ECE 321 - Homework #6

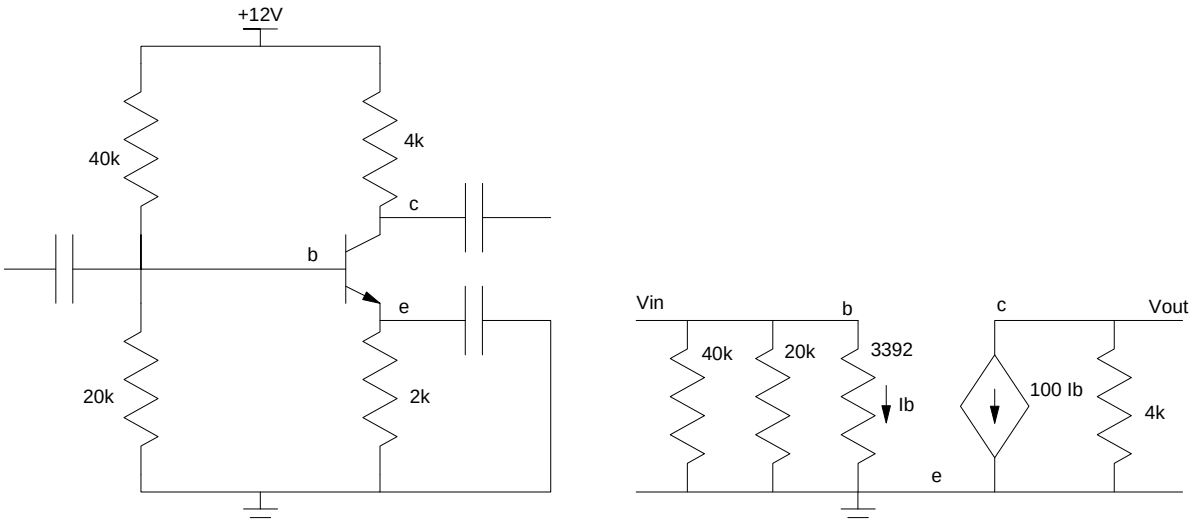
CE / CC / CB Amplifiers. Due Monday, December 5th

1a) Draw the small signal model for the transistor circuit below connected in commom emitter (CE) configuration.

note: From homework #5, the Q-point is

Ib = 15.33uA

$$r_f = \frac{nV_T}{I_b} = 3392\Omega$$



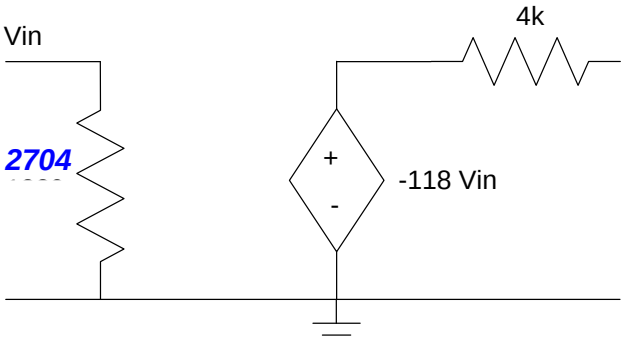
1b) Determine the 2-port model for this circuit in CE configuration.

