

ECE 320: Final - Part 1. Name _____

Semiconductors & Diodes - March 21, 2019

1a) Define the following terms:

p-type semiconductor

$$\# \text{holes} \gg \#e^-$$

n-type semiconductor

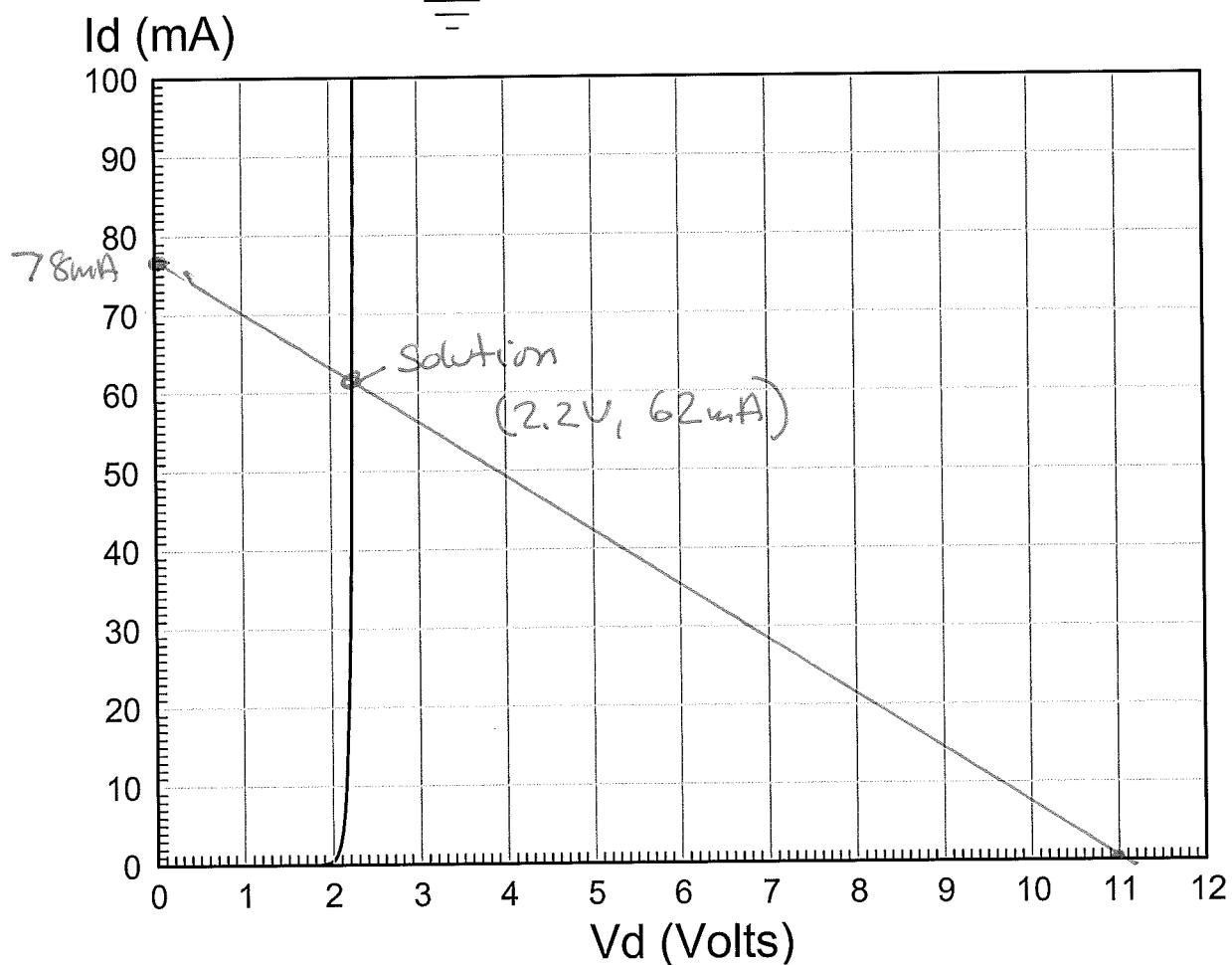
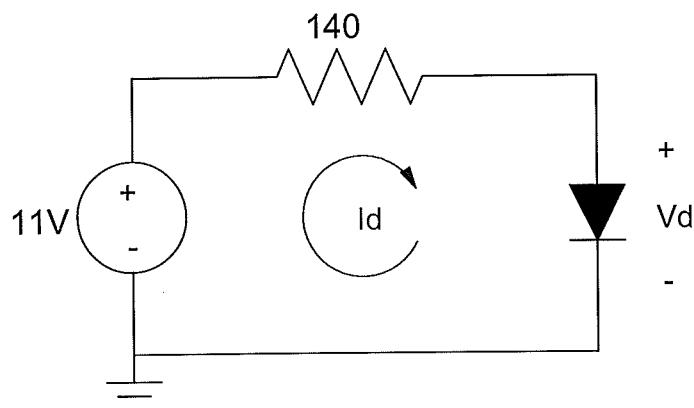
$$\#e^- \gg \#\text{holes}$$

