ECE 321 - Quiz #4 - Name _____

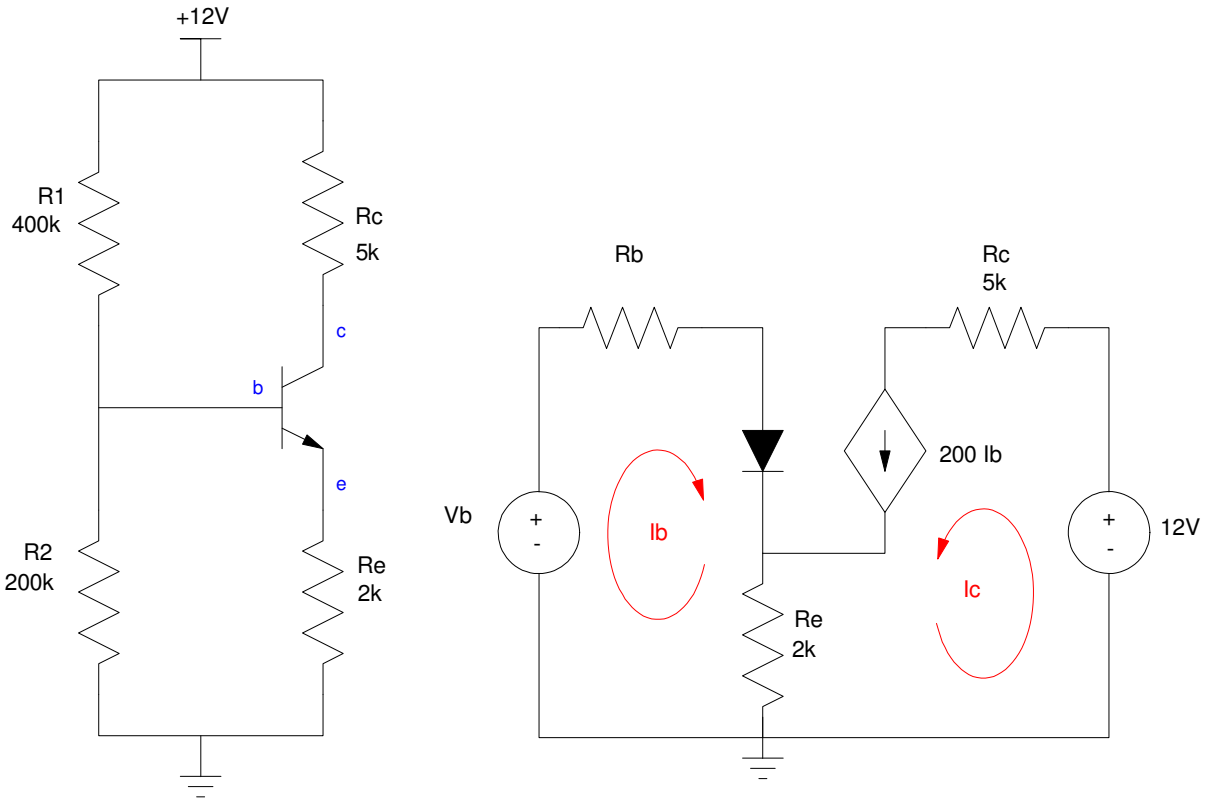
Transistor Amplifiers. Due midnight, May 8th, 2020

Calculators, internet, Matlab, circuit lab, tarot cards permitted. Just not someone else.

1) Determine Vb, Rb, and the Q-point for the following transistor circuit. Assume

