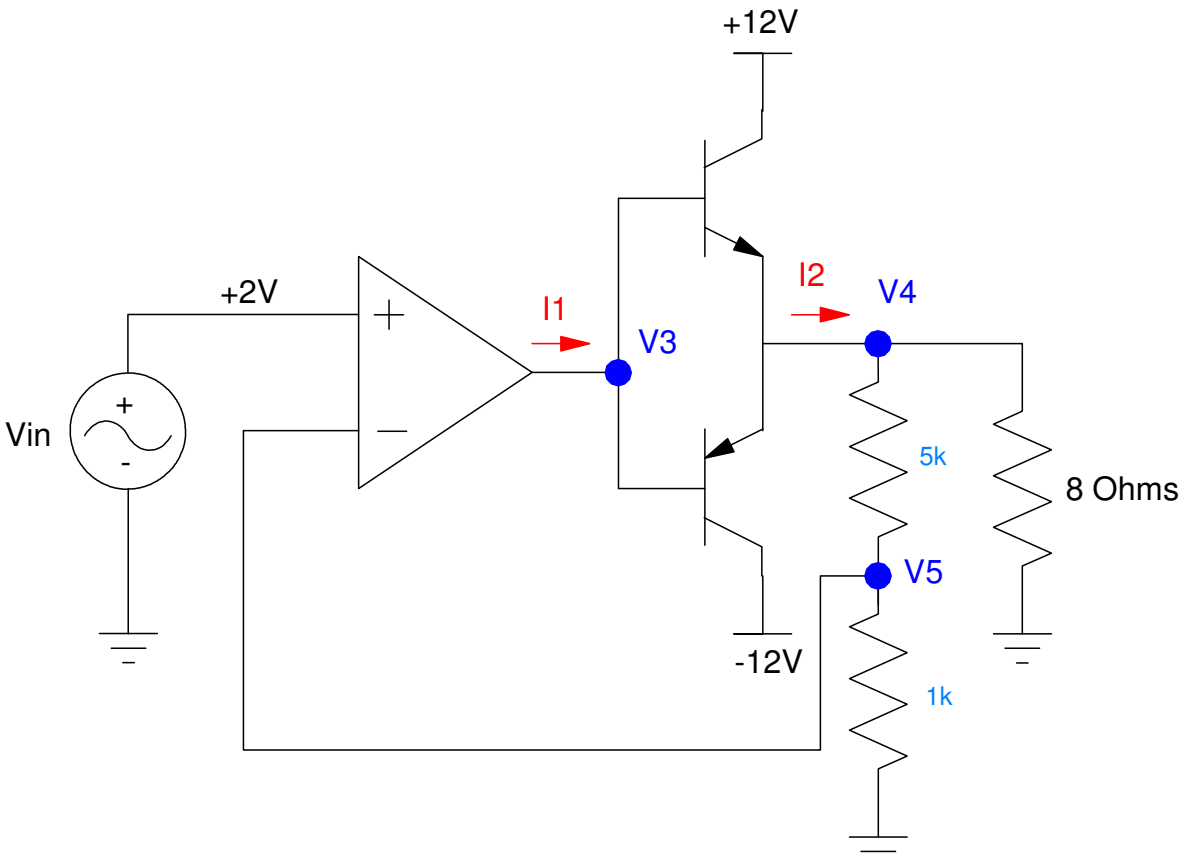
ECE 321 Final - Name _____

Closed-Book, Closed Notes, Calculators Permitted. - Spring 2019

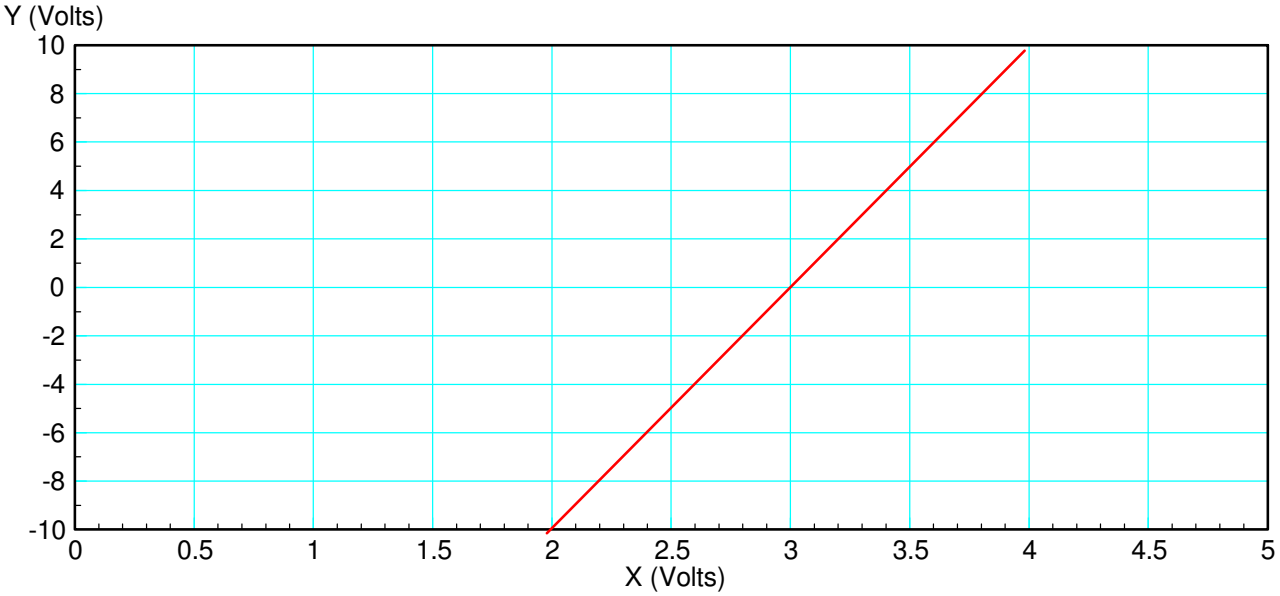
1) Push Pull AmplifiersDetermine the voltages and currents for the following