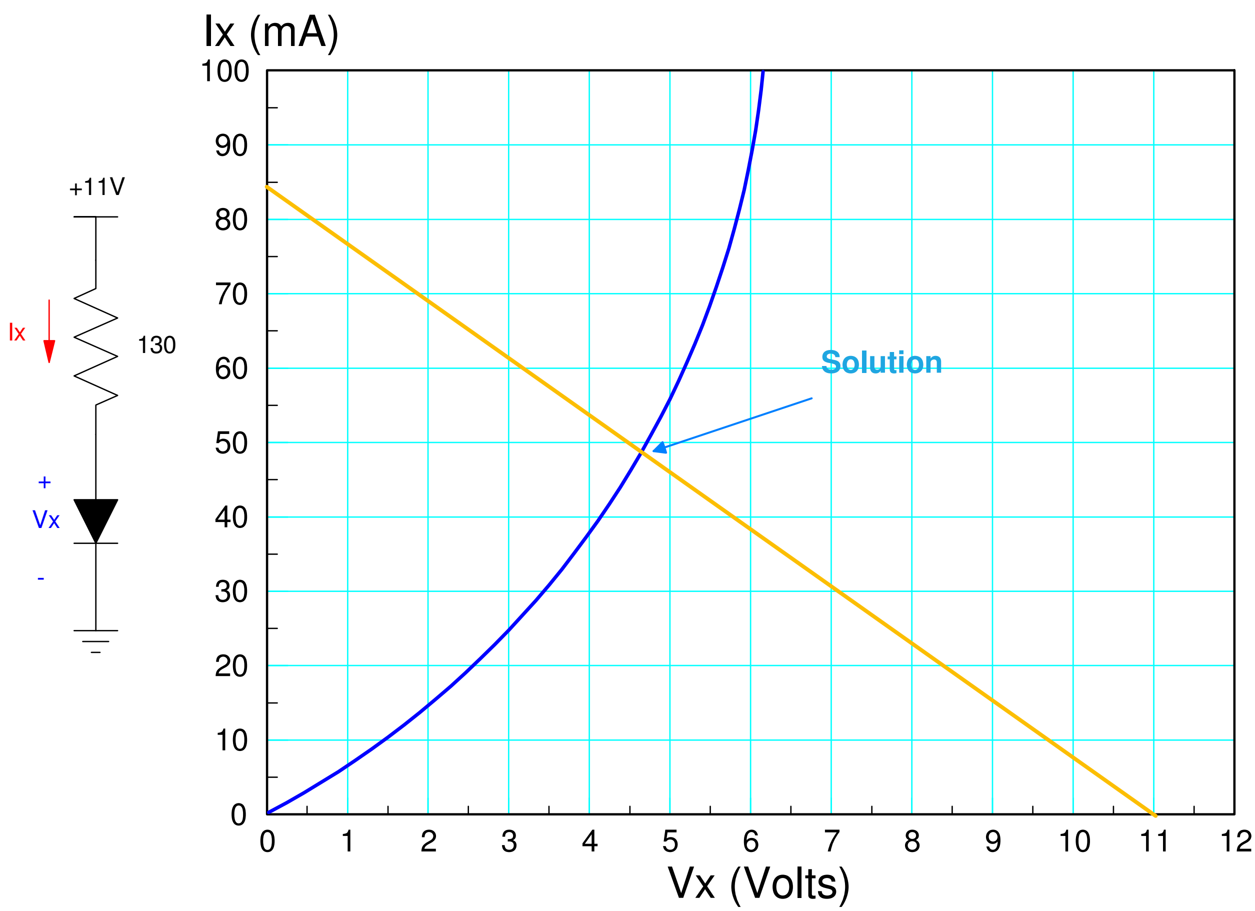
ECE 320 - Final (pt 1) - Name ____________________

Semiconductors & Diodes

1) Load Lines: Assume the VI characteristics for the diode is as shown in the graph. Draw the load line for the follosing circuit and determine Ix and Vx.

