ECE 321 - Quiz #3 - Name _____

2-Port Models, DC Analysis of Transistor Circuits. November 30, 2017

1) The transfer function for a 6th-order Butterworth filter with a corner at 1 rad/sec is

$$G(s) = \left(\frac{1}{(s+1\angle\pm 15^0)(s+1\angle\pm 45^0)(s+1\angle\pm 75^0)} \right)$$

What is the transfer function for a 6th-order Butterworth low-pass filter with

- A corner at 100 Hz and
- A DC gain of 1.00

G(s) = $\dfrac{(200\pi)^6}{(s+200\pi\angle\pm 15^\circ)(s+200\pi\angle\pm 45^\circ)(s+200\pi\angle\pm 75^\circ)}$

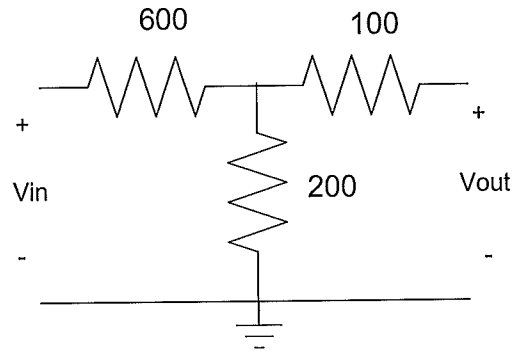
100Hz = 200π rad/sec

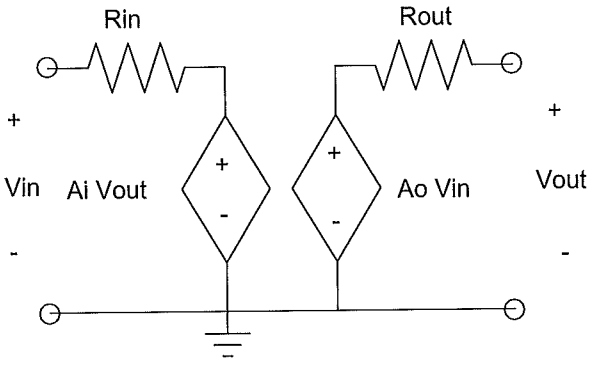
or -

$$\frac{1}{\left(\frac{s}{200\pi}+1\angle\pm 15^\circ\right)\left(\frac{s}{200\pi}+1\angle\pm 45^\circ\right)\left(\frac{s}{200\pi}+1\angle\pm 75^\circ\right)}$$

2) Determine the 2-port model for the following circuit

Rin	Ai	Ao	Rout
667	2/3	1/4	250





R_{in}: $600 + 100 \| 200 = 667$

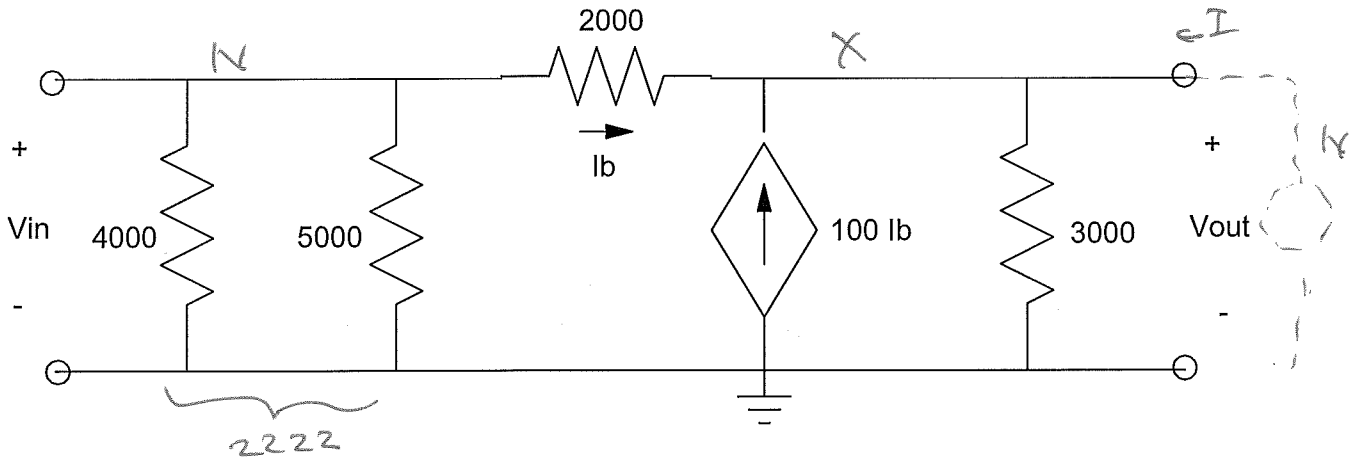
A_i: $\left(\frac{200}{200+100}\right) = 2/3$

