# ECE 321 - Final. Name _____

2-Port Models, Common Emitter Amplifiers. April 26, 2018

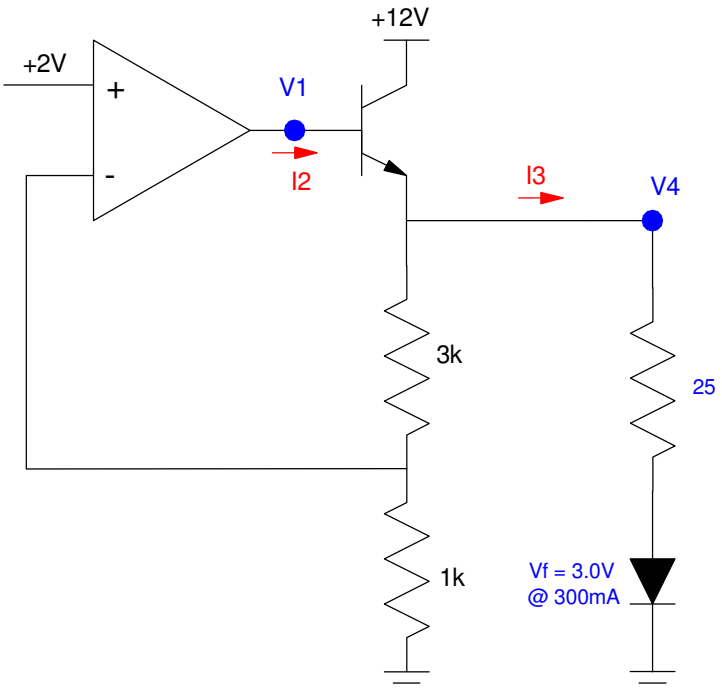
1) Determine the voltages and currents for the following push (pull) amplifier. Assume for the transistor

- $\beta = 1000$
- $V_{be} = 1.4V$

Assume for the LED

- Vf = 3.0V @ 300mA:

| V1 | I2 | I3 | V4 |
|---|---|---|---|
| | | | |



2) Determine the voltages and currents for the following push (pull) amplifier. Assume for the transistor

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Assume for the LED

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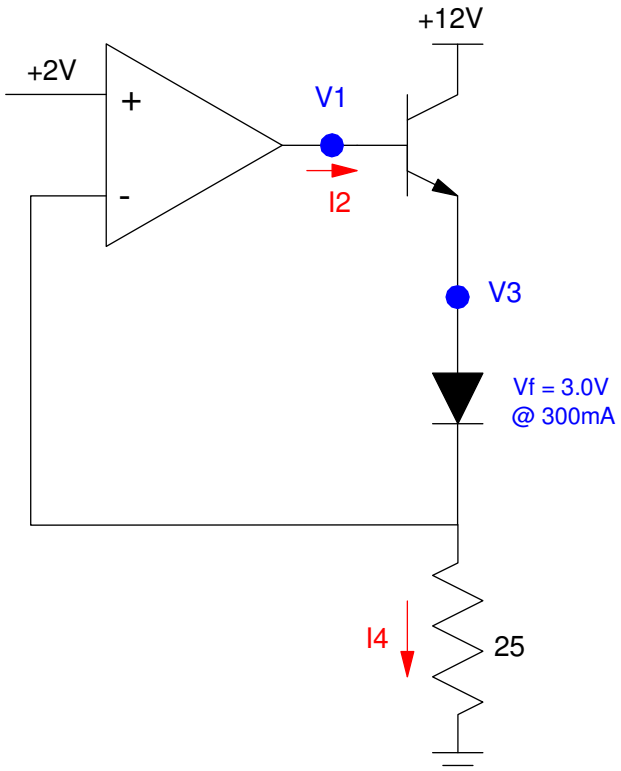
|---|---|---|---|
| | | | |