$$R_{in} = 40k||20k||3392 = 2704\Omega$$

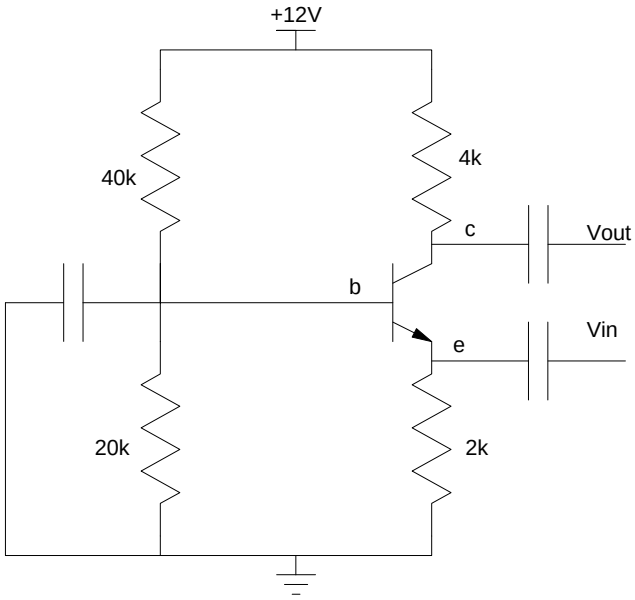
$$A_i = 0$$

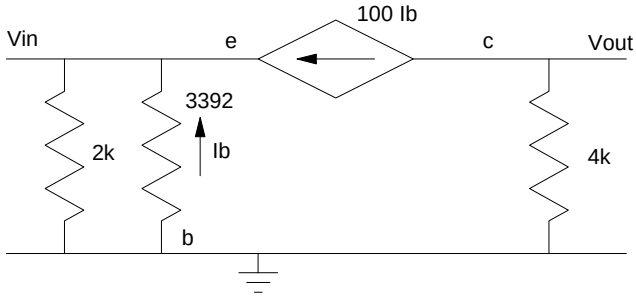
$$R_{out} = 4k\Omega$$

$$A_o = -\frac{100 \cdot 4k}{3392} = -118$$



2a) Draw the small signal model for the transistor circuit below connected in commom base (CB) configuration.





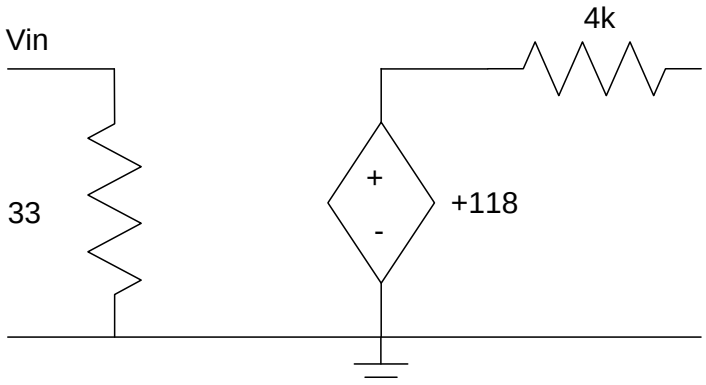
2b) Determine the 2-port model for this circuit in CB configuration.

$$R_{in} = 2k||3392||\frac{3392}{100} = 33\Omega$$

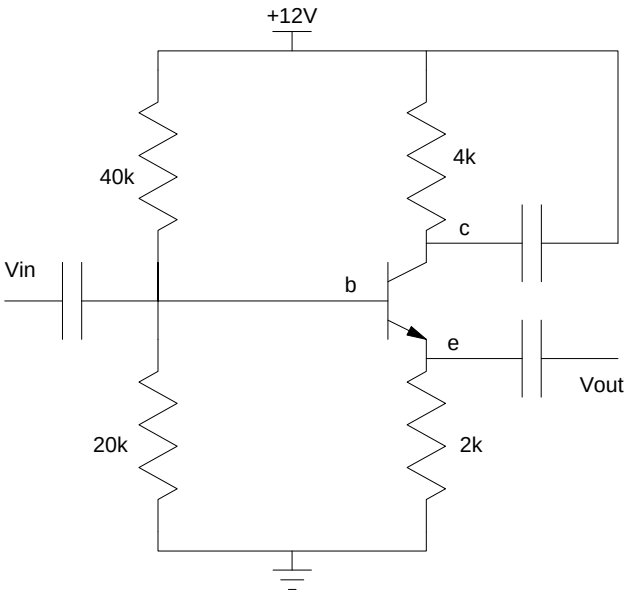
$$A_i = 0$$

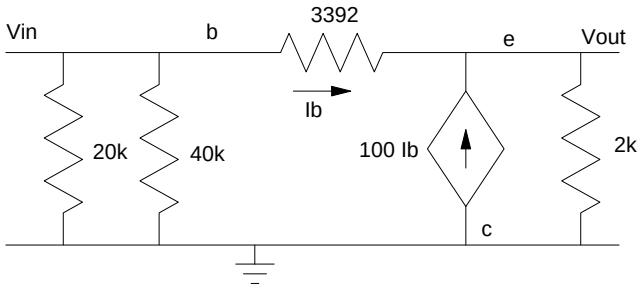
$$R_{out} = 4k$$

$$A_o = +\frac{100 \cdot 4k}{3392} = +118$$



3a) Draw the small signal model for the transistor circuit below connected in commom collector (CC) configuration.





3b) Determine the 2-port model for this circuit in CC configuration.

