ECE 321 - Homework #4

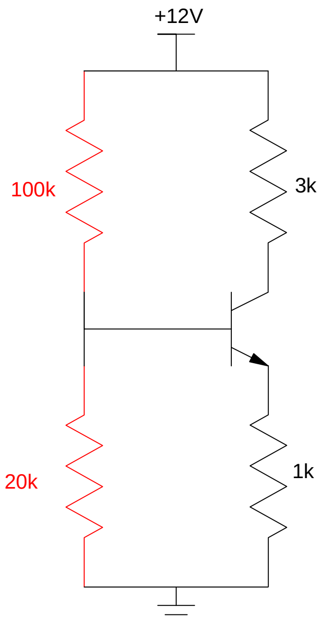
BJT Amplifiers, CE Amplifier. Due Monday, November 30th

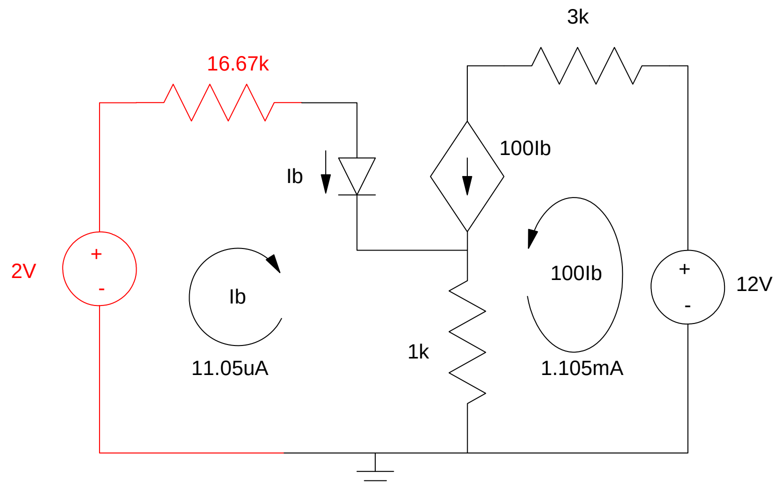
Assume a BJT transistor with a gain of 100

DC Analysis

1) Determine the Q-point for the following circuit.

Redraw the circuit





Write the loop equation around Ib:

$$-2 + 16667I_b + 0.7 + 1000(I_b + \beta I_b) = 0$$

$$I_b = 11.05\mu A$$

then

$$I_c = \beta I_b = 1.105mA$$

and the Q-point is

$$V_c = 12 - 3k \cdot I_c = 8.686V$$

$$V_e = (I_b + I_c)1k = 1.116V$$

$$V_{ce} = V_c - V_e = 7.57V$$

2) Change R1 and R2 so that

- The Q-point is stabilized for variations in β
- The Q point is Vce = 6V

Going backwards, if Vce = 6V

$$(12V - 6V) = 3k \cdot I_c + 1k \cdot (I_b + I_c)$$

$$I_c = \frac{6V}{3k+1.01k} = 1.496mA$$

$$I_b = \frac{I_c}{\beta} = 14.96\mu A$$

To stabilize the Q-point

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

$$101k\Omega >> R_b$$

Let

$$R_b = 10k$$

$$V_{bb} = 0.7V + R_b I_b + R_e(I_b + I_c)$$

$$V_{bb} = 2.361V$$

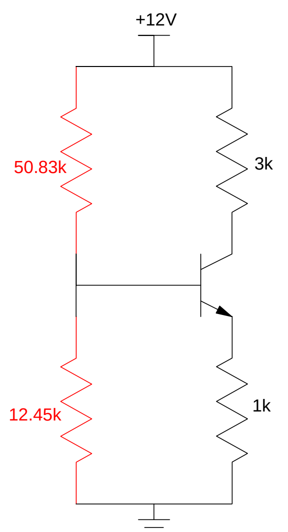
Converting back to R1 and R2

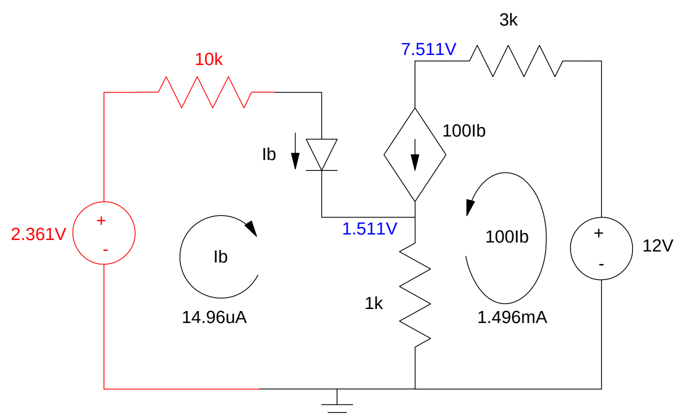
$$R_1 || R_2 = 10k$$

$$\left(\frac{R_2}{R_1+R_2}\right) 12V = 2.361V$$

$$R_1 = \left(\frac{12V}{2.361V}\right) 10k = 50.83k$$

$$R_2 = 12.45k$$



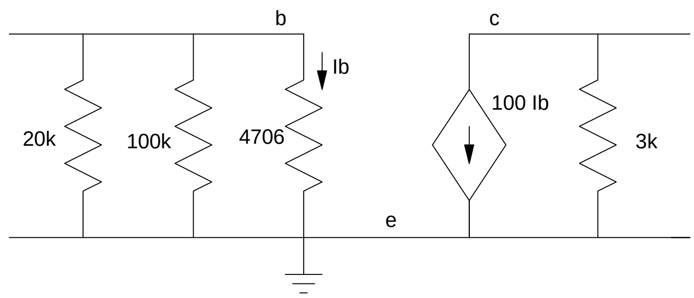


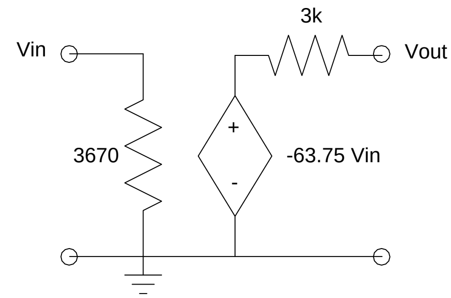
AC Analysis

3) Assume all capacitors are large $\left(\frac{1}{j\omega C} << 1k\right)$. Determine the 2-port model for this circuit

$$r_f = \frac{0.052V}{I_{be}} = \frac{0.052V}{11.05\mu A} = 4706\Omega$$

Redraw the circuit (show on left)





Rin:

Rin = 20k || 100k || 4706

Rin = 3670

Ai = 0 by inspection

Rout:

Set Vin = 0V

100Ib = 0

Rout = 3k

Aout:

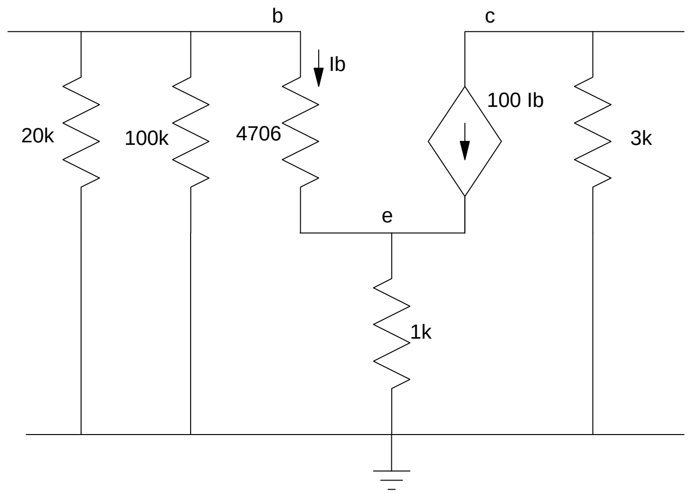
Set Vin = 1V

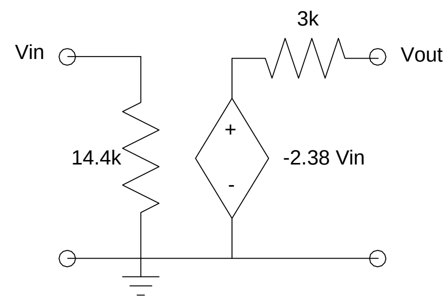
$$I_b = \frac{1V}{4706\Omega} = 212\mu A$$

$$100I_b = 21.25mA$$

$$V_{out} = -3000 \cdot I_c = -63.75V$$

4) Determine the 2-port model for this circuit when Ce is removed





Rin: Short Vout, apply 1V at Vin, determine the current

$$I_{in} = \frac{1}{20k} + \frac{1}{100k} + \frac{1}{4706+101k}$$

$$R_{in} = 20k||100k||(4706 + 101k)$$

$$R_{in} = 14.4k$$

Ai = 0

Rout: Short Vin

Vb = 0

Ve = 0

Ib = 100Ib = 0

Rout = 3k

Ao: Apply 1V at Vin

$$I_b = \frac{1}{4706+101k} = 9.46\mu A$$

$$I_c = 100 I_b = 946\mu A$$

$$V_o = -3000 I_c = -2.38V$$

ECE 321 - Homework #5 & #6

Term project (part 1). Due Monday, December 7th

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Term Project Requirements

- Must have two sections
- Must have analog signals (can take on any value between Vmin and Vmax)
- Must demonstrate knowledge of ECE 321 Electronics II

	HW 5: Section 1 Due Monday, December 7th	HW 6: sSection 2 Dut Monday December 14th
1) Requirements (20pt) Specify the requirements for the first section of your device. • Input Voltage range, current capability, frequency range • Output Voltage range, current capability • Relationship: What this section does (a picture is useful if it's a filter)		
2) Analysis (40pt) Computations for resistor and capacitor values. • Calculate the voltages at a few points (frequencies, temperatures, light levels). This allows you to compare calculations to simulations to lab • Matlab plots if its a filter to show you meet the requirements.		
3) Test / Simulation Results (20pt) • Simulate your circuit in PartSim or similar program • Check the gain at a few frequencies to compare to your calculations		
4) Validation (20pt) Lab Results Build your circuit in lab • Take measurements at a few frequencies • Compare your lab data to simulation data to computations. • Does the circuit behave as expected?		
Total (100pt)		