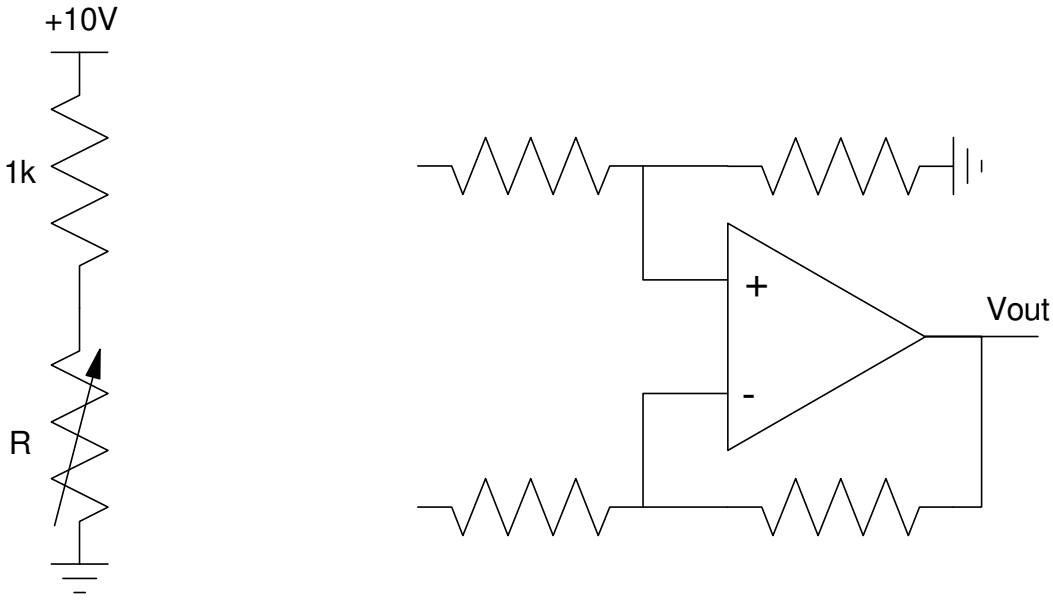


3) Design an instrumentation amplifier so that the output is

- -10V when R = 1000 Ohms
- +10V when R = 1200 Ohms

For your circuit, what is the output voltage (Vout) when R = 1100 Ohms?

| Vout when R = 1100: |
|---|



4) Give the transfer function for a low-pass filter which comes close to meeting the following requirements (fine tuning in Matlab might be required)

- $0.9 < \text{Gain} < 1.1$ frequencies less than 200 rad/sec
- $\text{Gain} < 0.1$ frequencies above 300 rad/sec

You are free to choose any type of filter you like (Chebychev, Butterworth, Elliptic, etc.)

5) A 3rd-order Butterworth low-pass filter has the following transfer function:

$$Y = \left(\frac{250}{(s+5)(s^2+5s+25)}\right)X = \left(\frac{250}{s^3+10s^2+50s+125}\right)X$$