push-pull amplifier. Assume TIP transistors:

- $\beta = 1000$
- $|V_{be}| = 1.4V$
- $\min(|V_{ce}|) = 0.9V$

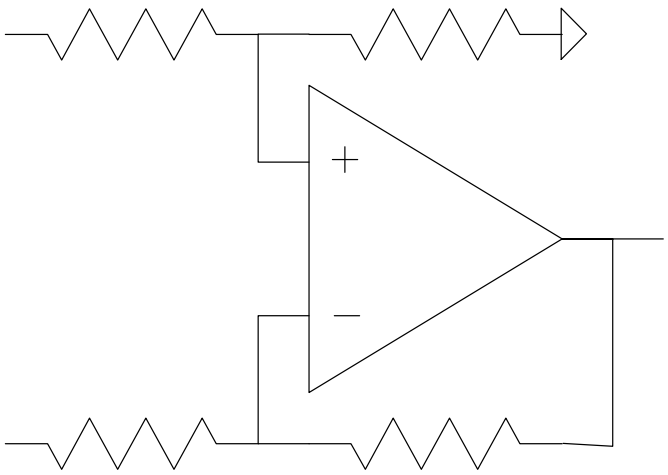
I1	I2	V3	V4	V5



2a) Determine the relationship between X and Y from the following graph.