- Vbe = 0.7V
- $\beta = 200$

Vb	Rb	Vce	Ic
4.00V	**133.33k**	**3.36V**	**1.23mA**



$$V_b = \left(\frac{200k}{200k+400k}\right)12V = 4.00V$$

$$R_b = 200k||400k = 133.33k$$

$$I_b = \left(\frac{4.00V-0.7V}{133.33k+(1+200)2k}\right) = 6.16\mu A$$

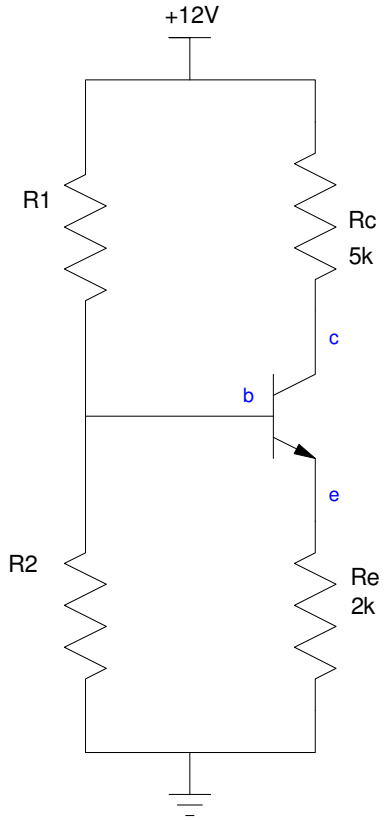
$$I_c = 200I_b = 1.23mA$$

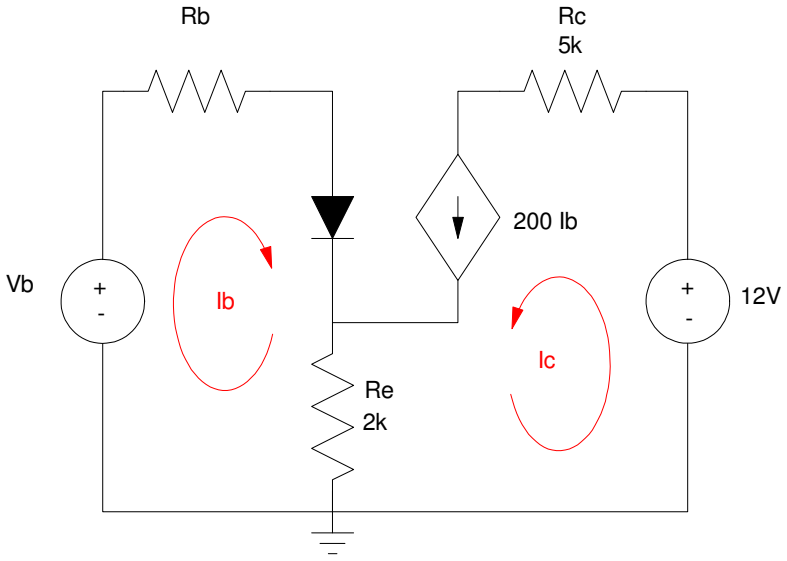
$$V_{ce} = 12 - 5k \cdot I_c - 2k(I_c + I_b) = 3.36V$$

