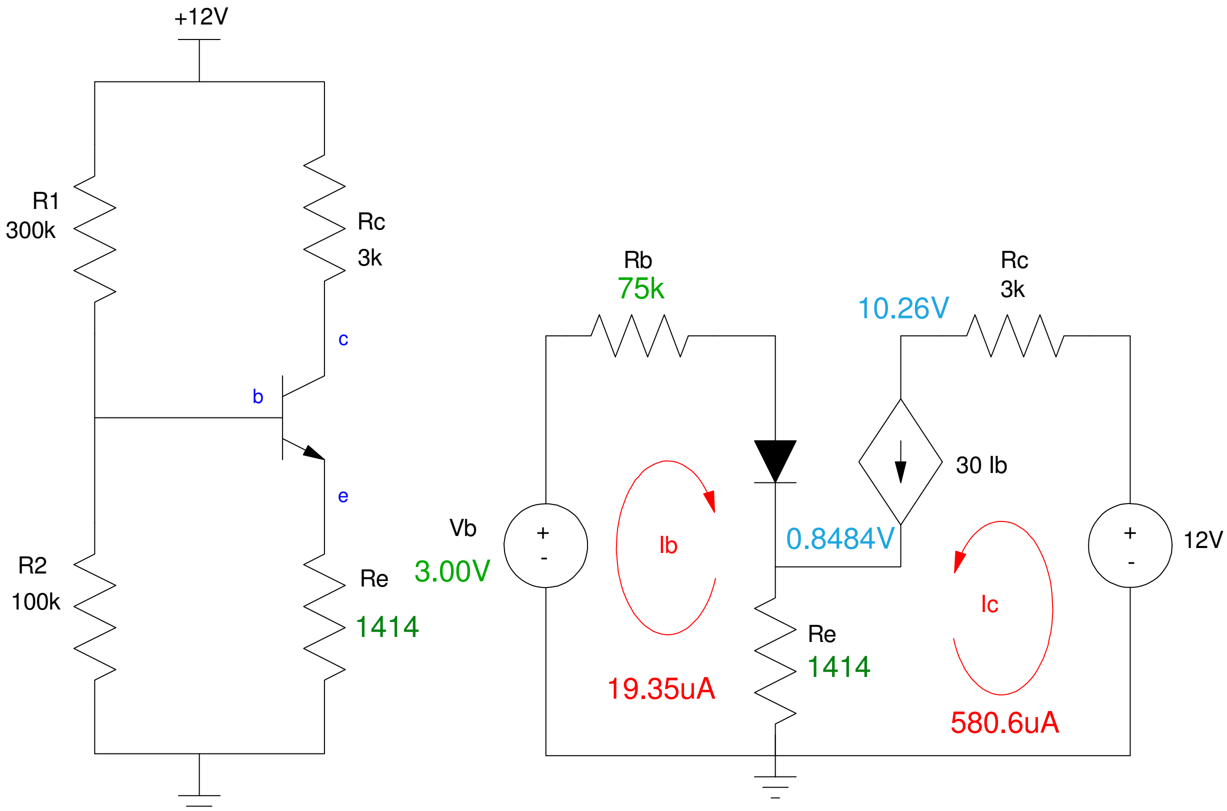
ECE 321 - Quiz #4 - Name ______________________

BJT Amplifiers & 2-Port Models

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
- $\beta = 30$
- Re = 900 + 100*(your birth month) + (your birth day)

Re 900 + 100*mo + day	Vb	Rb	Vce	Ic
1414	**3.00V**	**75k**	**9.41V**	**580.6uA**



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

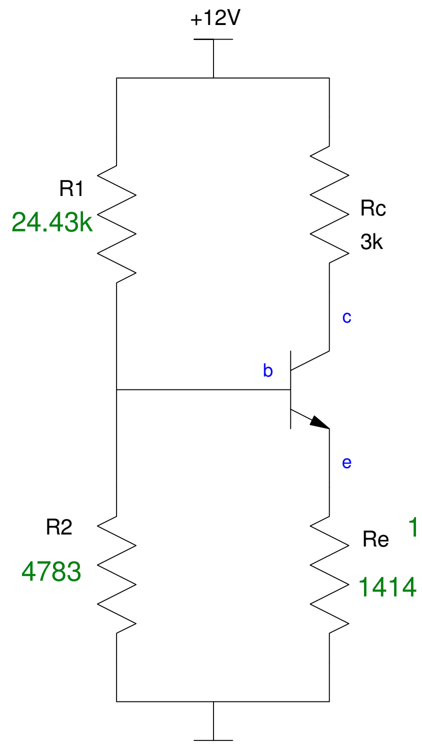
- The Q point is Vce = 6.00V and
- The Q point is stabilized for variations in β