Why does the resistance of silicon decrease as temperature increases?

as temp goes up, you get more thermal holes + e^- . More charge carriers means less resistance.

- 2) The VI characteristics for an LED is shown below. Draw the load line for the following circuit and determine the operating point.

Load Line	V_d	I_d
show on graph	2.2V	62mA



(can't happen \Rightarrow off)

19.8

-4.7 mA

14 mA

10.5 mA

- 3) Assume ideal silicon diodes ($V_f = 0.7V$). Determine the currents, $I_1 - I_4$

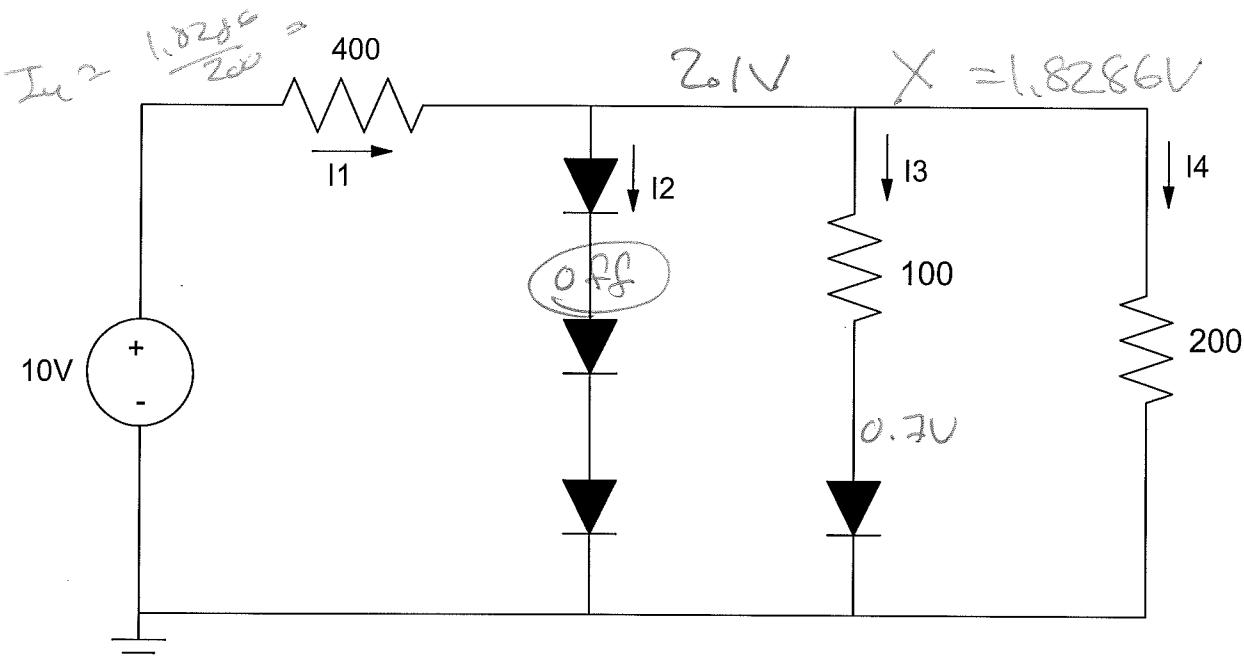
I_1	I_2	I_3	I_4
19.8 mA 20.4 mA	0 mA	11.3 mA	9.1 mA

