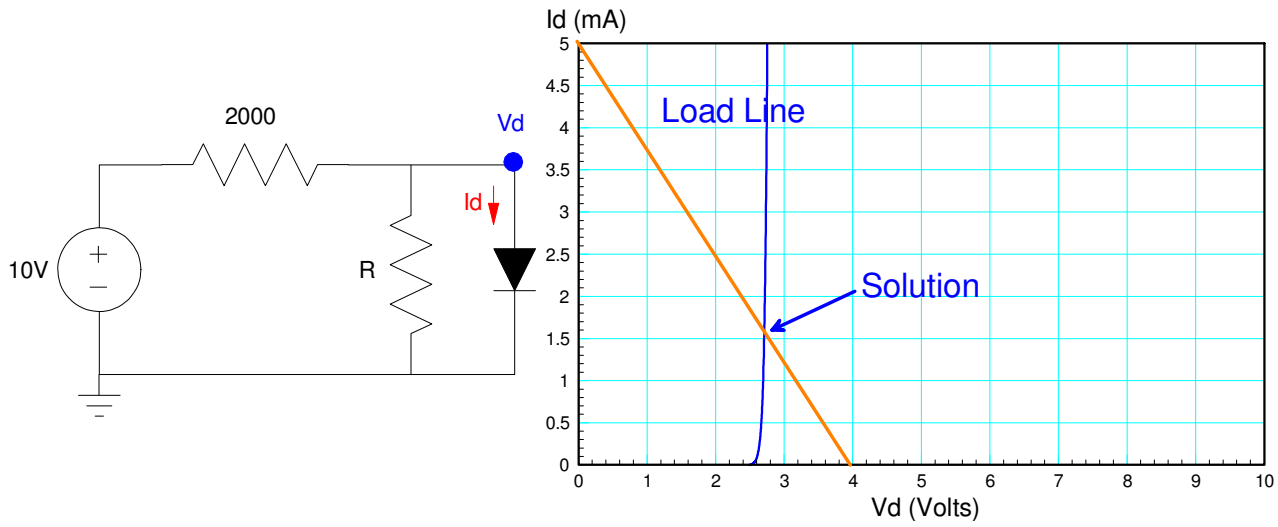
ECE 320 - Final (pt 1) - Name _____

Semiconductors & Diodes - Spring 2023

1) Load Lines: Assume the VI characteristics for the diode is as shown in the graph. Draw the load line for the following circuit and determine Id and Vd. Assume R = 800 + 100*(your birth month) + (your birth date).



R 800 + 100*mo + day	Load Line x-intercept (volts)	Load Line y-intercept (mA)	Vd Volts	Id mA
1314	**3.965V**	**5.00mA**	**2.7V**	**1.6mA**

Convert to a Thevenin equivalent:

$$V_{th} = \left(\frac{1314}{1314+2000}\right) 10V = 3.965V$$

$$R_{th} = 2000||1314 = 793.0\Omega$$

The load line is then

Xint = Vth = 3.965V

Yint = Vth / Rth = 5.00mA

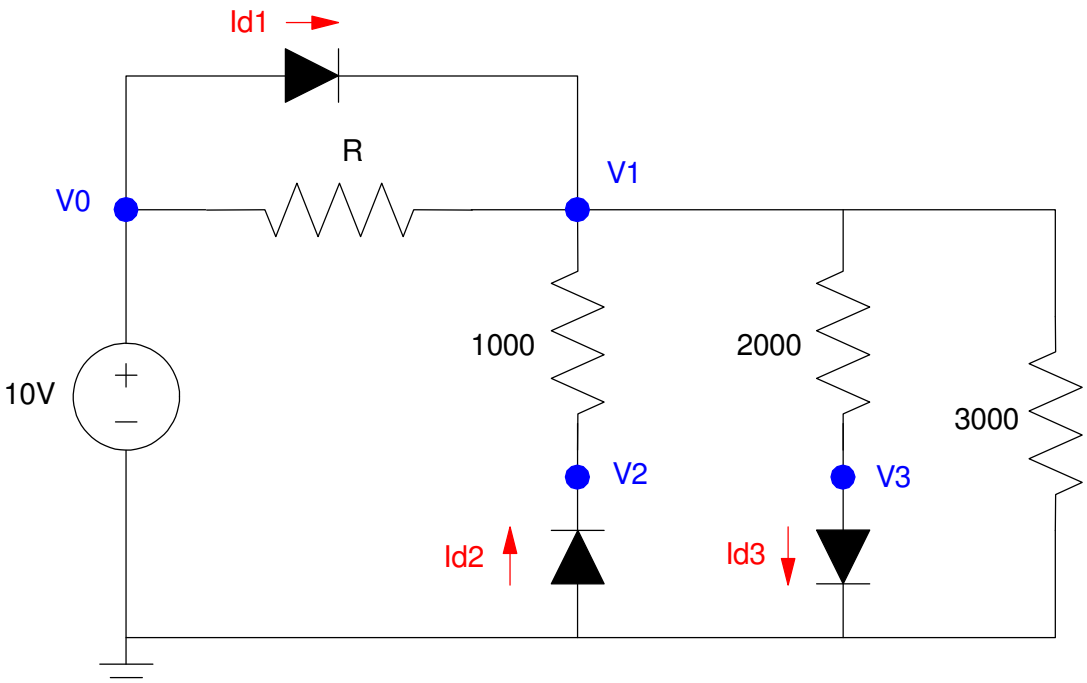
2) Nonlinear equations: Diode circuit

Assume the VI characteristics for the diodes shown below are

$$V_d = 0.038 \ln\left(10^{11} \cdot I_d + 1\right) \qquad I_d = 10^{-11} \cdot \left(\exp\left(\frac{V_d}{0.038}\right) - 1\right)$$

Write 6 equations to solve for 6 unknonws: {V1, V2, V3, V4, Id1, Id2, Id3}.

- Note: you do not need to solve.
- R = 800 + 100*(your birth month) + (birth date).



Start with the diode equations

$$I_{d1} = 10^{-11} \cdot \left(\exp\left(\frac{V_0 - V_1}{0.038}\right) - 1\right)$$

$$I_{d2} = 10^{-11} \cdot \left(\exp\left(\frac{0 - V_2}{0.038}\right) - 1\right)$$

$$I_{d3} = 10^{-11} \cdot \left(\exp\left(\frac{V_3 - 0}{0.038}\right) - 1\right)$$

$$V_0 = 10$$

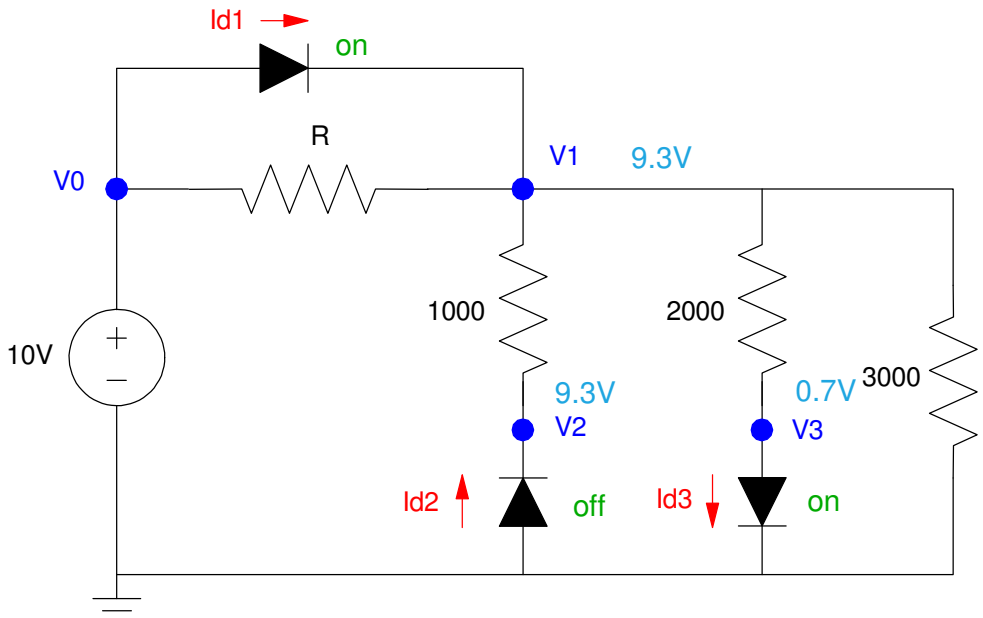
$$-I_{d1} + \left(\frac{V_1 - V_0}{1314}\right) + \left(\frac{V_1 - V_2}{1000}\right) + \left(\frac{V_1 - V_3}{2000}\right) + \left(\frac{V_1}{3000}\right) = 0$$

$$\left(\frac{V_2 - V_1}{1000}\right) - I_{d2} = 0$$

$$\left(\frac{V_3 - V_1}{2000}\right) + I_{d3} = 0$$

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 = 800 + 100*(your birth month) + (birth date).



