ECE 321: Quiz #4   Name _____

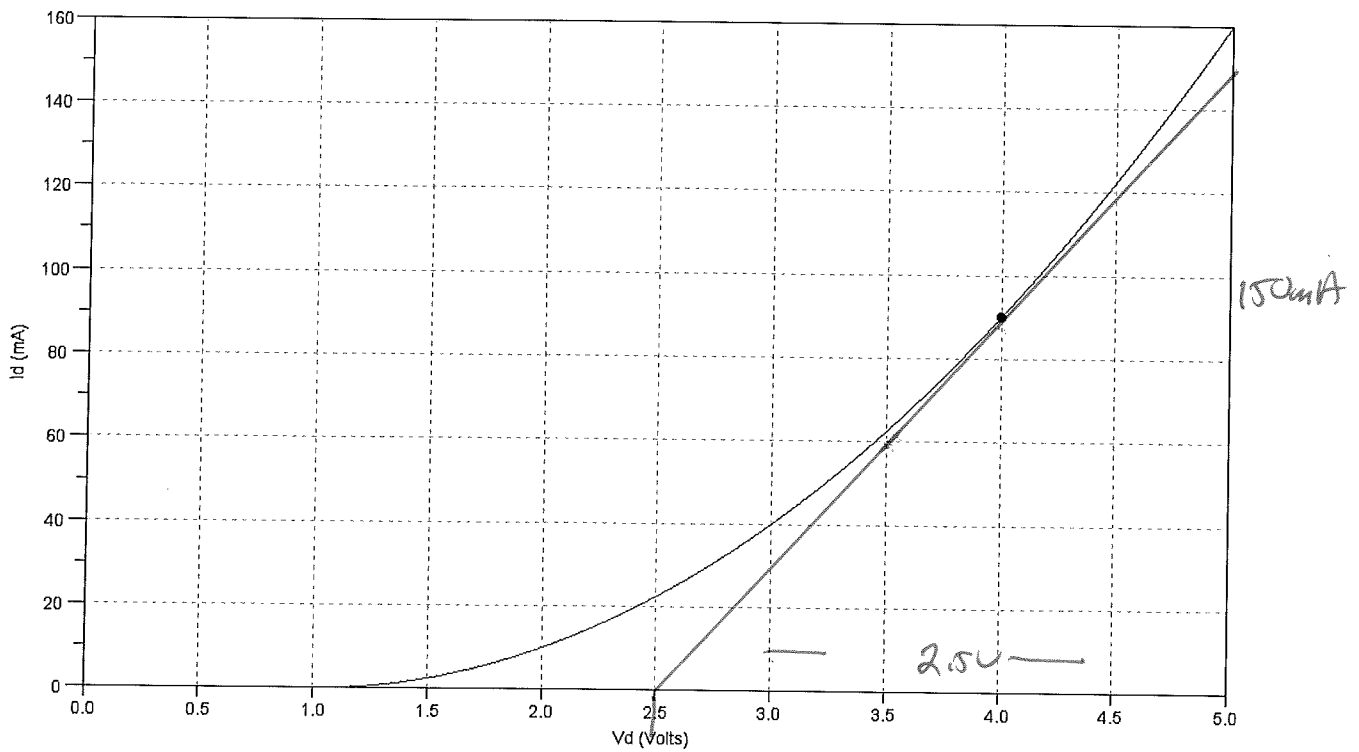2-port models, DC Analysis of BJT Circuits - December 1, 2016

1) Small Signal Model: The VI characteristics for a MOSFET are:

$$I_d = 0.01(V_d - 1)^2$$

Determine the small-signal model at the Q-point (4.00V, 90.0mA)