$$I_1 = \frac{10 - 1.8286}{400}$$

$$I_3 = \frac{1.8286 - 0.7}{100} = 11.3 \text{ mA}$$

$$\frac{x-10}{400} + \frac{x-7}{100} + \frac{x}{200} = 0$$

$$x = 1.8286 \text{ V}$$



$$I_1 = \frac{10 - 2.1}{400} = 19.8 \text{ mA}$$

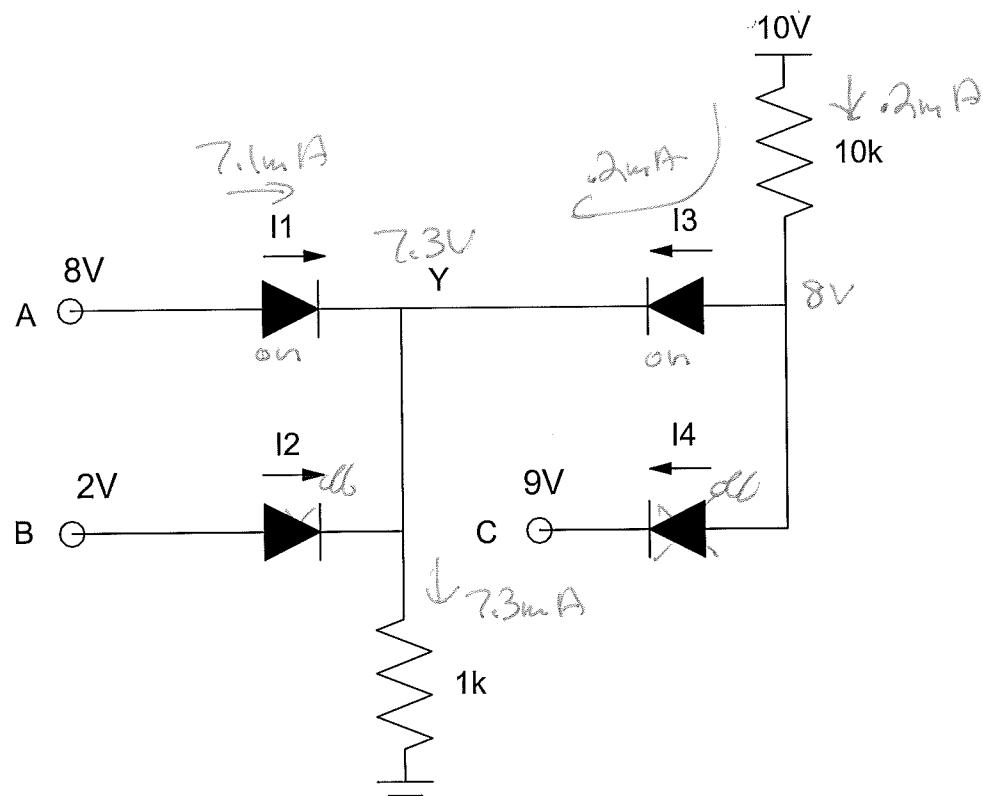
$$I_3 = \frac{2.1 - 0.7}{100} = 14.0 \text{ mA}$$

$$I_4 = \frac{2.1}{200} = 10.5 \text{ mA}$$

$> 19.8 \text{ mA}$

4) Assume ideal silicon diodes ($V_f = 0.7V$). Determine the currents, $I_1 - I_4$