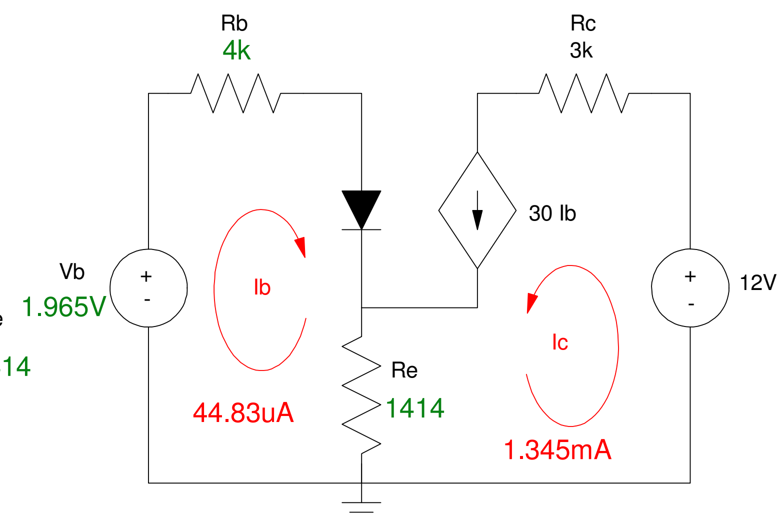
Assume

- Ideal silicon transistors (Vbe = 0.7V, β = 30)
- Re = 900 + 100*(birth month) + (birth day)

Re 900 + 100*mo + day	R1	R2	Vb	Rb
1414	**~~24.43k~~**	**~~4783~~**	**~~1.965V~~**	**4k**

16.875k 5243 2.844V





To stabilize the Q-point

$$(1+\beta)R_e >> R_b$$

$$43.83k\Omega >> R_b$$

Let Rb = 4k

For Vce = 6V

$$I_c = \left(\frac{12V-6V}{3000+1414\left(\frac{31}{30}\right)}\right) = 1.345mA$$