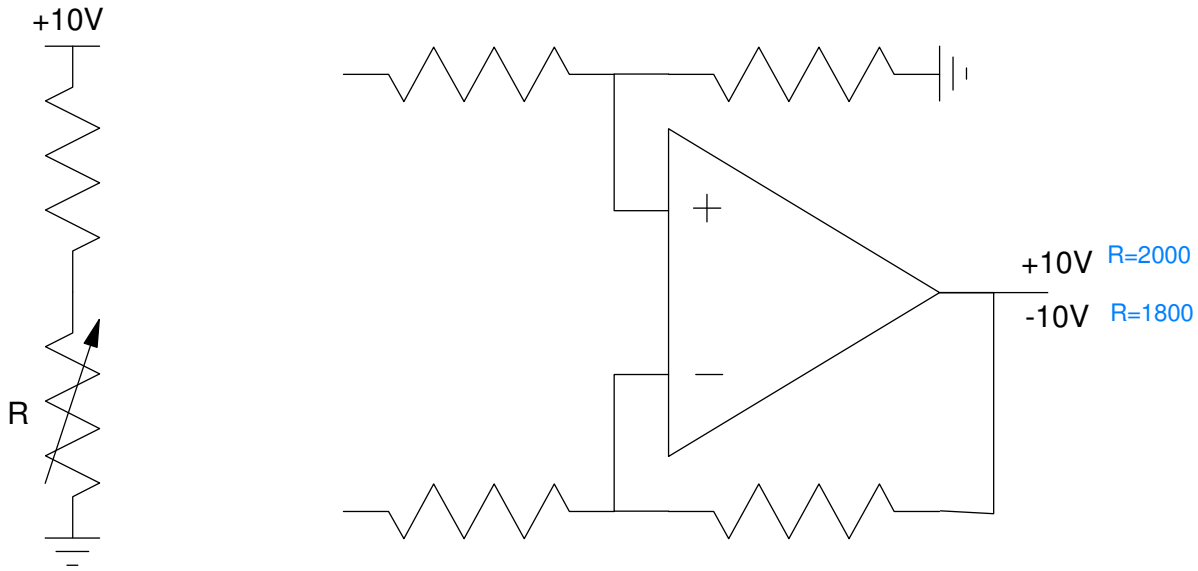


2b) Design an op-amp circuit to match the following relationship between X and Y:



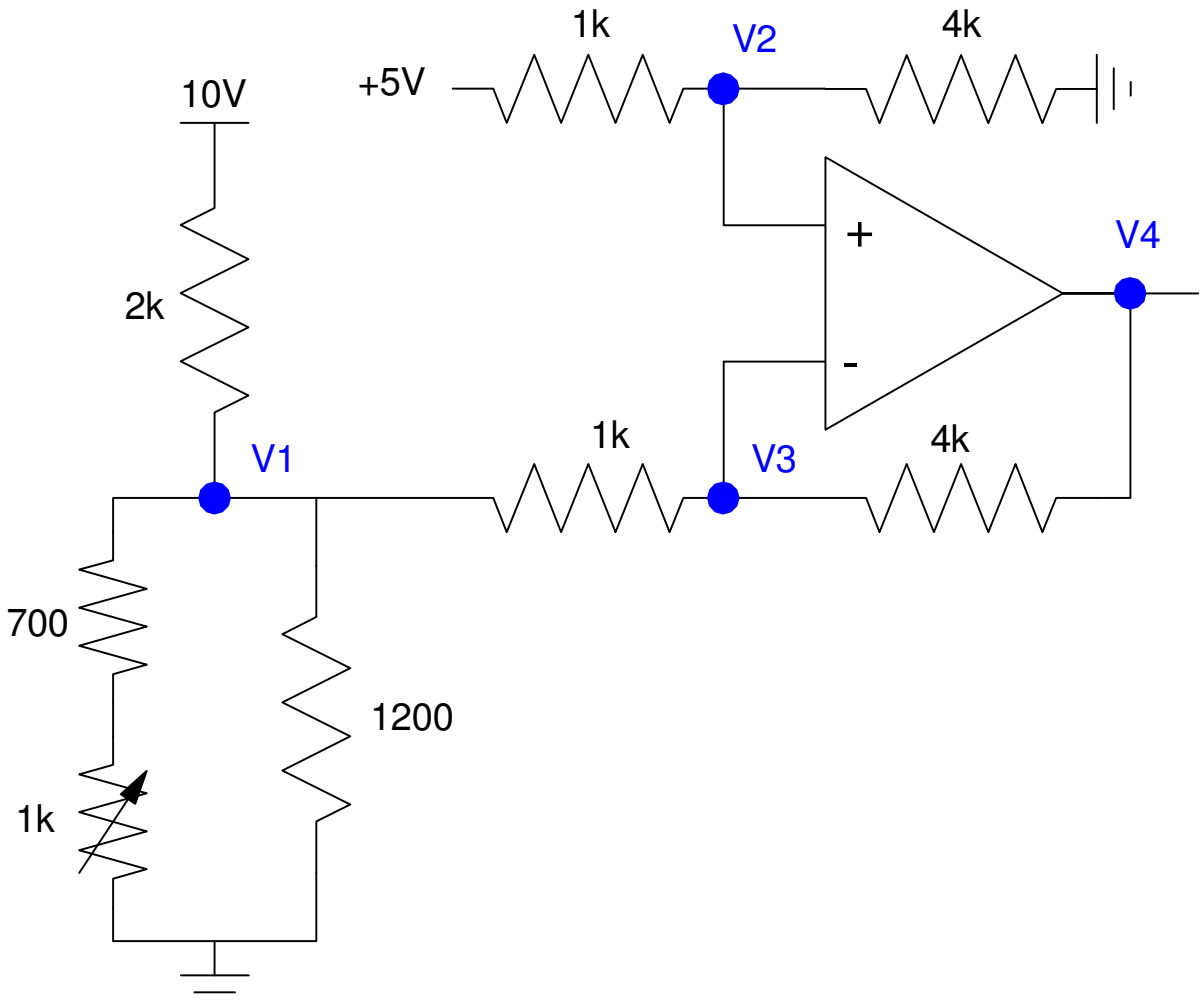
3) Design a circuit which outputs

- -10V when R = 1800 Ohms
- +10V when R = 2000 Ohms



4) The following circuit uses a linearizing circuit with an instrumentation amplifier. Determine the voltages at V1..V4

V1	V2	V3	V4



5) X and Y are related by the following filter

$$Y = \left(\frac{2s+7}{s^2+2s+17}\right)X = \left(\frac{2s+7}{(s+1+j4)(s+1-j4)}\right)X$$

a) What is the differential equation relating X and Y?

b) Find y(t) assuming

$$x(t) = 5 + 6\sin(10t)$$

6) The transfer function for a 4th-order Butterworth low-pass filter with a corner at 100 rad/sec is

$$Y = \left(\frac{100^4}{\left(s+100\angle 22.5^0\right)\left(s+100\angle -22.5^0\right)\left(s+100\angle 67.5^0\right)\left(s+100\angle 67.5^0\right)} \right) X$$

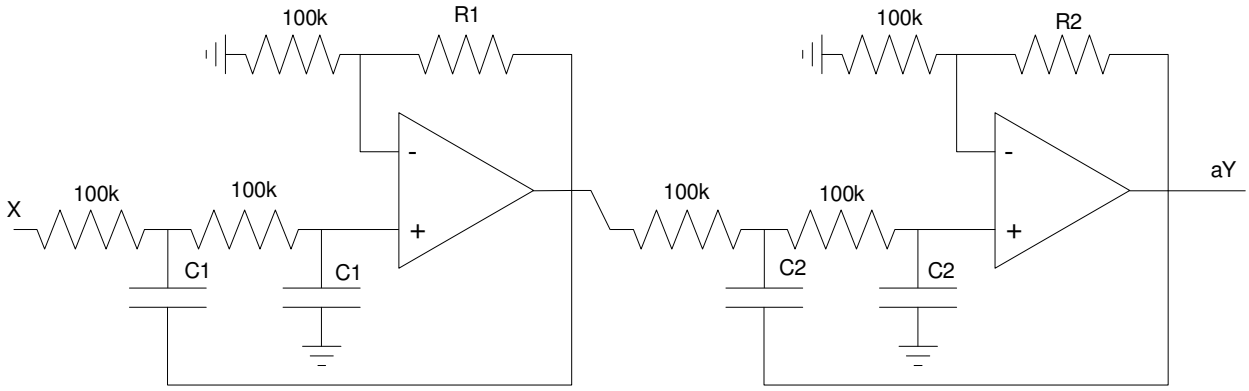
Find R and C to implement this filter

C1	R1	C2	R2

Note: The transfer function for the first stage is

$$\left(\frac{k\left(\frac{1}{RC}\right)^2}{s^2+\left(\frac{3-k}{RC}\right)s+\left(\frac{1}{RC}\right)^2} \right) \qquad k = 1 + \frac{R_1}{100{,}000}$$