Load Line	Vx	Ix
show on graph	**4.6V**	**48mA**



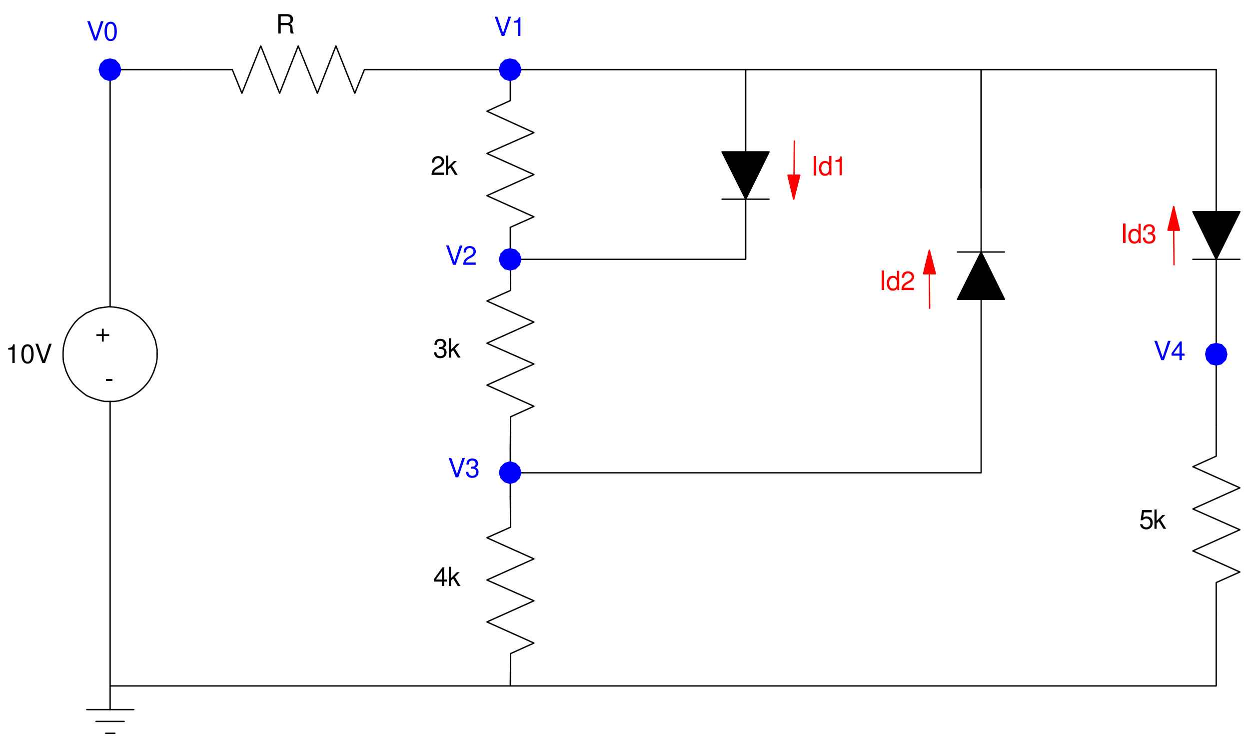
2) Nonlinear equations: Diode circuit

Assume the VI characteristics for the diodes shown below are

$$V_d = 0.052\ln\left(10^8 \cdot I_d + 1\right) \qquad I_d = 10^{-8} \cdot \left(\exp\left(\frac{V_d}{0.052}\right) - 1\right)$$

Write N equations to solve for N unknonws: {V1, V2, V3, V4, Id1, Id2, Id3}.

- Note: you do not need to solve.
- R = 1000 + 100*(your birth month) + (birth date). For example, May 14th gives 1514 Ohms.



$$I_{d1} = 10^{-8} \cdot \left(\exp\left(\frac{V_1 - V_2}{0.052}\right) - 1\right)$$

$$I_{d2} = 10^{-8} \cdot \left(\exp\left(\frac{V_3 - V_1}{0.052}\right) - 1\right)$$

$$-I_{d3} = 10^{-8} \cdot \left(\exp\left(\frac{V_1 - V_4}{0.052}\right) - 1\right)$$

$$\left(\frac{V_1 - V_0}{R}\right) + \left(\frac{V_1 - V_2}{2k}\right) + I_{d1} - I_{d2} - I_{d3} = 0$$

$$\left(\frac{V_2 - V_1}{2k}\right) + \left(\frac{V_2 - V_3}{3k}\right) - I_{d1} = 0$$