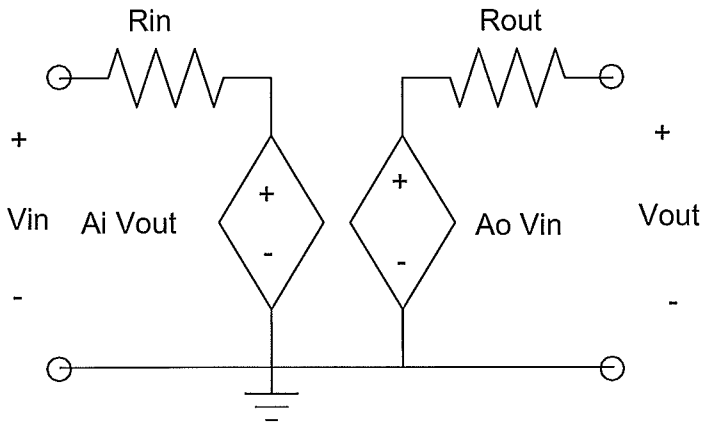
A_o: $\left(\frac{200}{200+600}\right) = 1/4$

$R_{out} = 100 + 600 \| 200 = 250$

3) Determine the 2-port model for the following circuit

Rin	Ai	Ao	Rout
1052	.53	.75	19.67





Rin: $4k \| 5k \| 2k = 1052$

Ai: $\left(\frac{2222}{2000+2222}\right) = .53$

Ao: $\frac{X-1}{2k} + 100\frac{X-1}{2k} + \frac{X}{3k} = 0$

$X = \frac{1/2k + 1/2k}{1/2k + 1/2k + 1/3k} = .75$

Rout: $I = \frac{1}{3k} + \frac{1}{2k} + \frac{100}{2k}$

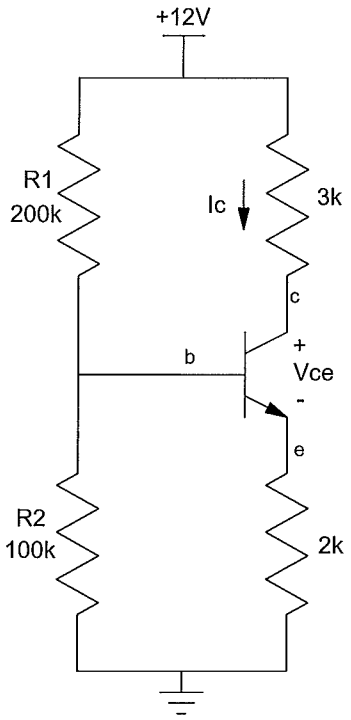
$I = 50mA$

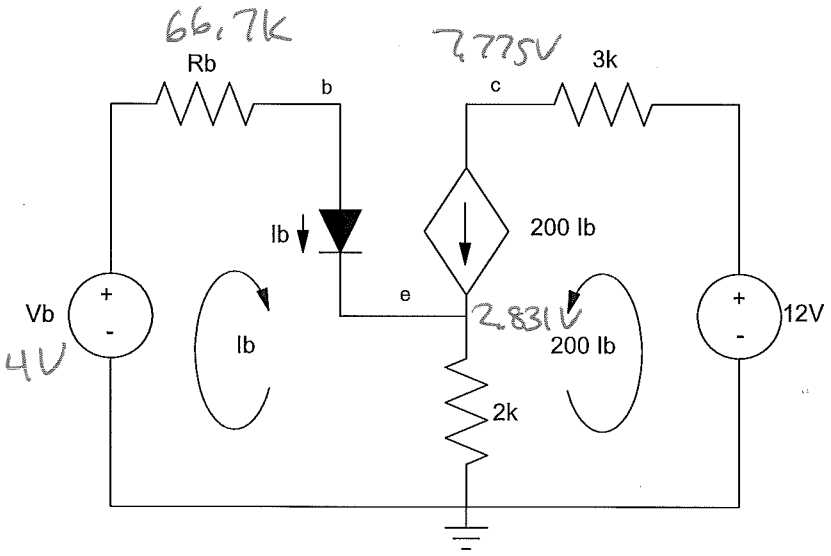
$R = 1/I = 19.67\Omega$

4) Determine the Thevenin equivalent for R1 and R2 as well as the Q-point for the following transistor amplfier. Assume ideal silcon transistors with