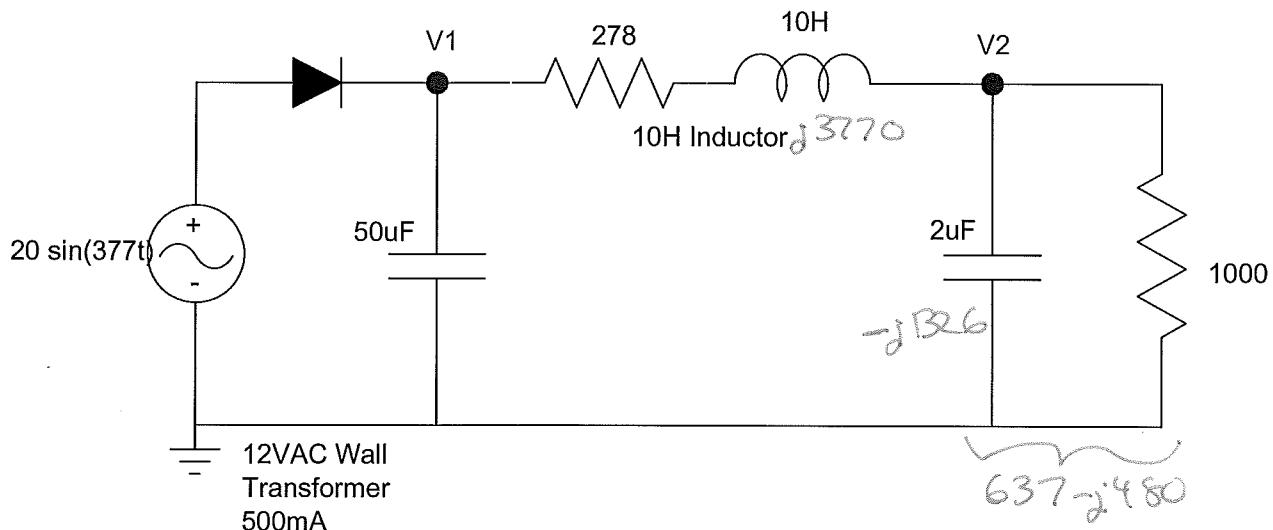
I_1	I_2	I_3	I_4
-7.1mA	0	0.2mA	0



5) For the following AC to DC converter, determine the following

V1 (peak)	V1pp (AC)	V2 (DC)	V2pp (AC)
19.3V	5.03V _{PP}	16.78V 13.13V	1.176V _{PP}

16.78V DC



$$I = \frac{19.3V}{1278\Omega} = 15.1mA$$

$$I = C \frac{dV}{dt}$$

$$15.1mA = 50\mu F \cdot \frac{dV}{\sqrt{60}}$$

$$dV = 5.03 V$$

$$V_2 = \left(\frac{(637-j480)}{(637-j480)+(278+j3770)} \right) \cdot 5.03V_{PP}$$