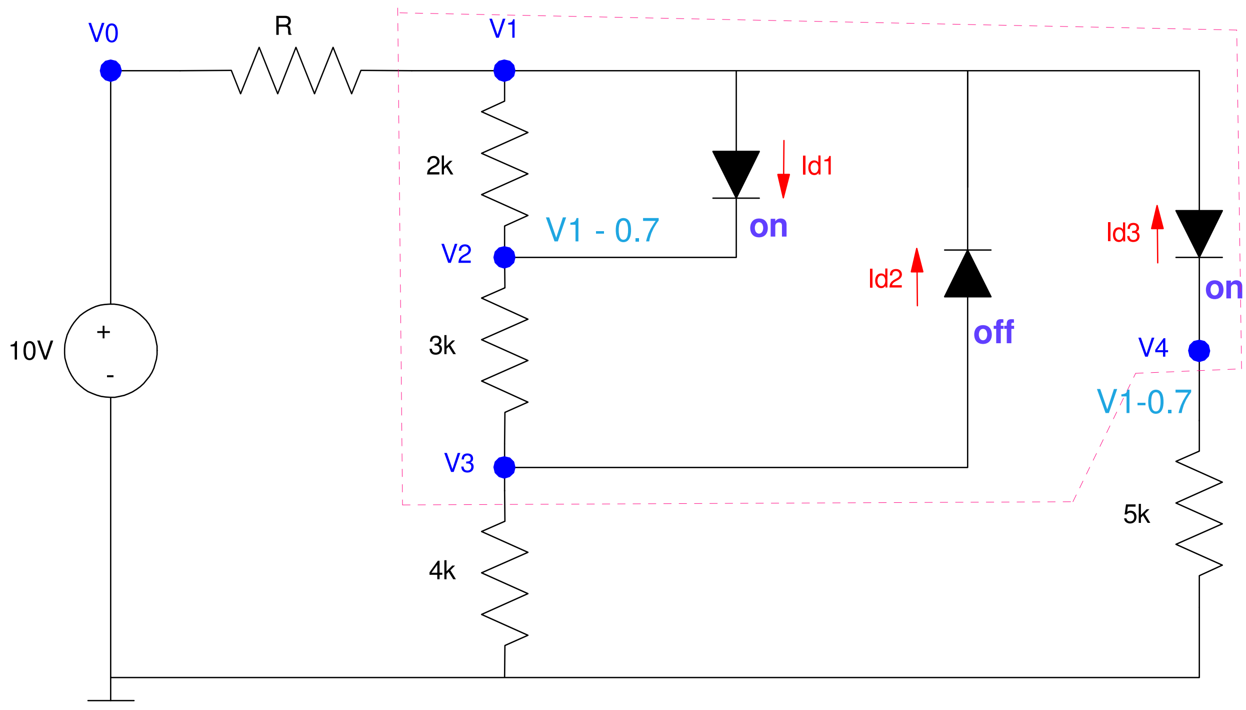
$$\left(\frac{V_3 - V_2}{3k}\right) + \left(\frac{V_3}{4k}\right) + I_{d2} = 0$$

$$Id3 + \left(\frac{V_4}{5k}\right) = 0$$

3) Ideal Silicon Diodes. Assume the diodes in this circuit are ideal silicon diodes:

- Vd = 0.7V   Id > 0
- Id = 0   Vd < 0.7V
- R = 1000 + 100*(your birth month) + (birth date). For example, May 14th gives 1514 Ohms.

R 1000 + 100*mo + day	V1	V2	V3
1514	**6.8221V**	**6.1221V**	**3.4983V**



SuperNode

$$\left(\frac{V_1-10}{1514}\right)+\left(\frac{V_3}{4k}\right)+\left(\frac{V_1-0.7}{5k}\right)=0$$

Node V3

$$\left(\frac{V_3-(V_1-0.7)}{3k}\right)+\left(\frac{V_3}{4k}\right)=0$$

Solving

$$V_3=\left(\frac{4}{7}\right)(V_1-0.7)$$

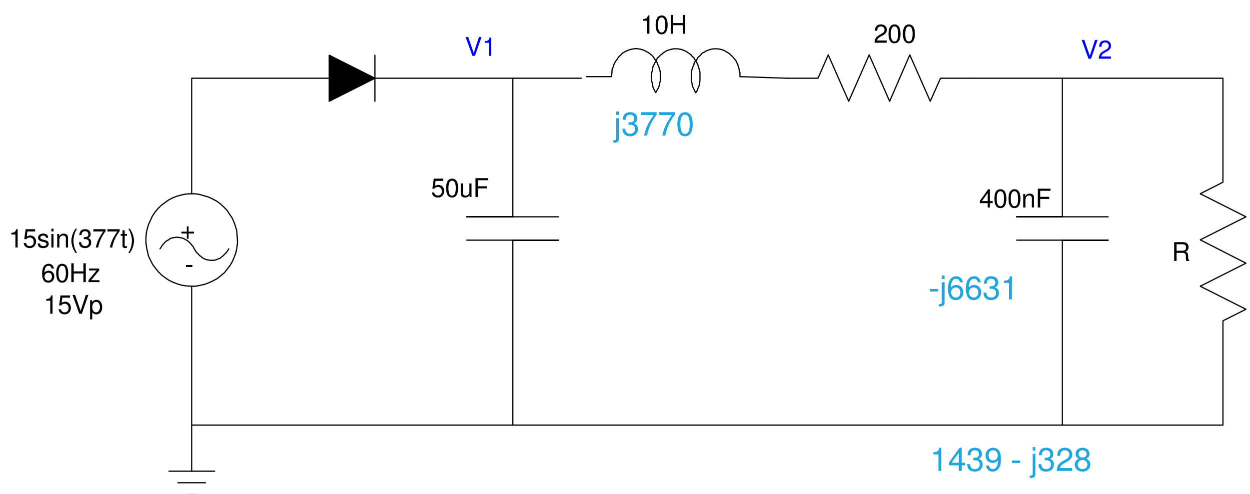
V1 = 6.8221V

V2 = V1 - 0.7 = 6.1221V

V3 = 3.4983C

4) AC to DC: Analysis: Determine V1 and V2 (both DC and AC) for the following AC to DC converter