$$V_d \approx r_f \cdot I_d + V_f$$

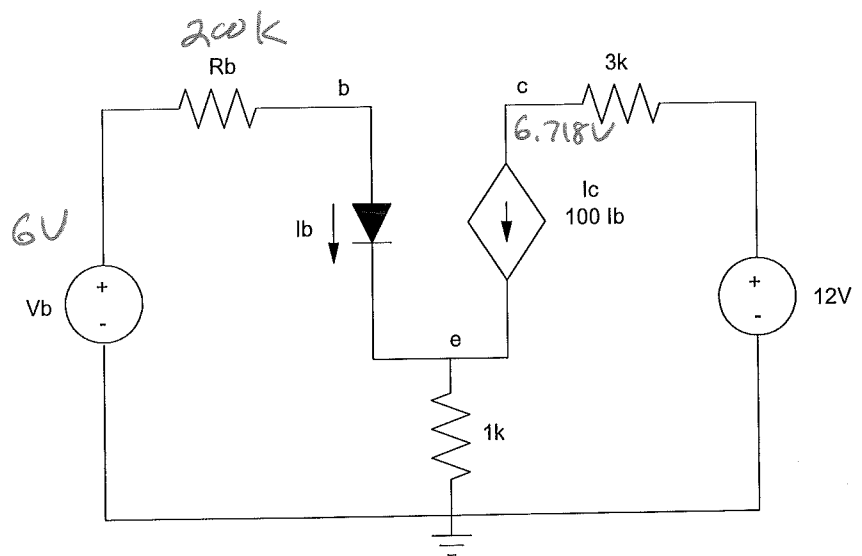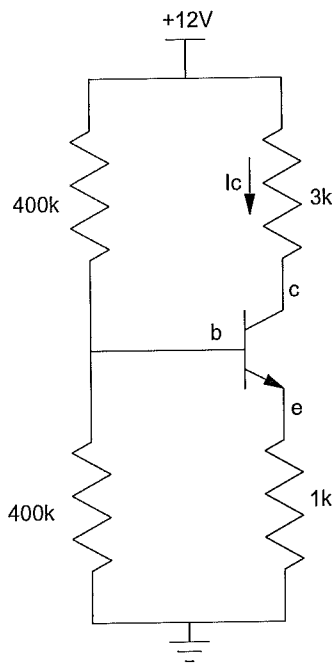| Tangent Line	Vf	rf
show on graph	2.5V	16.67 Ω

$$V_f$$

$$r_f = \frac{\delta V}{\delta I} = \frac{2.5V}{150mA} = 16.67$$

2) Determine the Thevenin Equivalent for R1 and R2 as well as the Q-point: Ic and Vce.

Assume $\beta = 100$

Vb	Rb	Vce	Ic
6.0V	200k	4.939V	1.761mA

+12V

400k

400k

3k

1k

Ic

b

c

e

200k

Rb

6U

Vb

b

Ib

e

1k

3k

6.718V

c

Ic

100 Ib

12V

$$I_b = \frac{6 - 0.7}{200k + 101(1k)} = 17.61 \mu A$$

$$I_c = \beta I_b = 1.761 mA$$

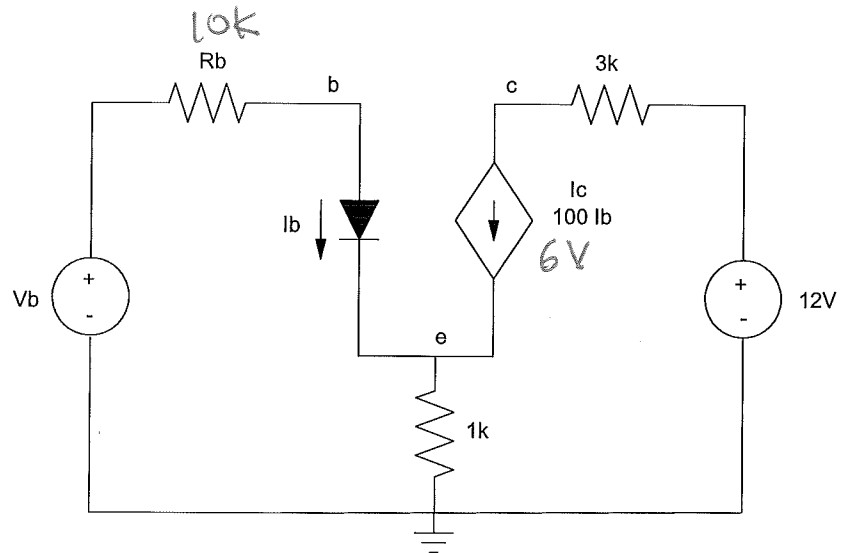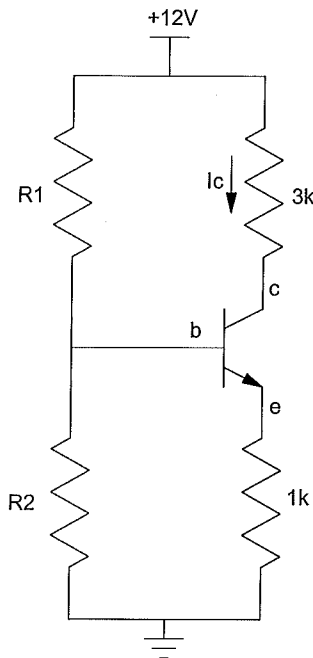$$V_c = 6.718 V = 12 - 3k \cdot I_c$$