$$V_2 = 1.176V_{PP}$$

Bonus 60%

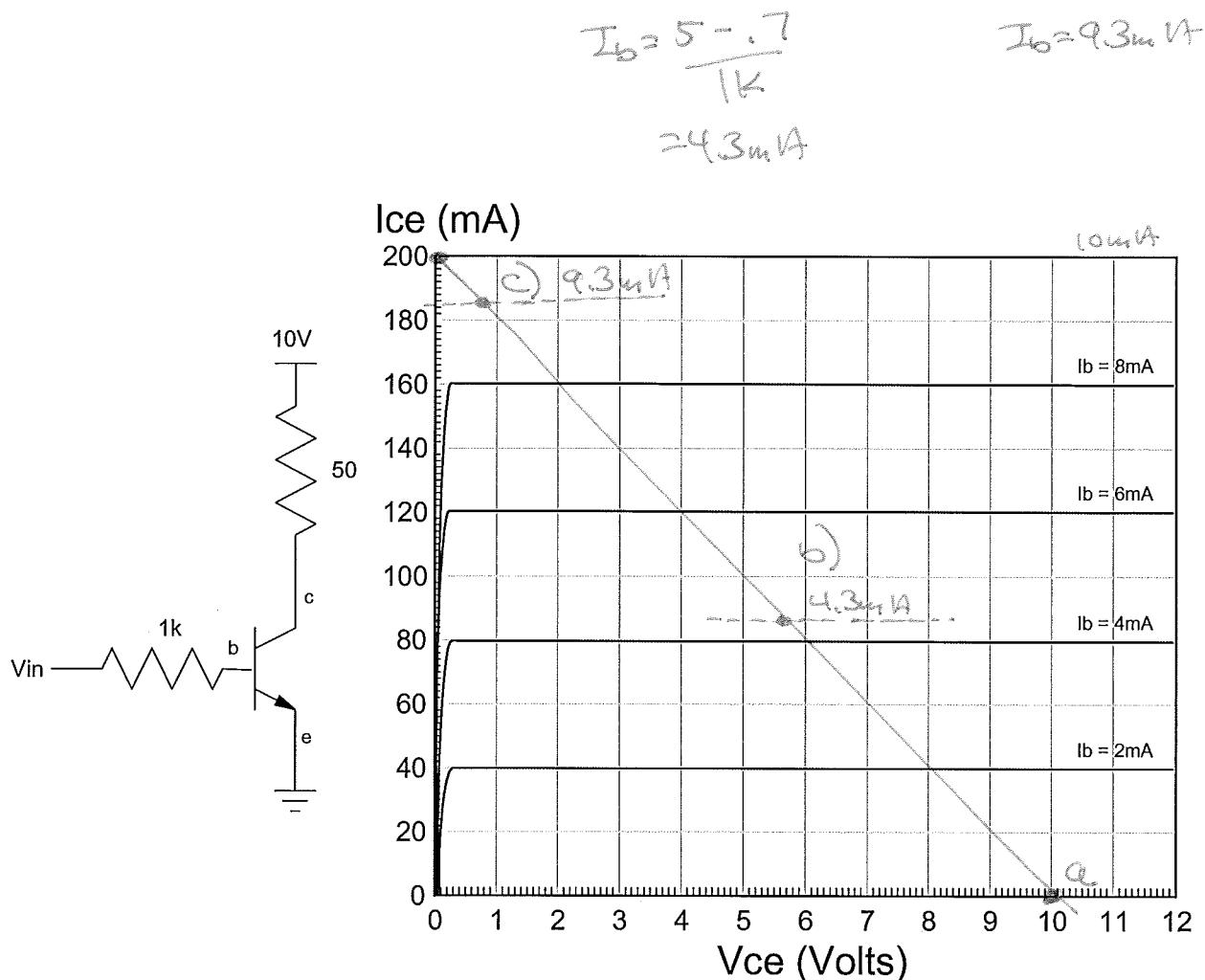


ECE 320: Final - Part 2. Name _____

BJT Transistors & MOSFET Circuits - March 22, 2019

- 1) The VI characteristics for an NPN transistor are shown below. Draw the load-line and mark the operating point for $V_{in} = \{0V, 5V, 10V\}$

Load Line	a) $V_{in} = 0V$	b) $V_{in} = 5V$	c) $V_{in} = 10V$
show on graph	show on graph	show on graph	show on graph



2) Transistor Switch: A circuit to allow a function generator to turn on and off an LED is shown below.