R	V1		V2	
	DC	AC	DC	AC
1514	**12.91V**	**2.781Vpp**	**11.40V**	**1.077V$_{pp}$**



max(V1) = 14.3V

$$I \approx \left(\frac{14.3V}{R+200}\right) = 8.34mA$$

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

$$8.34mA = 50\mu F \cdot \frac{dV}{1/60s}$$

$$dV = 2.781V = V_{1pp}$$

$$V_1(DC) = 14.3V - \frac{1}{2} \cdot 2.781V_{pp} = 12.91V$$

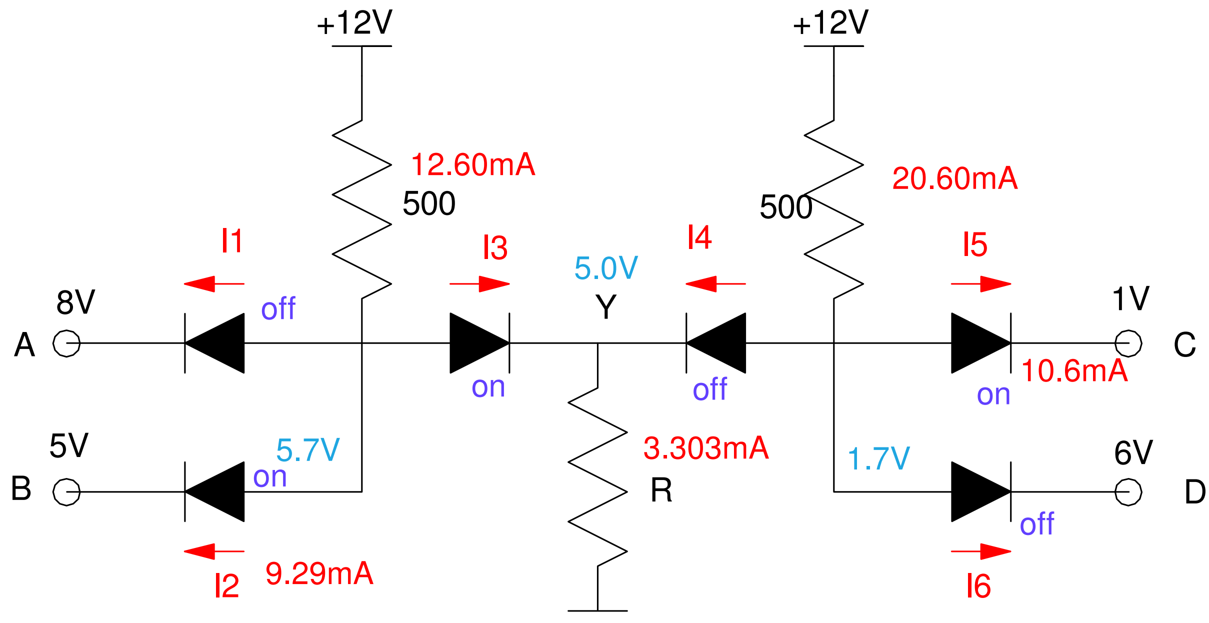
$$V_2(DC) = \left(\frac{1514}{1514+200}\right) V_1(DC) = 11.40V$$

$$V_2(AC) = \left(\frac{1439-j328}{(1439-j328)+(200+j3770)}\right) V_1(AC) = 1.077V_{pp}$$

5) Max/Min: Analysis: Determine currents I1..I6. Assume

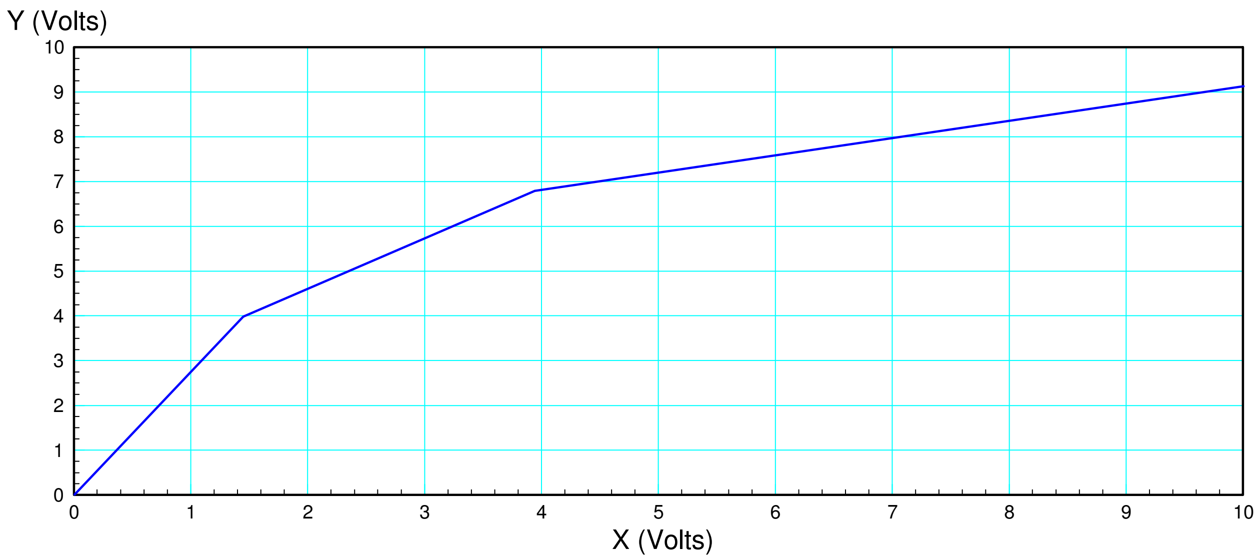
- Ideal silicon diodes (Vf = 0.7V)
- R = 1000 + 100*(your birth month) + (birth date)