- Vbe = 0.7V
- β = 200

Thevenin Equivalent of R1 and R2		Q-Point	
Vb	Rb	Vce	Ic
4V	66.7k	4.944V	1.408mA





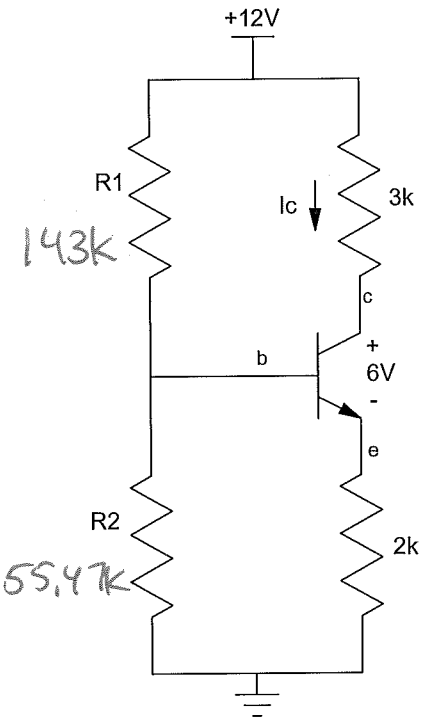
$$I_b = \frac{4 - .7}{66.7k + 2k(1+2\omega)} = 7.04\mu A$$

$$I_c = \beta I_b = 1.408mA$$

5) Design a transistor amplifier so that the Q-point is

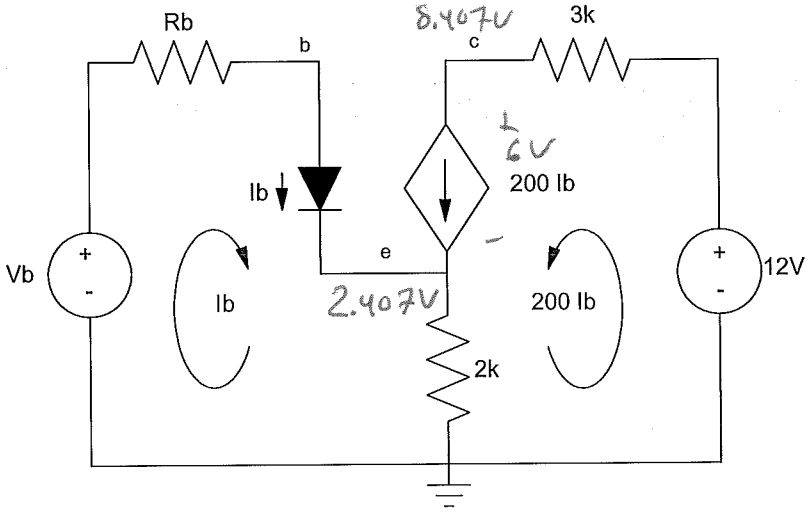
- Vce = 6.0V

R1 and R2		Thevenin Equivalent of R1 and R2	
R1	R2	Vb	Rb
143k	55.47k	3.347V	40k



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

$R_b \ll 402k$



$\frac{R_1 R_2}{R_1+R_2} = 40k$

$2000 \cdot 201 I_b + 3020 \cdot 200 I_b = 6V$

$I_b = 5.988 \mu A$

$V_b = 3.347V$

$R_{eq}\left(\frac{R_2}{R_1+R_2}\right) 12V = 3.347V$

Bonus! How close is solar to being competitive? In industry, a 7-year payback is considered the break-even point: if an investment pays for itself in less than 7 years, you do it. If it takes more than 7 years, you don't.

What is the present payback time (in years) for solar energy in Fargo, ND at 10 cents / kWh with no government subsidies?

12 years