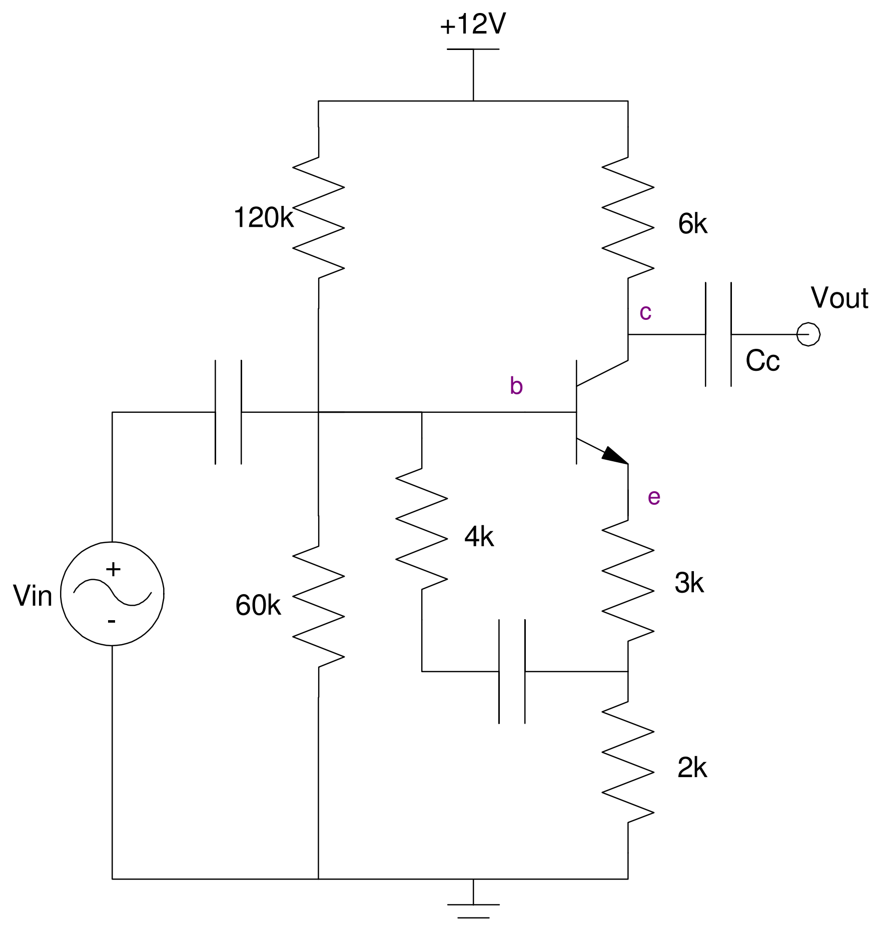
$$I_b = \frac{I_c}{30} = 44.83\mu A$$

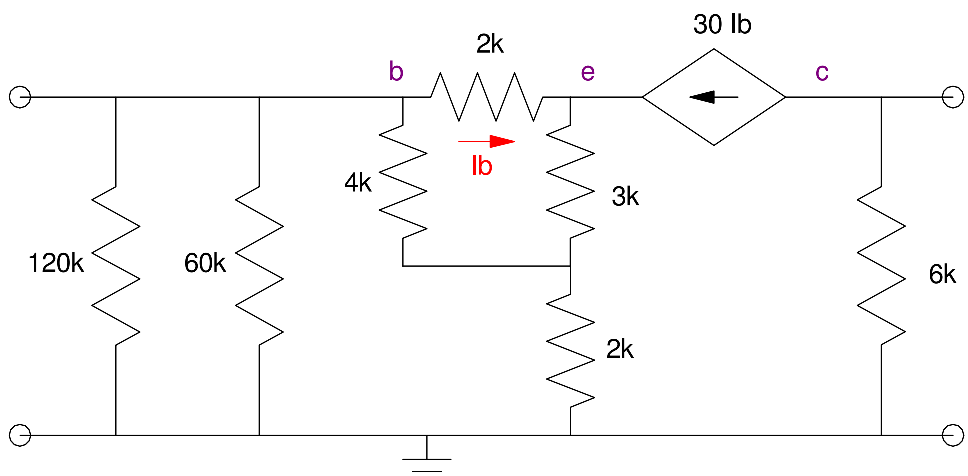
$$V_b = R_b I_b + 0.7 + R_e(I_b + I_c) = \sout{1.965V}\ \ 2.844V$$

$$R_1 = \left(\frac{12V}{1.965V}\right)R_b = \sout{24.43k\Omega}\ \ 16.875k$$

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

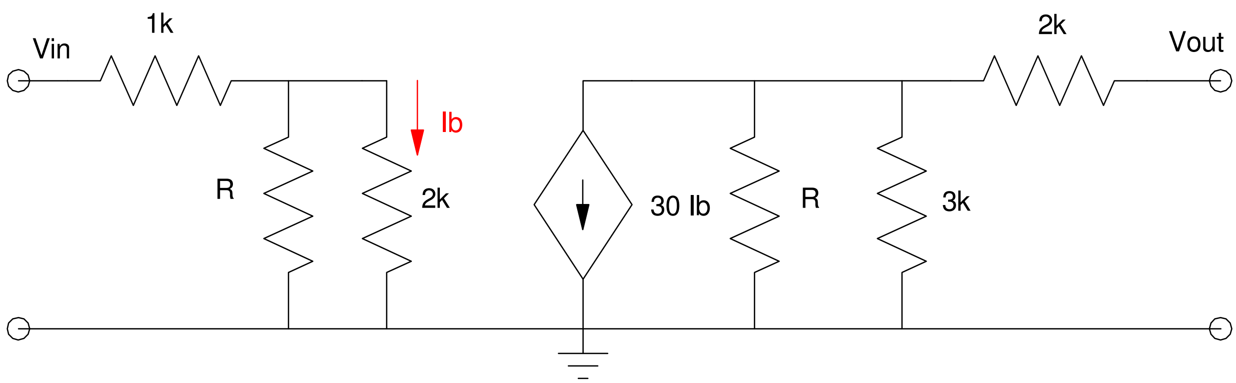
- $r_f = 2000\Omega$
- $\beta = 30$





4) 2-Port Models. Determine the 2-port model for the following circuit:

R 900 + 100*mo + day	Rin	Ain	Rout	Ao
1414	**1828**	**0**	**2961**	**-6.53**



Rin = 1k + 1414 || 2000 = 1828

Ain = 0

Rout = 2k + 3k || 1414 = 2961

Ao: Set Vin = 1V

$$V_b = \left(\frac{828.4}{828.4+1k}\right) 1V = 0.4531V$$

$$I_b = \left(\frac{0.4531V}{2k}\right) = 226.5\mu A$$

$$30I_b = 6.796mA$$

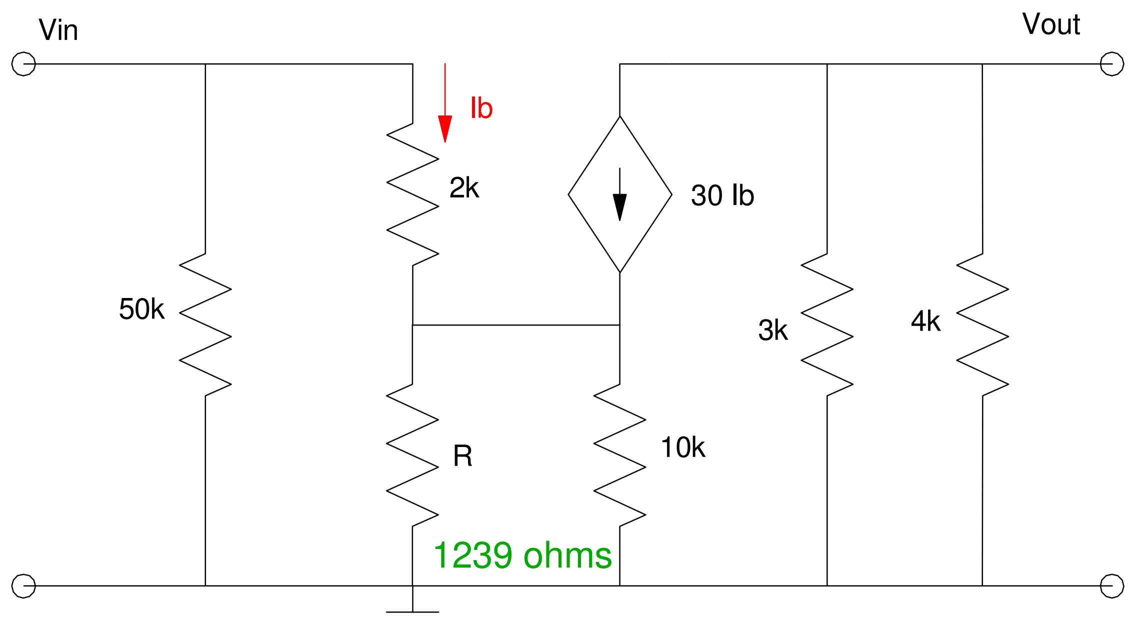
$$V_{out} = -6.796mA \cdot (1414||3000)$$

$$V_{out} = -6.531V$$

$$Ao = -6.531$$

5) 2-Port Models. Determine the 2-port model for the following circuit:

R 900 + 100*mo + day	Rin	Ain	Rout	Ao
1414	**22.35k**	**0**	**1714**	**-1.273**



$$R_{in} = 50k||(2k + 31(1239))$$

$$R_{in} = 22.35k\Omega$$

Ai = 0

Rout = 3k || 4k = 1714 Ohms

Ao: Apply 1V to Vin

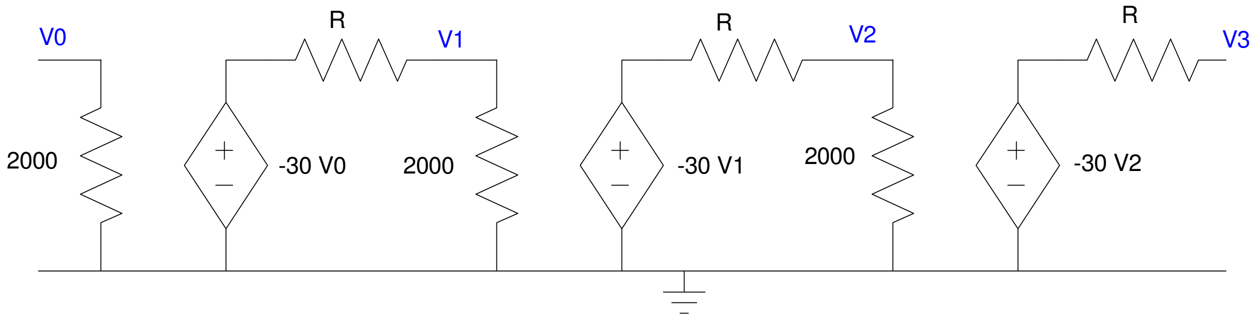
$$I_b = \left(\frac{1V}{2k+31\cdot 1239}\right) = 24.75\mu A$$

$$I_c = 30I_b = 742.6\mu A$$

$$V_{out} = -(3k||4k)742.6\mu A = -1.273$$

6) Determine the 2-port model for three cascaded CE amplifiers

R 900 + 100*mo + day	Rin	Ain	Rout	Ao
1414	**2000**	**0**	**1414**	**-9266**



Aout: Apply 1V to Vin

$$V_0 = 1V$$

$$V_1 = \left(\frac{2000}{2000+1414}\right)(-30)(V_0) = -17.57V$$

$$V_2 = \left(\frac{2000}{2000+1414}\right)(-30)(V_1) = +308.9V$$

$$V_3 = (-30)V_2 = -9266V$$