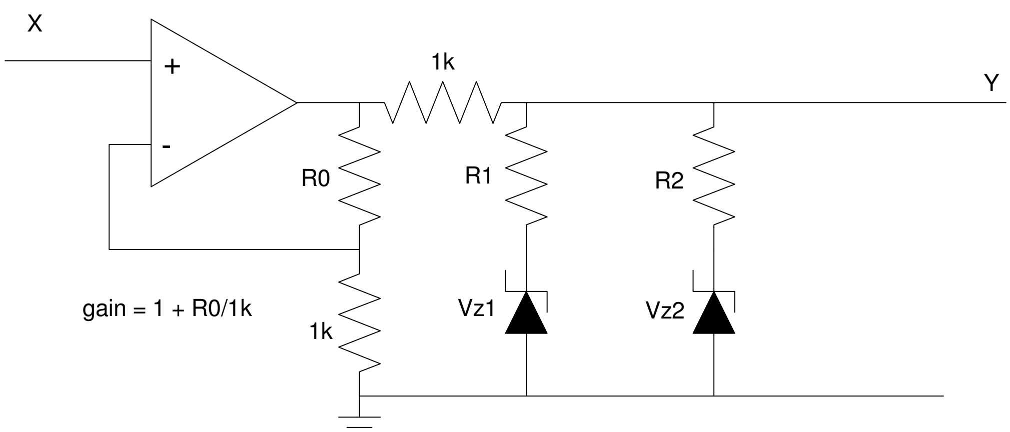
R	I1	I2	I3	I4	I5	I6
1514	**0**	**9.29mA**	**3.303mA**	**0**	**20.6mA**	**0**



6) Clipper Design: Determine the resistor and zerner voltages to implement the following function

R0	Vz1	R1	Vz2	R2





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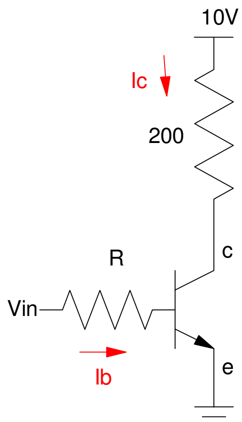
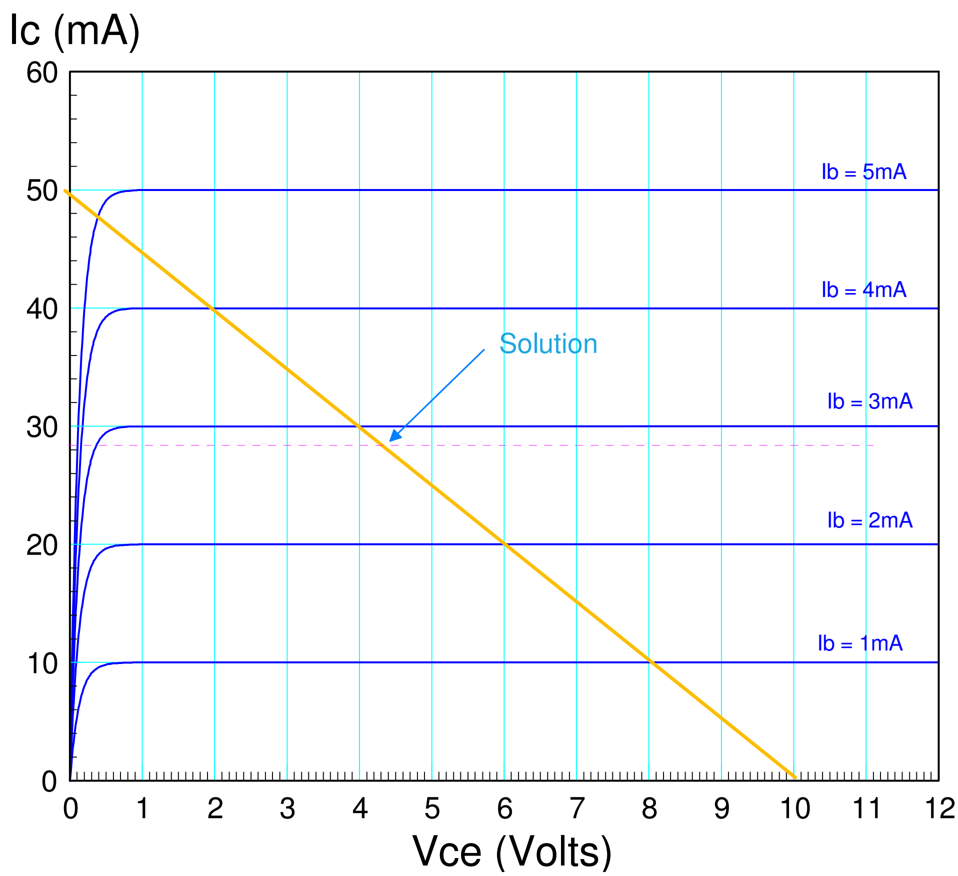
Transistors and Mosfets