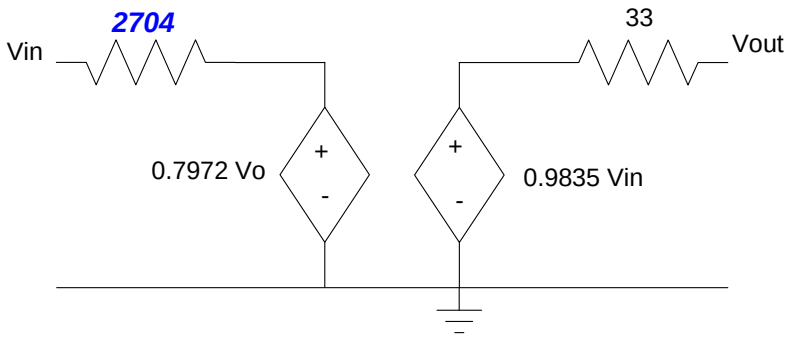
$$R_{in} = 20k||40k||3392 = 2704\Omega$$

$$A_i = \left(\frac{20k||40k}{20k||40k+3392}\right) = 0.7972$$

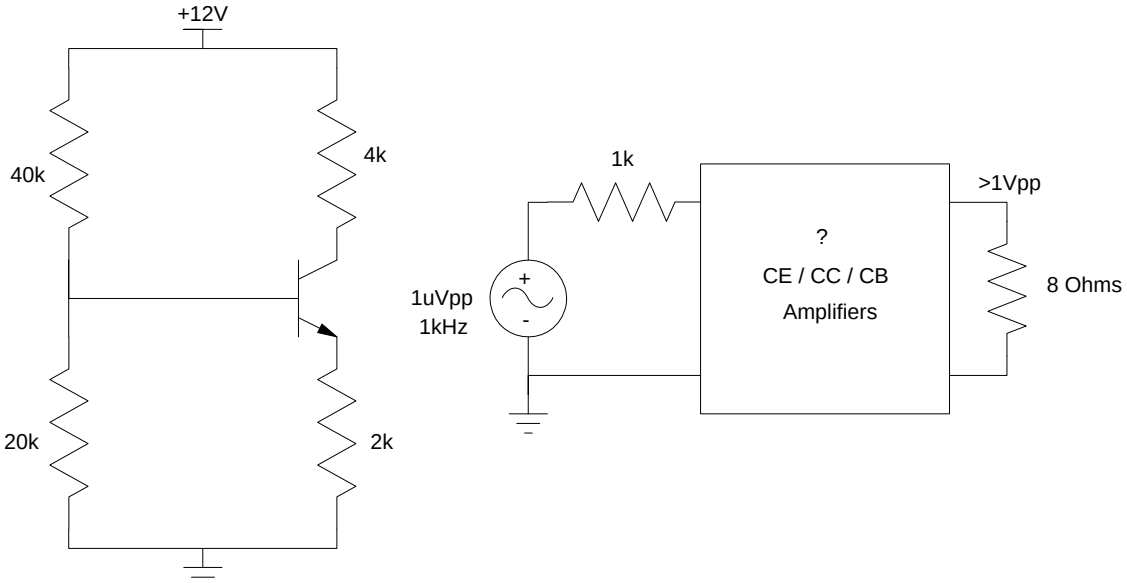
$$R_{out} = 2k||3392||\frac{3392}{100} = 33\Omega$$

$$A_o: \quad \left(\frac{X-1}{3392}\right) + 100\left(\frac{X-1}{3392}\right) + \left(\frac{X}{2k}\right) = 0$$

$$A_o = X = \left(\frac{\frac{101}{3392}}{\frac{101}{3392}+\frac{1}{2000}}\right) = 0.9835$$



4) Design a multi-stage amplifier using CE / CC / CB amplifiers to amplify a 1uVpp signal to >1Vpp at 8 Ohms.

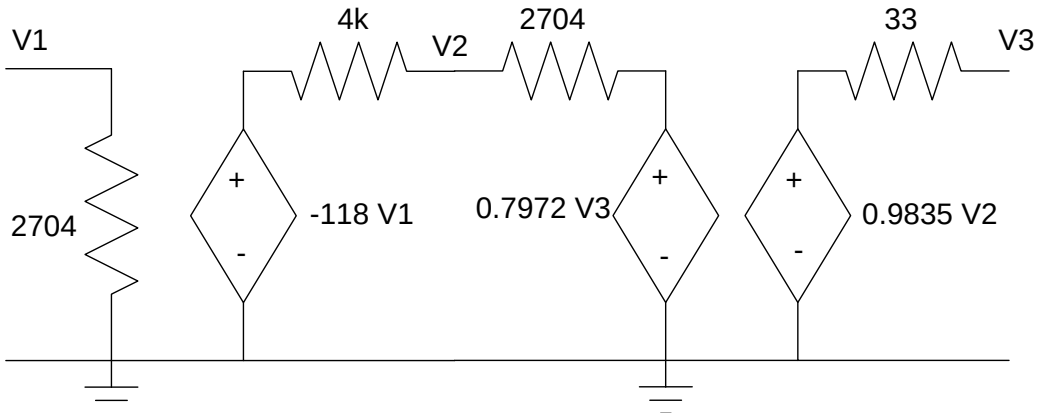


Problem 1-4: BJT Circuit for CE / CC / CB Amplifiers. Beta = 100

Stage 1: CE amplfier (high input R)