2) Determine R1 and R2 so that the following circuit

- Has a Q-point which is stabilized for variations in β, and
- Vce = 6.0V

R1	R2	Vb	Rb
185.2k	**51.02k**	**2.592V**	**40k**





$$R_b << (1+\beta)R_e = 403k$$

Let Rb = 40k

$$12V = 5k \cdot I_c + V_{ce} + 2k(I_c + I_b)$$

$$I_c = 855.9\mu A$$

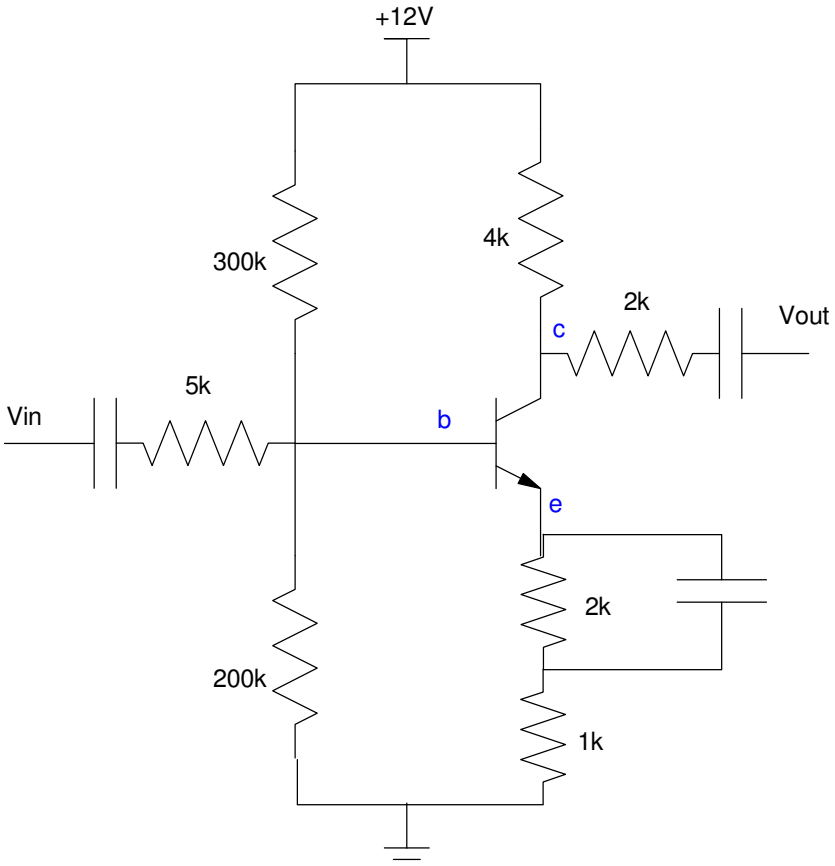
$$I_b = \frac{I_c}{200} = 4.280\mu A$$

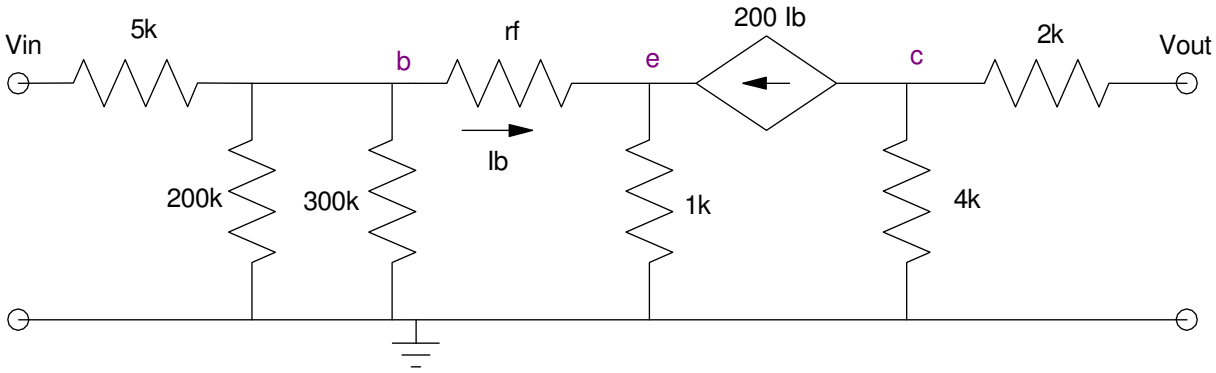
$$V_b = R_b I_b + 0.7 + R_e(I_b + I_c) = 2.592V$$

$$\left(\frac{R_1 R_2}{R_1 + R_2}\right) = 40k$$

$$\left(\frac{R_2}{R_1 + R_2}\right) 12V = 2.5292V$$

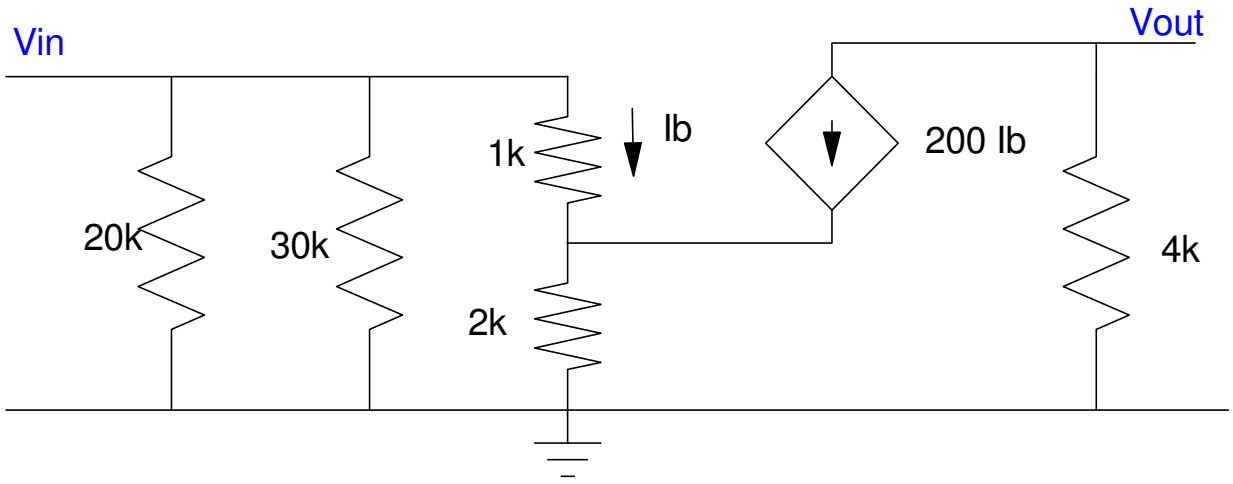
3) Draw the small signal model for the following circuit. Assume rf = 3000 Ohms