6) Determine the current gain, β. Also draw the load line and determine the operating point when Vin = 5V

R 1000 + 100*Mo + Day	Current Gain hfe = beta	Load Line	Vce	Ic
1514	**10**	show on graph	**4.2V**	**28mA**



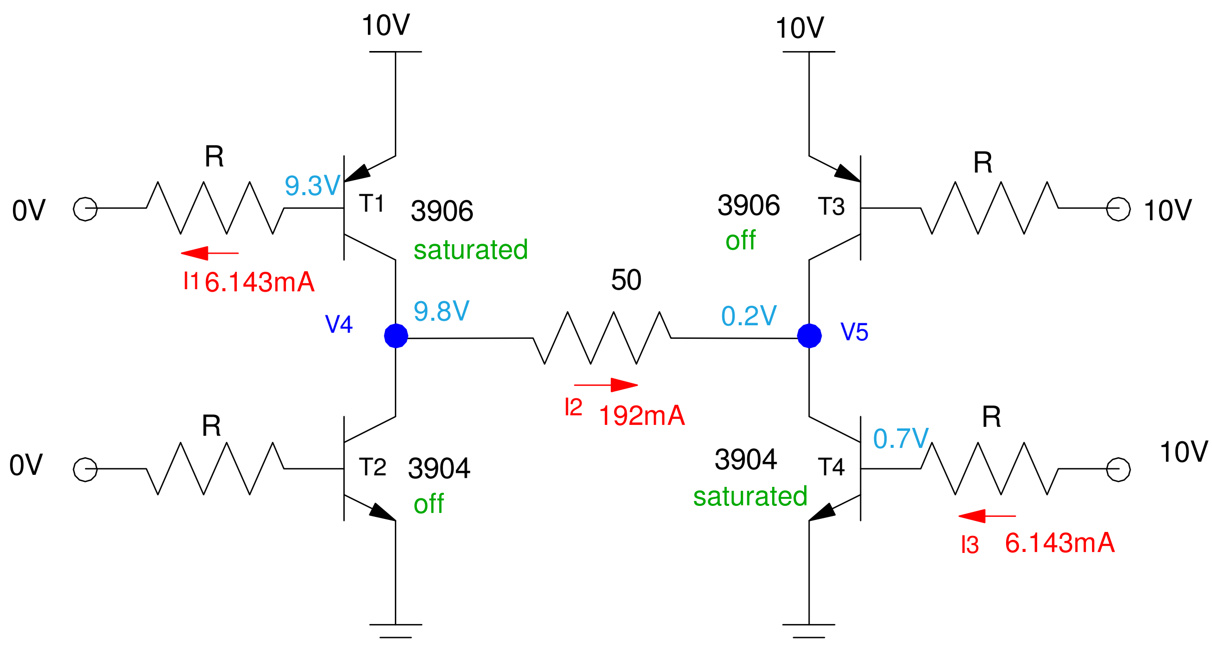


7) H-Bridge: Assume

- R = 1000 + 100*(birth month) + (birth day). May 14th would ive 1514 Ohms
- Ideal silicon transistors (Vbe = 0.7V, Vce(sat) = 0.2V, β = 100)

Determine the currents for voltages for the following H bridge.

R 1000 + 100*Mo + Day	I1	I2	I3	V4	V5
1514	**6.143mA**	**192mA**	**6.143mA**	**9.8V**	**0.2V**

