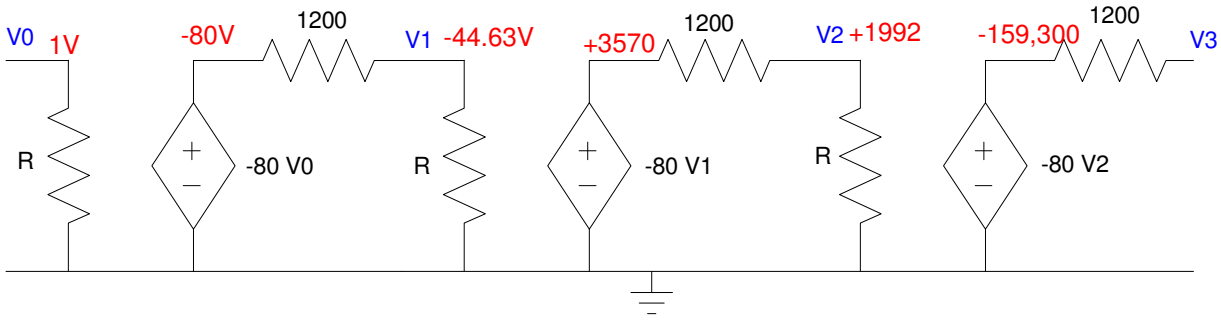
Case 3 tells you Rout

$$\left(\frac{1514}{R_{out}+1514}\right) 173mV = 50mV$$

$$R_{out} = \left(\frac{173mV-50mV}{50mV}\right) 1514\Omega = 3723\Omega$$

6) Determine the 2-port model for the following cascaded CE amplfier

R 1000 + 100*mo + day	Rin	Ai	Rout	Ao
1514	**1514** R	**0**	**1200**	**-159,300** varies with R



Ao: Apply 1V at V0