$$V_e = 1k(101) I_b = 1.778 V$$

$$V_{ce} = 4.939 V$$

3) Determine R1 and R2 so that

- The Q-point is stabilized for variations in β ($(1+\beta)R_e \gg R_b$), and
- $Vce = 6.0V$

Assume $\beta = 100$

R1	R2	Vb	Rb
50.83k	12.45k	2.361V	10k

$$I_c = \frac{6V}{3k + (1.01)1k} = 1.496 mA$$

$$I_b = 14.96 \mu A$$

$$R_b \ll 101k = 10k$$

$$V_b = 2.361V$$

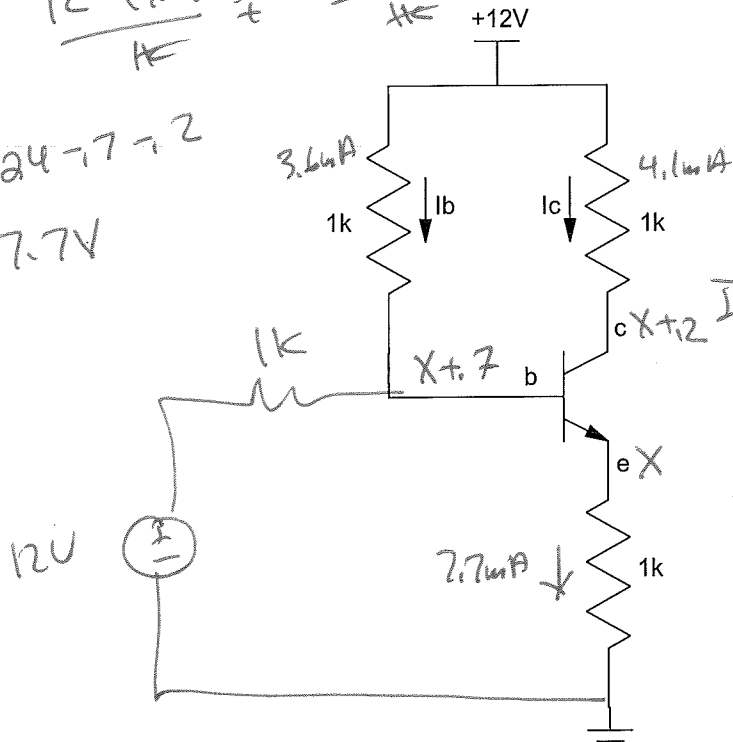4) Determine the voltages and currents. Assume $\beta = 100$

Ib	Ic	Vc	Ve
3.6 mA	4.1 mA	7.9V	7.7V

-3 $(110\,\mu A)$ $(11\,mA)$ saturated $(11.08V)$ $(0.92V)$

$$\frac{X}{1k} = \frac{12-(X+.7)}{1k} + \frac{12-(X+.2)}{1k}$$
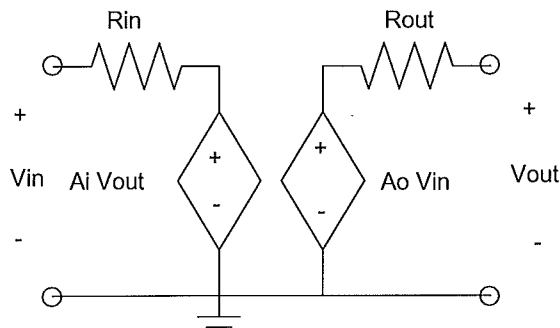
$3x = 24 - .7 - .2$