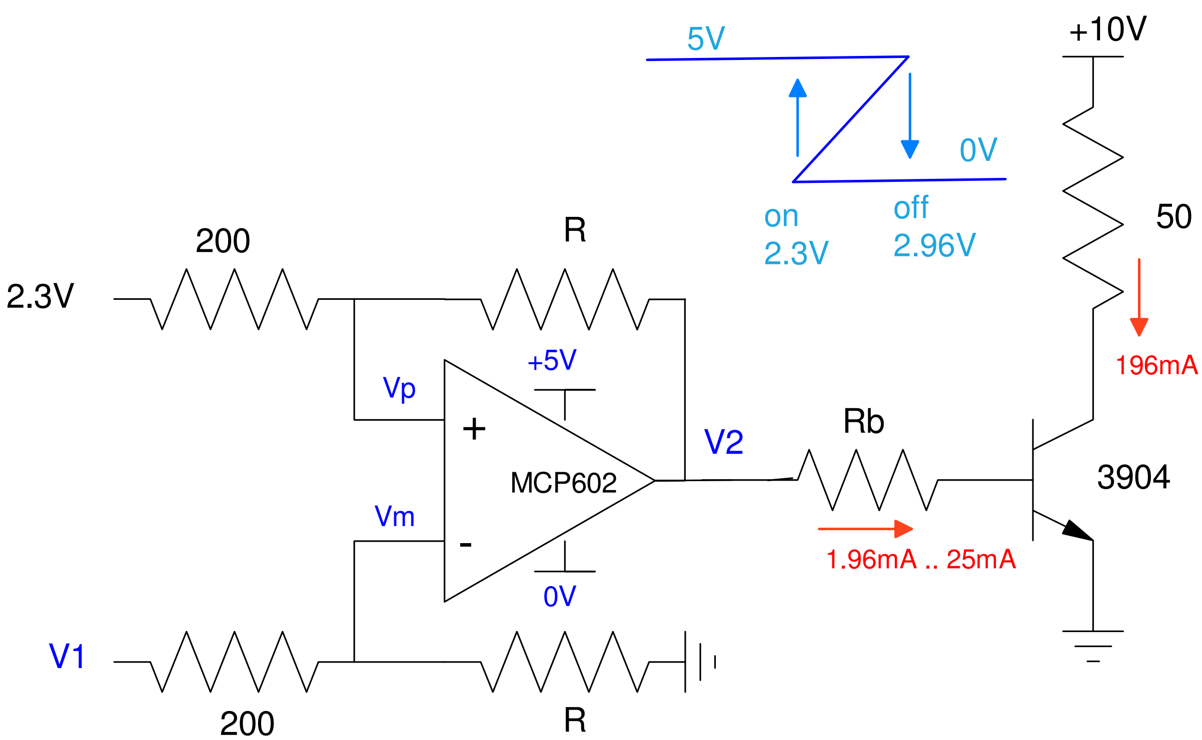


8) Schmitt Trigger: For the following Schmitt trigger, determine

- The voltage at V1 where V2 goes,
- The voltage at V1 where V2 goes low, and
- Rb so that the transistor is saturated when V2 = +5V

Let R = 1000 + 100*(birth month) + (birth day)

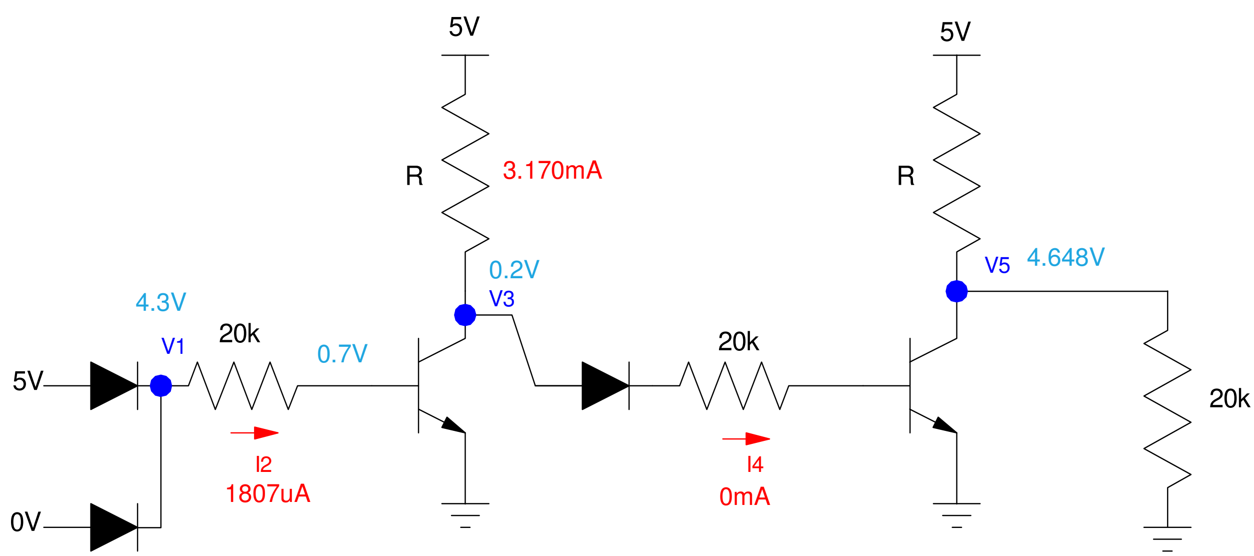
R 1000 + 100*Mo + Day	V1(on) Voltage at V1 where V2 goes high	V1(off) Voltage at V1 where V2 goes low	Rb Pick Rb so that the transistor saturates
1514	**2.3V**	**2.96V**	**172<Rb<2150** 25mA < Ib < 1.96mA