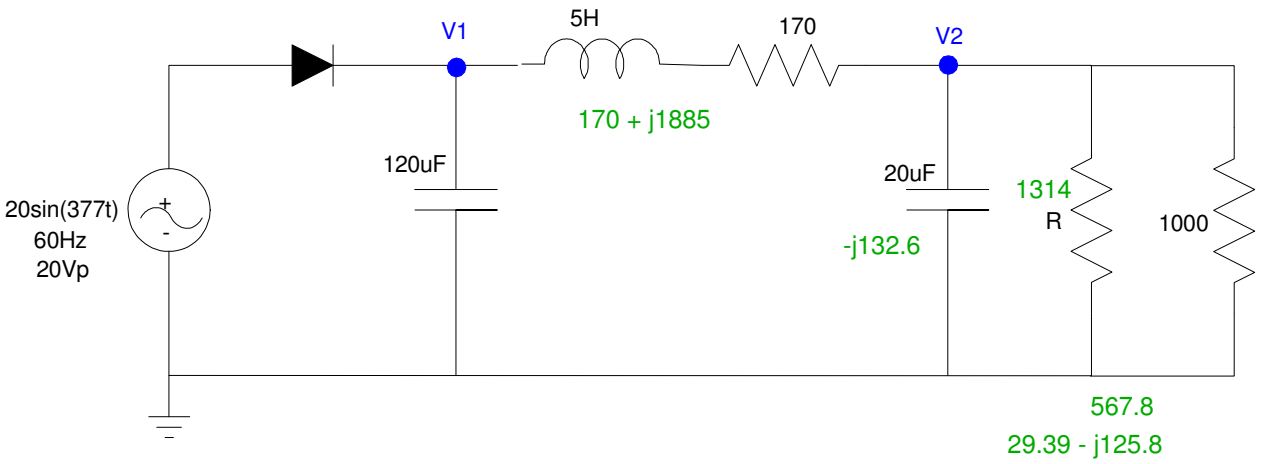
R 800 + 100*mo + day	Id1	Id2	Id3
1314	**6.867mA**	**0mA**	**4.30mA**
	V1	V2	V3
	9.30V	**9.30V**	**0.70V**

Id1: Current In = Current Out

$$I_{d1} = \left(\frac{V_1 - V_0}{1314}\right) + 0 + \left(\frac{V_1 - V_3}{2000}\right) + \left(\frac{V_1}{3000}\right)$$

$$I_{d1} = 6.867mA$$

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



R 800 + 100*mo + day	V1		V2	
	DC	AC	DC	AC
1314	**17.48V**	**3.633Vpp**	**13.46V**	**0.265Vpp**

$$I \approx \left(\frac{19.3V}{170+567.8}\right) = 26.16mA$$

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

$$26.16mA = 120\mu F \cdot \frac{dV}{1/60s}$$

$$dV = V_1(AC) = 3.633V_{pp}$$

$$V_1(DC) = 19.3V - \frac{1}{2}V_{1pp} = 17.48V$$

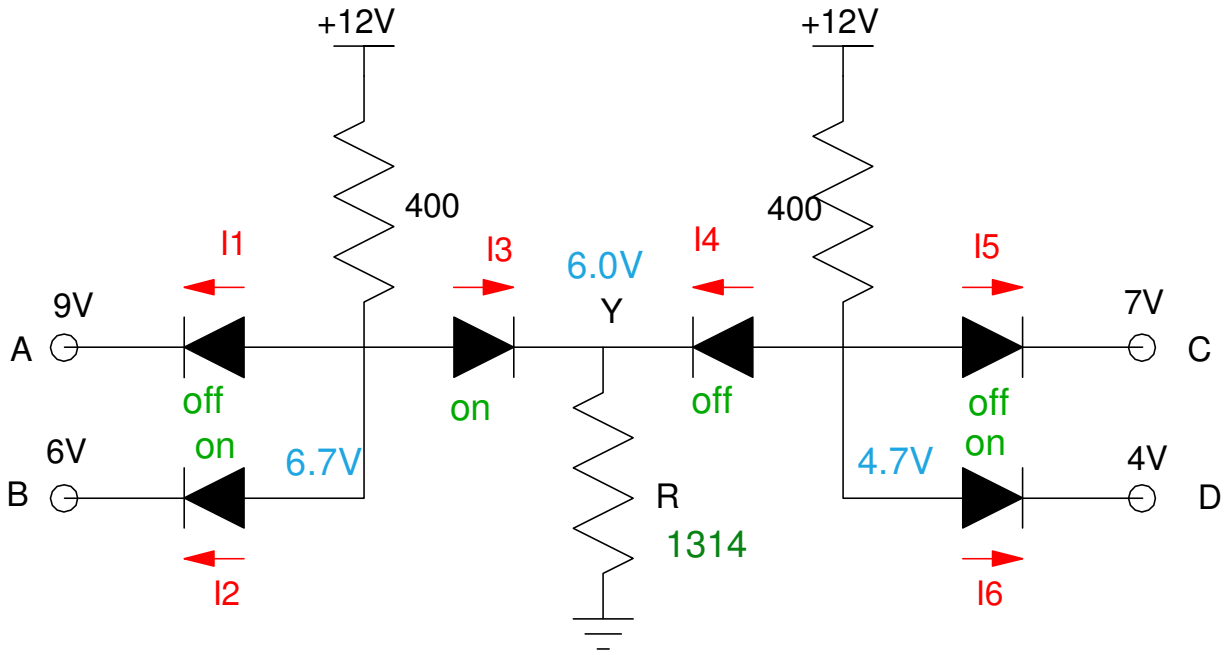
$$V_2(DC) = \left(\frac{567.8}{567.8+170}\right)V_1(DC) = 13.46V$$