Stage n: CC Amplifier (low output R)

Combine into a CE:CC amplifier. The 2-port model is:



This simplifies to

$$R_{in} = 2704$$

$$A_i = 0$$

$$A_o: \quad V_2 = \left(\frac{2704}{2704+4k}\right)(-118) + \left(\frac{4k}{4k+2704}\right)(0.7972)(0.9835V_2)$$

$$V_2 = -89.43$$

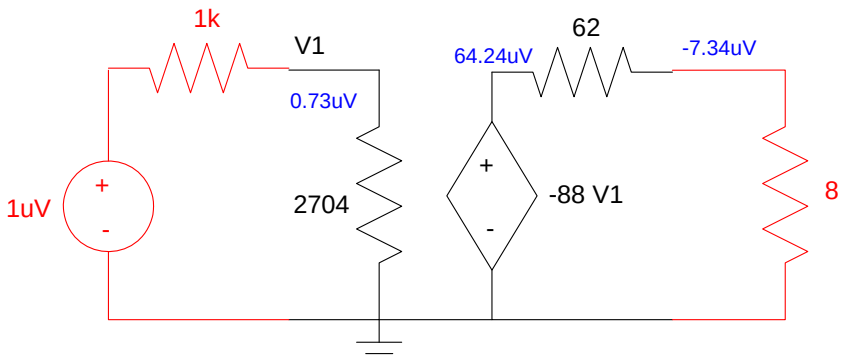
$$A_o = 0.9835V_2 = -87.95$$

$$R_{out}:\ V_2 = \left(\frac{4k}{4k+2704}\right)(0.7972V) = 0.4757V$$

$$I = \left(\frac{1-0.9835V_2}{33}\right)$$

$$R_{out} = \left(\frac{33}{1-0.9835V_2}\right) = 62\Omega$$

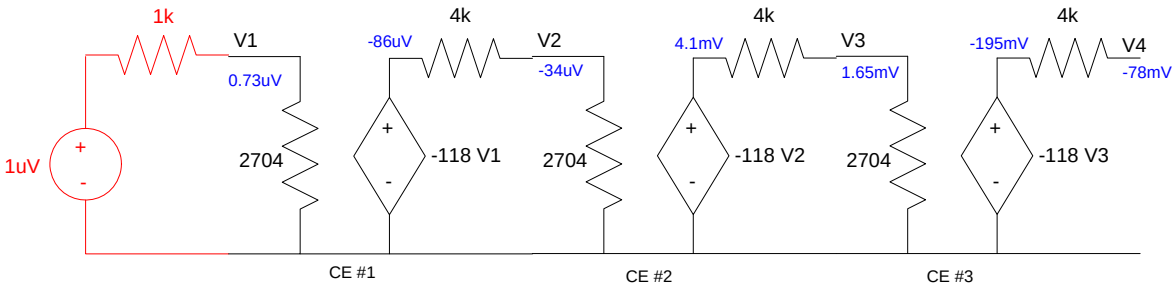
Adding the input and output

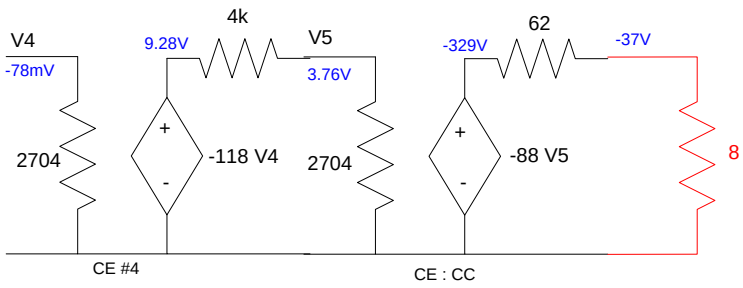


One CE amplifier isn't enough. If you add more, each stage increases the gain by

$$-118\left(\frac{2704}{2704+4k}\right) = -47.59$$

To get the output up to 1V, you need to multiply the previous answer by -47.59 four times, resulting in an output of 37.66V





Term Project: Select one part of your term progect. For this part, give

5) Requirements: Specify the inputs, outputs, and how they relate.
6) Analysis. Calculations for a circuit that meets your requirements.
7) Test: Simulate your circuit to check your analysis.
8) Validation: Build your circuit in lab and collect data to validate it meets your requirements.