4) Find the 2-port model for the following circuit

Rin	Ai	Rout	Ao
11.65k	**0**	**4k**	**-1.985**



Rin: Apply 1V to the input. Compute the current

$$R_{in} = 20k \,||\, 30k \,||\, 1k + (1+200)(2k)$$

$$R_{in} = 11.65k\Omega$$

Rout: Set Vin = 0. That sets Ib=0 and all you see at the output is 4k

Rout = 4k

Aout: Apply 1V at the input. Ib is then

$$I_b = \left(\frac{1V}{1k+(1+200)2k}\right) = 2.481\mu A$$

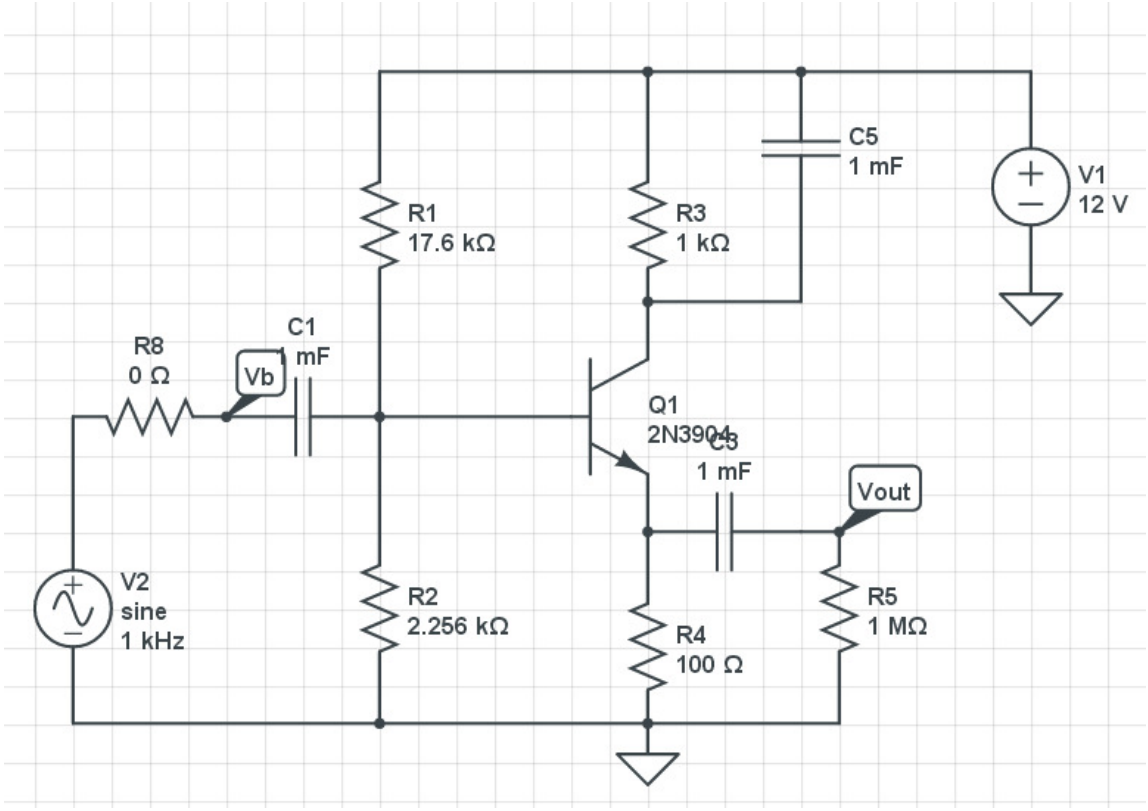
$$I_c = 200 I_b = 496.3\mu A$$

$$V_{out} = -4000 I_c = -1.985$$

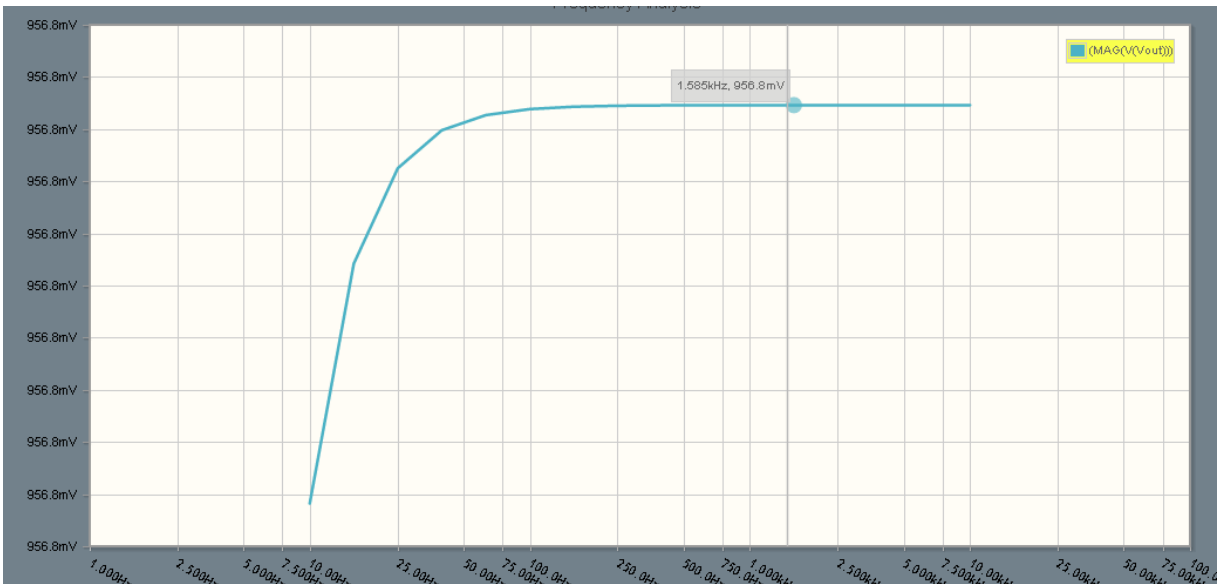
5) Determine the 2-port parameters for the following circuit using CircuitLab

Rin	Ai	Rout	Ao
1768	**0.7460**	**4.32**	**0.958**

Start in CircuitLab:



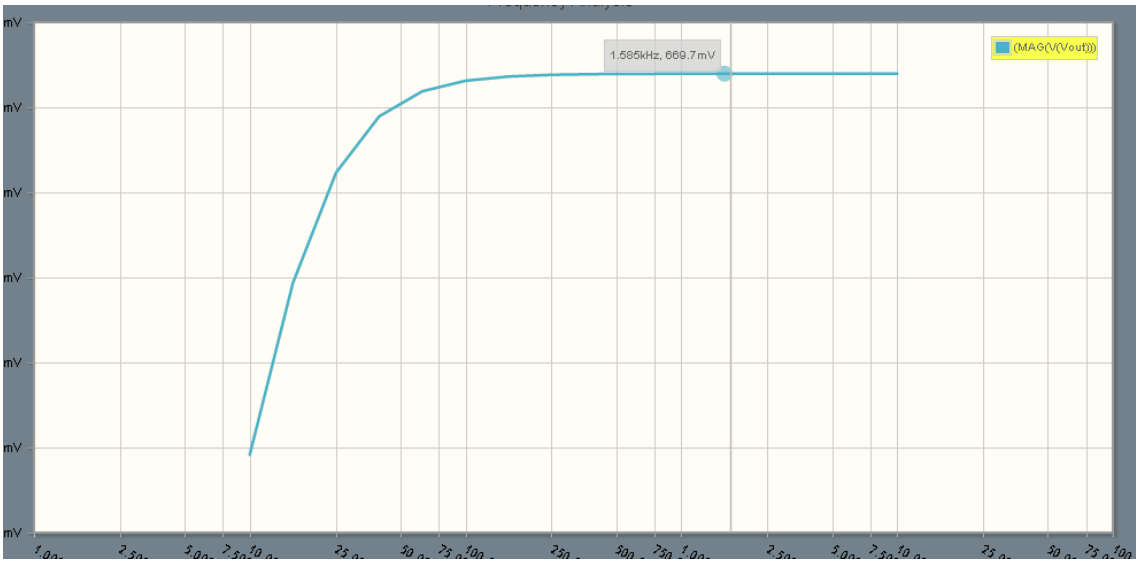
Ao: R8 = 0, R5 = 10M The gain in the plateau is what we want (when C is neglibable): Ao = 0.958