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

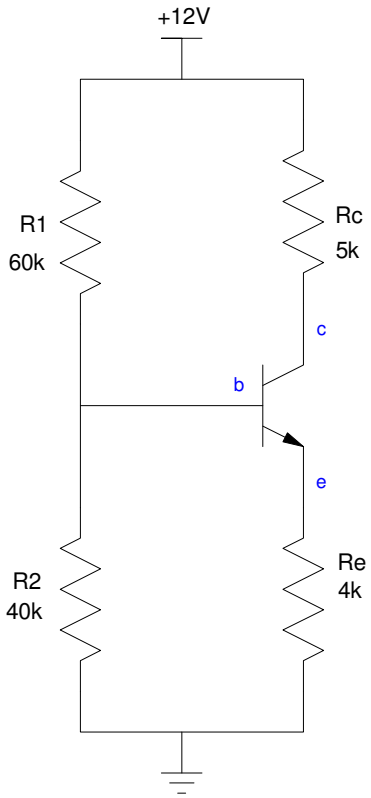
b) Determine y(t) assuming

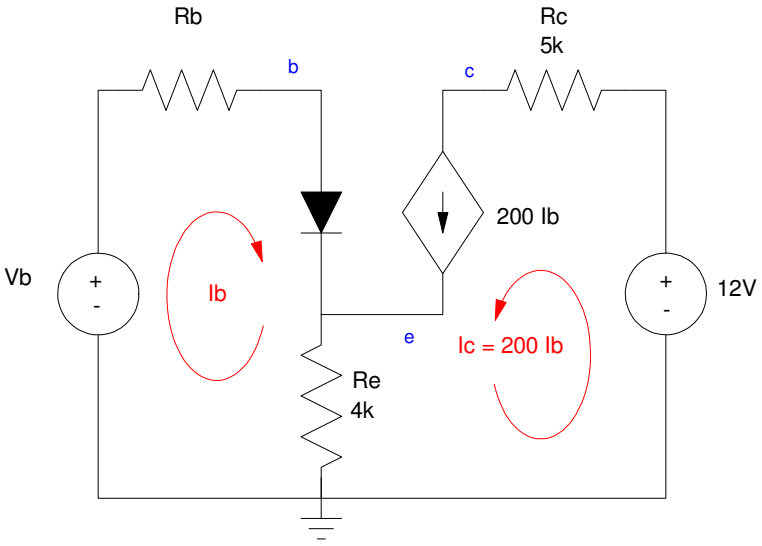
$$x(t) = 3\sin(4t) + 5\cos(10t)$$

6) Find the Thevenin equivalent of R1, R2 (Vb, Rb), and the Q-point (Ic, Vce) for the following transistor circuit. Assume a 3904 transistor:

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

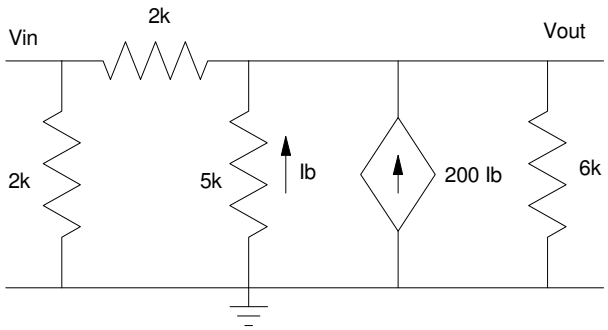
| Vb | Rb | Ic | Vce |
|---|---|---|---|
| | | | |

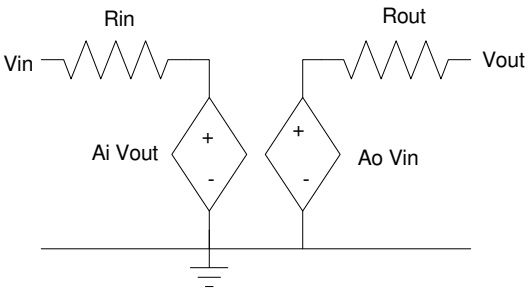


7) Find the 2-port model for the following circuit:

| Rin | Ai | Ao | Rout |
|---|---|---|---|
| | | | |

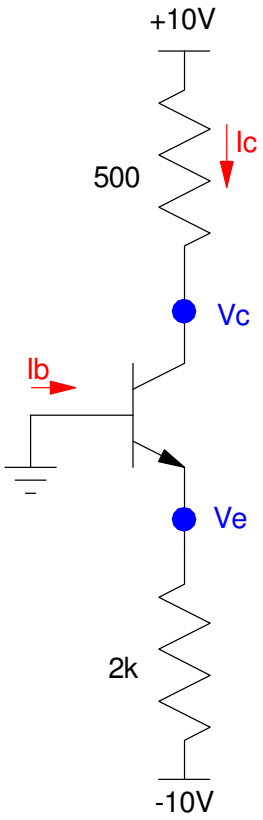


8) Determine the operating point for the following transistor circuit. Assume

- $\beta = 200$
- $V_{be} = 0.7V$
- $V_{ce:sat} = 0.2V$

| Ib | Ic | Ve | Vc |
|---|---|---|---|
| | | | |




**Bernie vs. Godzilla Bonus!!** Three of the following are U.S. Senators. Three are Godzilla monsters. Which are the Senators?

Barrasso Ebirah Kiryu Minya Stabenow Wicker