9) DTL Logic: Determine the voltages and currents for the following DTL logic gage. Assume

- R = 1000 + 100*(your birth month) + (birth day)
- Ideal silicon diodes (Vf = 0.7V), and
- Ideal 3904 transistors (Vbe = 0.7V, Vce(sat) = 0.2V, β=100)

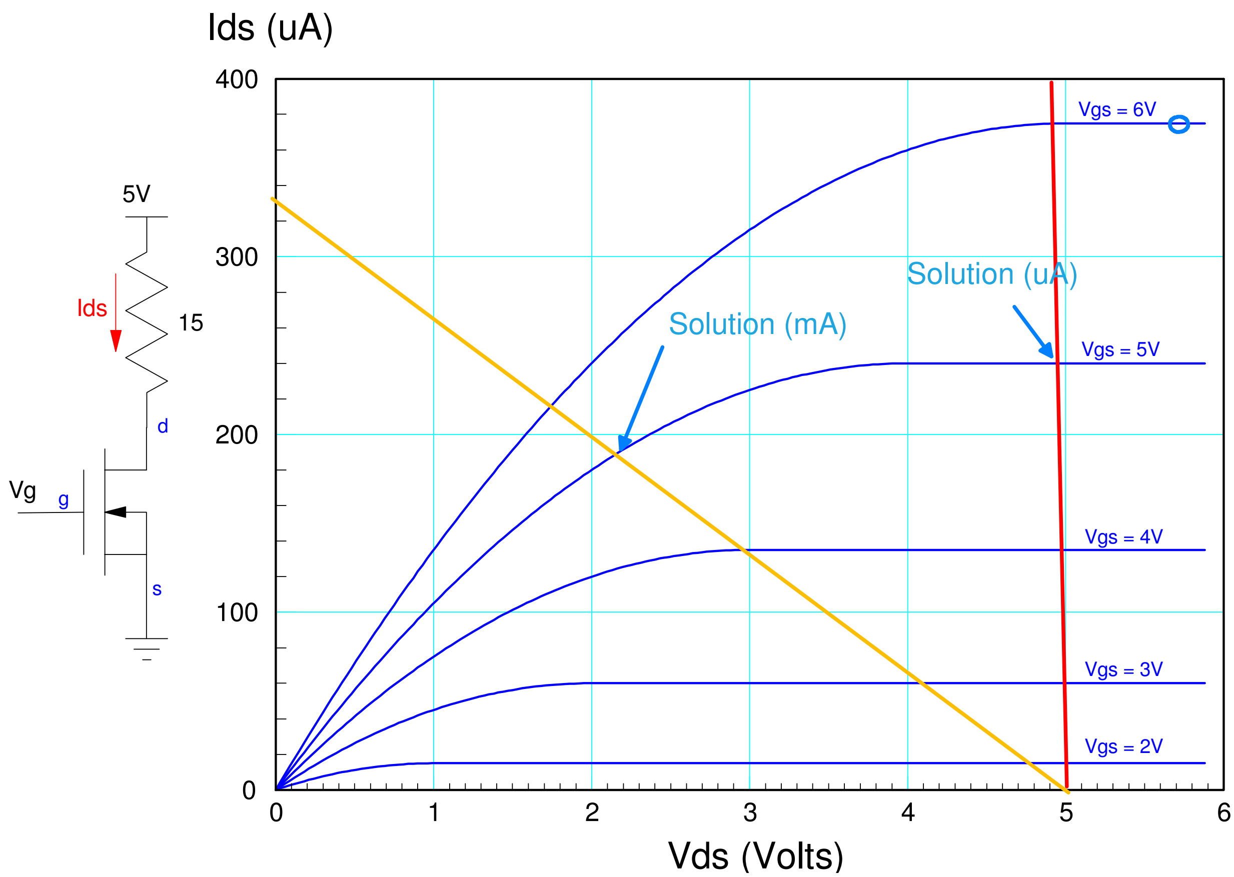
R	V1	I2	V3	I4	V5
1514	**4.3V**	**180uA**	**0.2V**	**0mA**	**4.648V**



10) MOSFET Load Line: For the following MOSFET circuit

- Determine the transconductance gain, kn,
- Draw the load line, and
- Determine {Vds, Ids} when Vg = 5V

kn transconductance gain	Load Line	Ids	Vds	Operating Region off / active / ohmic
30.4 uA/V^2 or 30.4 mA/V^2	show on graph	240uA or 190mA	4.95V or 2.2V	saturated or ohmic



Pick a point A (saturated region)

$$I_{ds} = \frac{k_n}{2}(V_{gs} - V_{th})^2$$

$$380\mu A = \frac{k_n}{2}(6-1)^2$$

$$k_n = 30.4\ \frac{\mu A}{V^2}$$