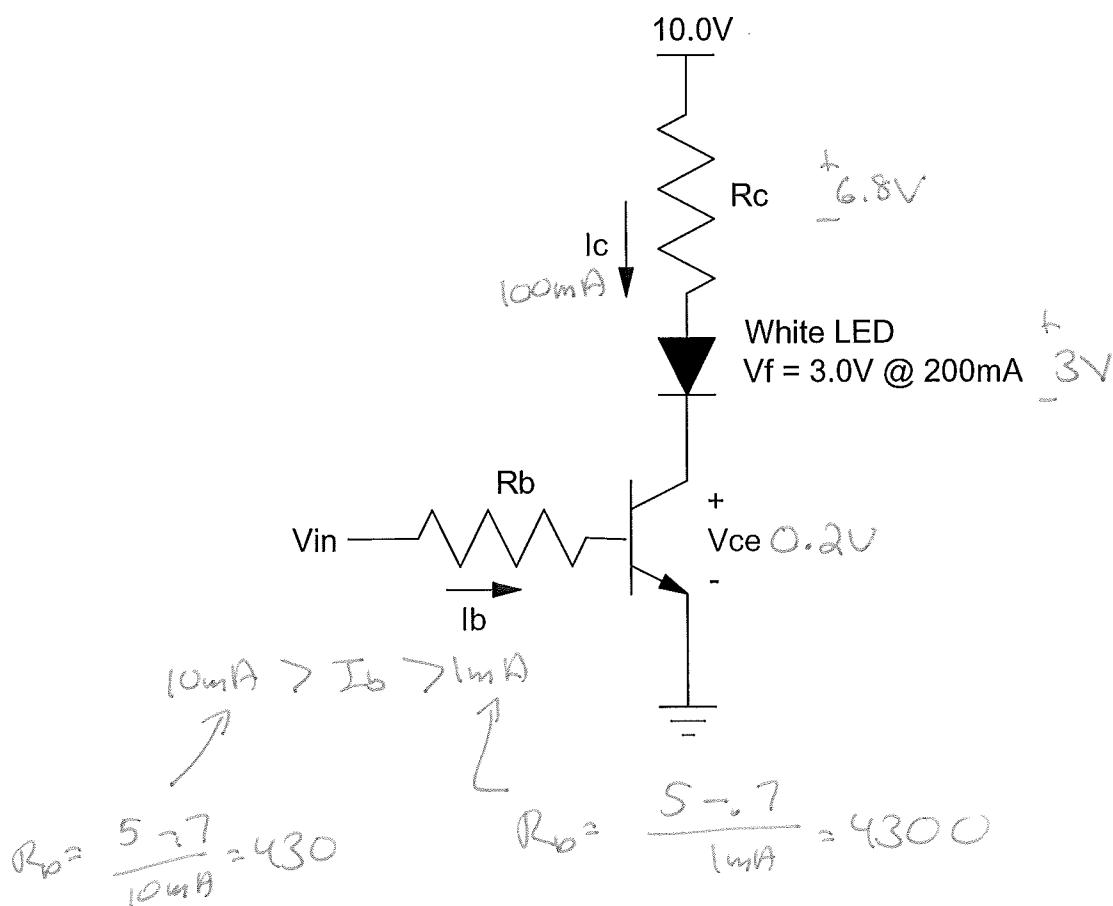
- $V_{in} = 5V$: LED is on ($I_c = 100mA$)
- $V_{in} = 0V$: LED is off ($I_c = 0mA$)

Find the range of R_b and R_c for this circuit to work as a switch. Assume

- V_{in} can only supply 10mA (or less)
- An ideal silicon transistor ($V_f = 0.7V$) with $\beta = 100$
- The LED has a 3.0V drop when $I_d = 200mA$