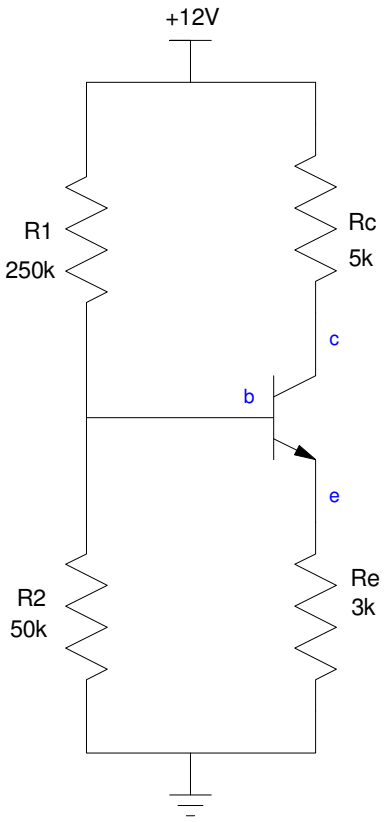
$$3 - k = 2\cos\theta$$

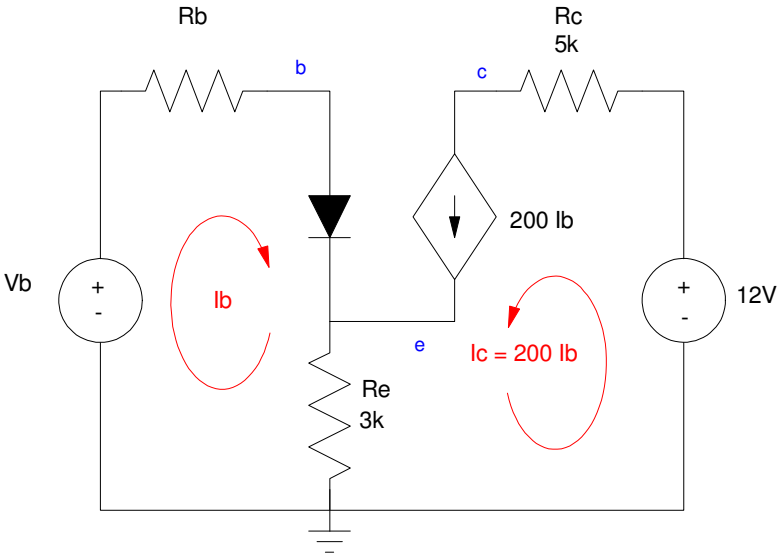


7) Q-Point Analysis. Determine the Thevenin equivalent for R1 and R2 (Vb and Rb) and determine the Q-point for the following transistor circuit. Assume ideal silicon transistors:

- $V_{be} = 0.7V$
- $\beta = 200$

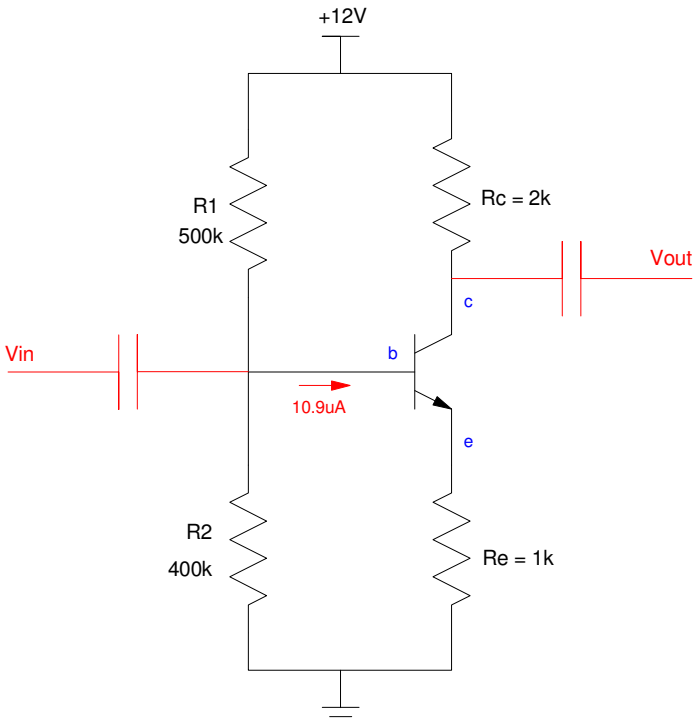
Vb	Rb	Vce	Ic





8) Draw the small signal model for the following common emitter amplifier (with Ce removed) and determine the corresponding 2-port model

Small Signal Model	Rin	Ao	Rout
draw the AC model. Assume Zc = 0			



Bonus! Four for the following are Democratic canidates running for President in 2020, four are Godzilla monsters. Circle the ones who are Democrats

Baragon - Buttigieg - Ebirah - Gabbard - Kamacuras - Messam - Orga - Swalwell