Rout: R8 = 0, R5 = 10. Measure the gain

$$gain = 0.669 = \left(\frac{10}{10+R_{out}}\right)0.958$$

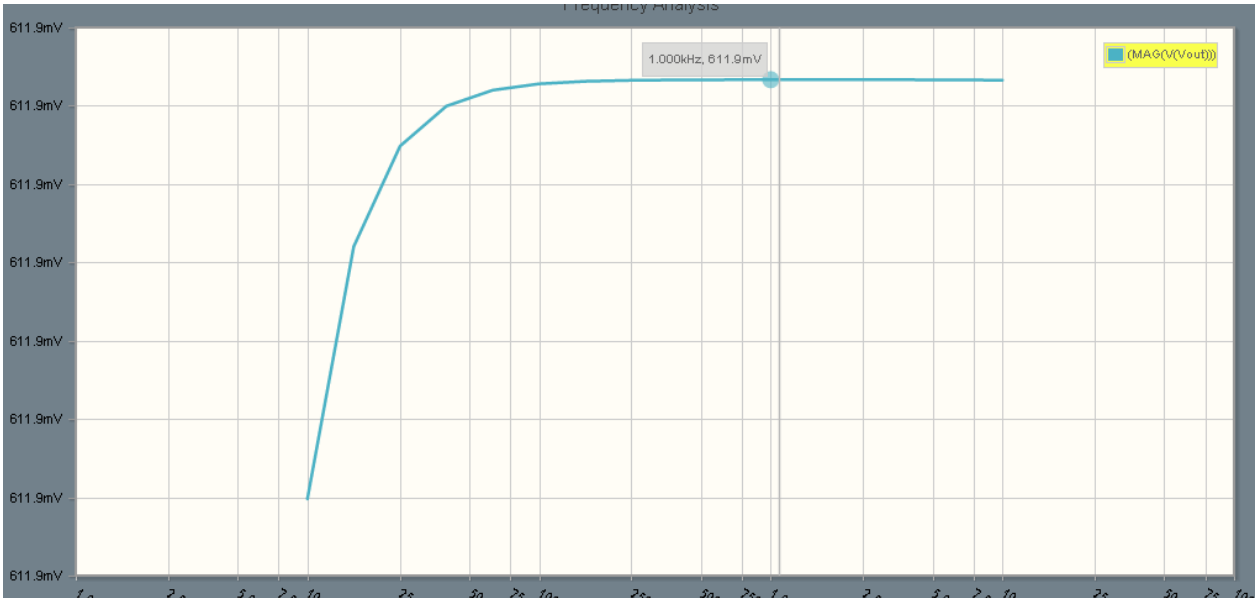
$$R_{out} = \left(\frac{0.958-0.669}{0.669}\right)10 = 4.32\Omega$$



Ri: R8 = 1000, R5 = 10M. Measure the gain

$$gain = 0.612 = \left(\frac{R_{in}}{R_{in}+1000}\right)0.958$$

$$R_{in} = \left(\frac{0.612}{0.958-0.612}\right)1000 = 1768$$



Ai: Apply a source to Vout. Ai = 0.7460