$$V_2(AC) = \left(\frac{(29.39-j125.8)}{(29.39-j125.8)+(170+j1885)}\right)V_1(AC)$$

$$|V_1(AC)| = 0.265V_{pp}$$

5) Max/Min Circuits. Determine the currents I1 .. I6. Assume

- Ideal silicon diodes (Vf = 0.7V)
- R = 800 + 100*(your birth month) + (birth date)



R 800 + 100*mo day	I1	I2	I3	I4	I5	I6
1314	**0mA**	**8.684mA**	**4.566mA**	**0mA**	**0mA**	**18.25mA**

$$I_6 = \left(\frac{12V - 4.7V}{400\Omega}\right) = 18.25mA$$

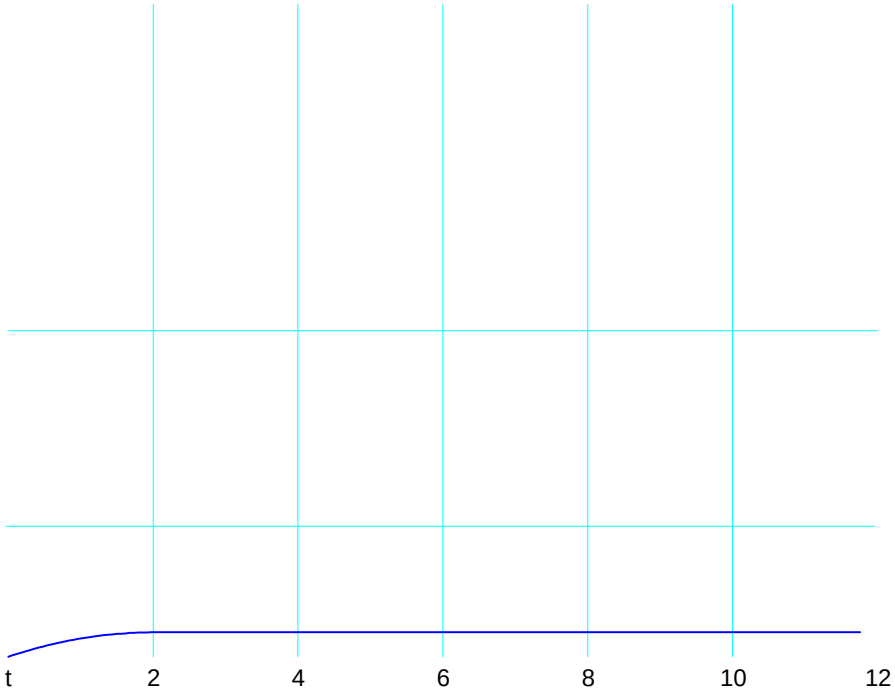
$$I_3 = \left(\frac{6V}{1314\Omega}\right) = 8.684mA$$

$$I_2 + I_3 = \left(\frac{12V - 6.7V}{400\Omega}\right) = 13.25mA$$

[redacted]

- [redacted]
- [redacted]
- [redacted]

[redacted]



D

AB \ CD	00	01	11	10
00	1	0	1	1
01	X	0	X	1
11	1	0	0	X
10	1	1	0	0

$$\overline{Y} \quad AC \quad BD \quad \overline{A}\overline{C}D$$

$$Y \quad \left(\overline{A} \quad \overline{C}\right)\left(\overline{B} \quad \overline{D}\right)\left(A \quad C \quad \overline{D}\right)$$