$x = 7.7V$

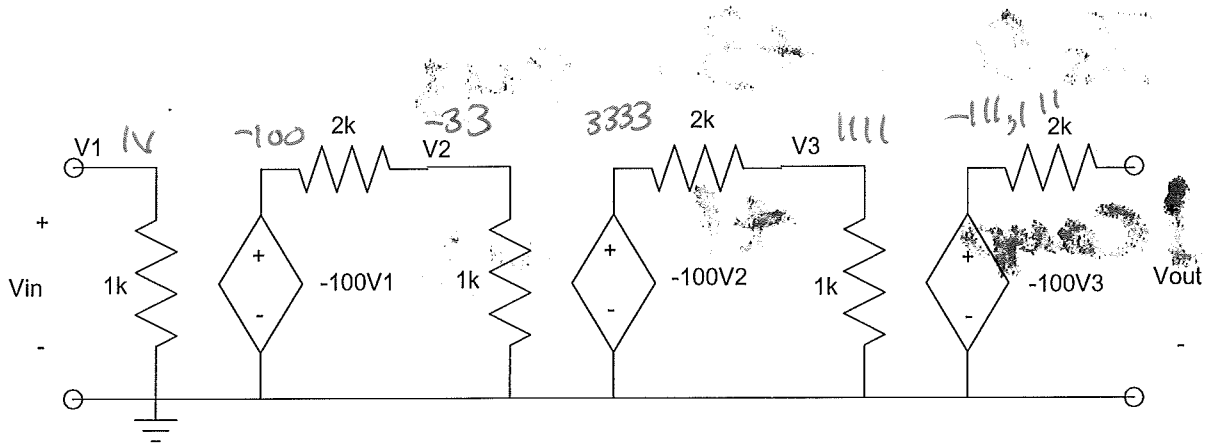3.6 μA 4.1 mA

+12V

1k   Ib   Ic   1k

$\frac{12-.7}{1k+(101)1k}$

c X+.2 $I_b =$

$= 110.8\,\mu A$

1k

X+.7 b

12U

e X

$I_c = 11.08\,mA$

$> 6\,\mu A$ (saturated)

7.7mA   1k

1k

12

I_b .7

$100 I_b$

12

110.8 μA

1k

11.08 mA

1k

12
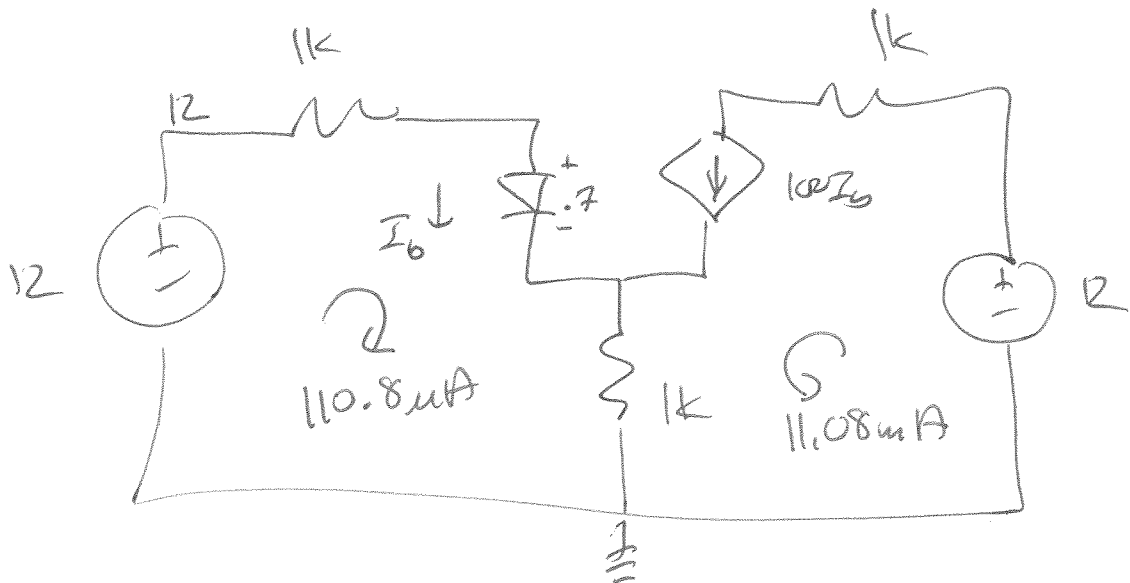
5) Determine the 2-port model for the following circuit

Rin	Ai	Rout	Ao
1k	◯	2k	-111,111

Bernie Bonus! Two of these are illegal activities in Vermont, two are illegal in North Dakota. Which ones are illegal in Vermont?
- Delivery men not walking backwards in driveways of homes worth more than $500,000
- Wearing false teeth without permission of your spouse.
- Sleeping with your shoes on
- Serving pretzels with beer at a restaraunt