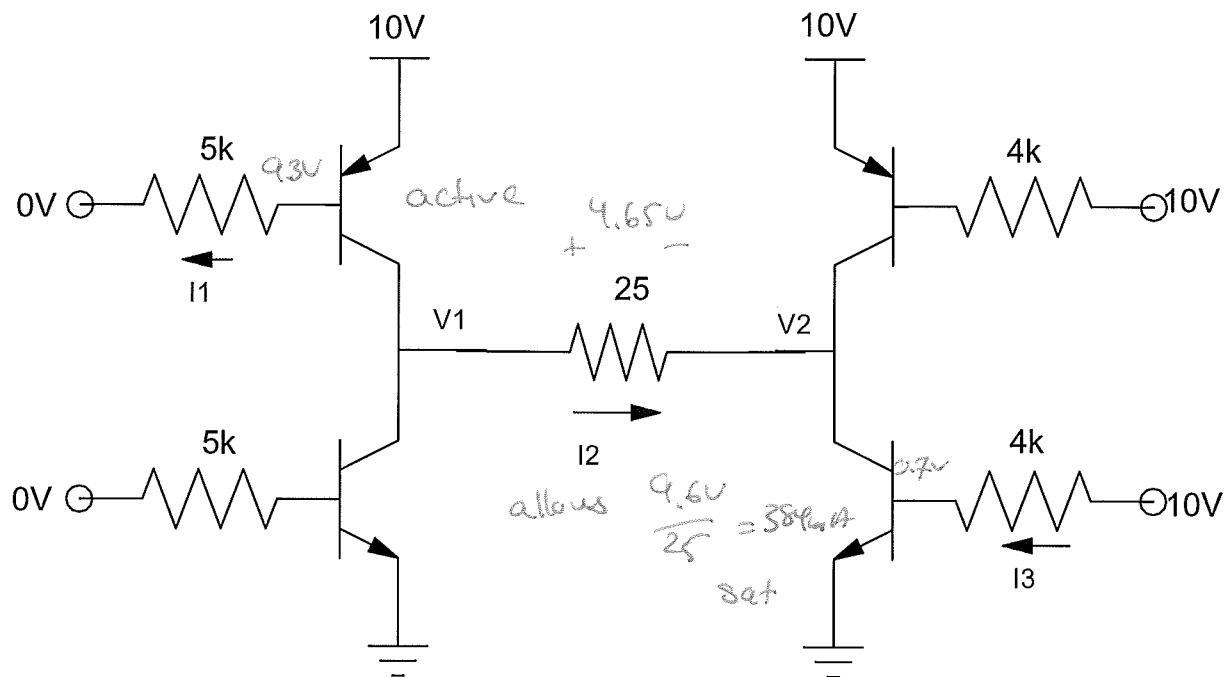
Smallest Value of R_b	Largest Value of R_b	R_c
430 Ω	4300 Ω	68 Ω

3 3 3



3) H-Bridge. Determine the currents and voltages for the following H-bridge. Assume ideal silicon transistors with $\beta = 100$

I1	I2	I3	V1	V2
1.86mA	1.86mA	2.32mA	4.85V	0.2V



$$I_1 = \frac{9.3V}{5k} = 1.86mA$$

allows 186mA

$$I_3 = \frac{9.3V}{4k} = 2.325mA$$

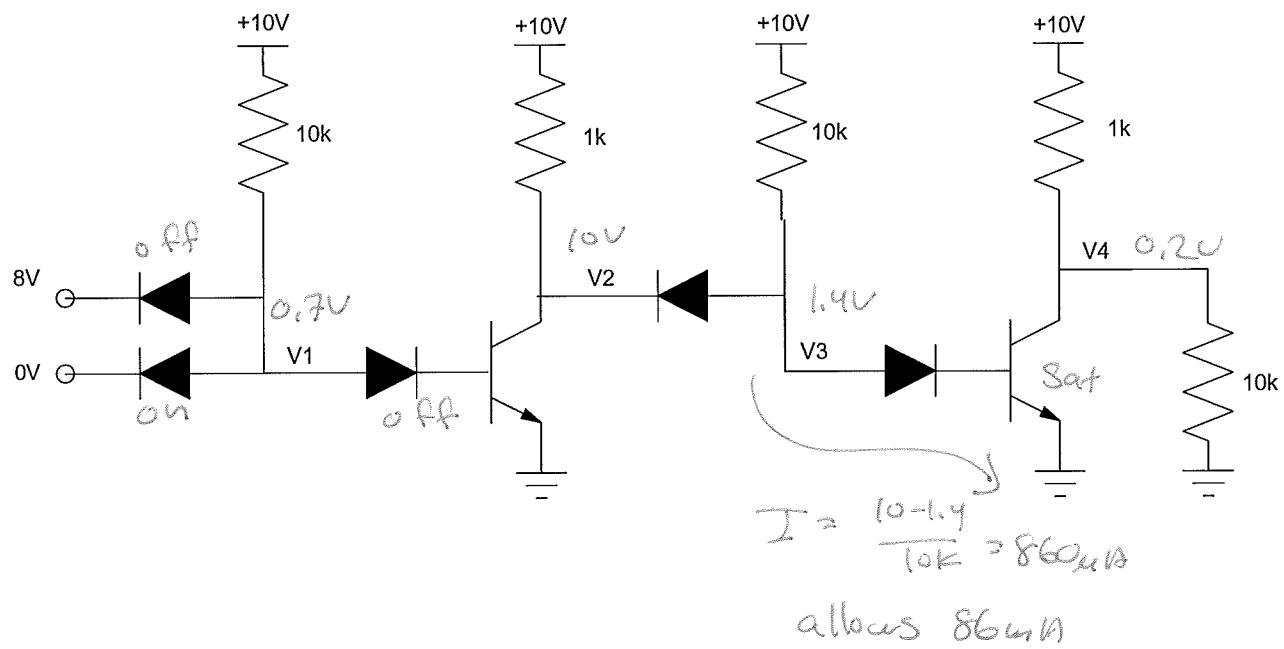
allows 232mA

$$V_{25} = (186mA)(25\Omega)$$

$$\approx 4.65V$$

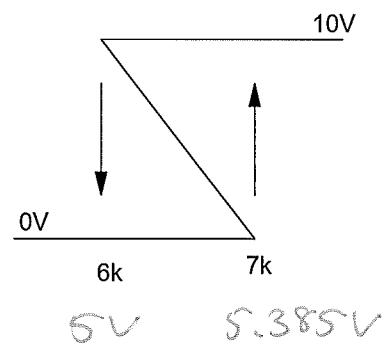
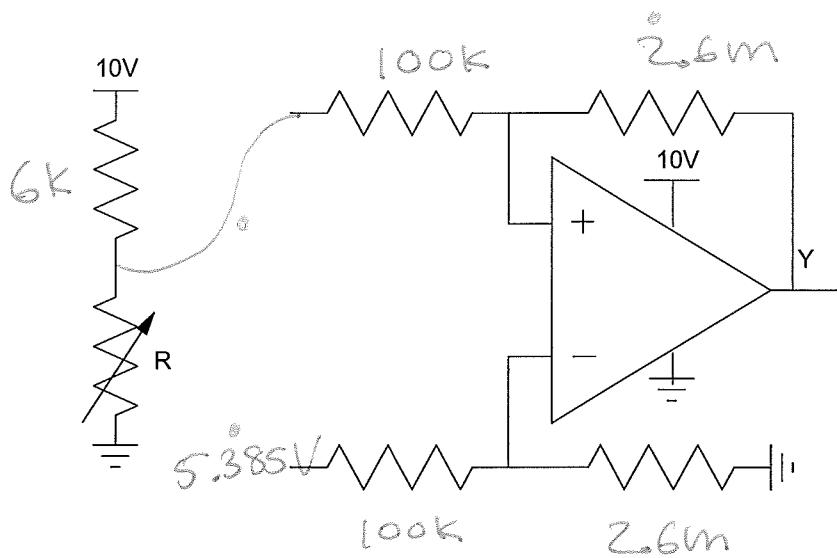
4) DTL Logic: Determine the voltages for the following DTL logic gate. Assume $\beta = 100$

V1	V2	V3	V4
0.7V	10V	1.4V	0.2V



5) Design a Schmitt Trigger which outputs

- +10V when $R > 7k$ Ohms
- 0V when $R < 6k$ Ohms, and
- Is unchanged for $6k < R < 7k$



$$\text{Gain} = 26$$

