ECE 320 - Quiz #7 - Name _____

DC to AC, SCR

DC to AC Converter

1) Assume the Fourier transform for the output of a DC to AC converter driving a 1 Ohms reisistor is as follows:
   - note: units are Vp (peak voltage)
   - $Energy = \frac{1}{2}(a_n^2 + b_n^2)$ *Watts: assumes a 1 Ohm resistive load*

Harmonic	0 (DC)	1	2	3	4	5
an (cosine)	0	**5** Birth Month (1..12)	0	0	0	0
bn (sine)	0	**14** Birth Date (1..31)	0	0	0	0
Energy (Watts)	**0**	**110.5**	**0**	**0**	**0**	**0**

Determine the following:

Total Energy in the signal Watts	Energy in the 1st harmonic Watts	Efficiency % of energy in the 1st harmonic
110.5	**110.5**	**100%**

DC to AC Converter

2) Assume the Fourier transform for the output of a DC to AC converter driving a 1 Ohms reisistor is as follows:

- note: units are Vp (peak voltage)
- *Watts: assumes a 1 Ohm resistive load*
- $Energy = \frac{1}{2}(a_n^2 + b_n^2)$

Harmonic	0 (DC)	1	2	3	4	5
an (cosine)	0	60Vp	0	10Vp	**14** Birth Date (1..31)	0
bn (sine)	0	0	**5** Birth Month (1..12)	0	0	5Vp
Energy (Watts)	**0**	**1800**	**12.5**	**50**	**98**	**12.5**

Determine the following:

Total Energy in the signal Watts	Energy in the 1st harmonic Watts	Efficiency % of energy in the 1st harmonic
1973 W	**1800 W**	**91.2%**

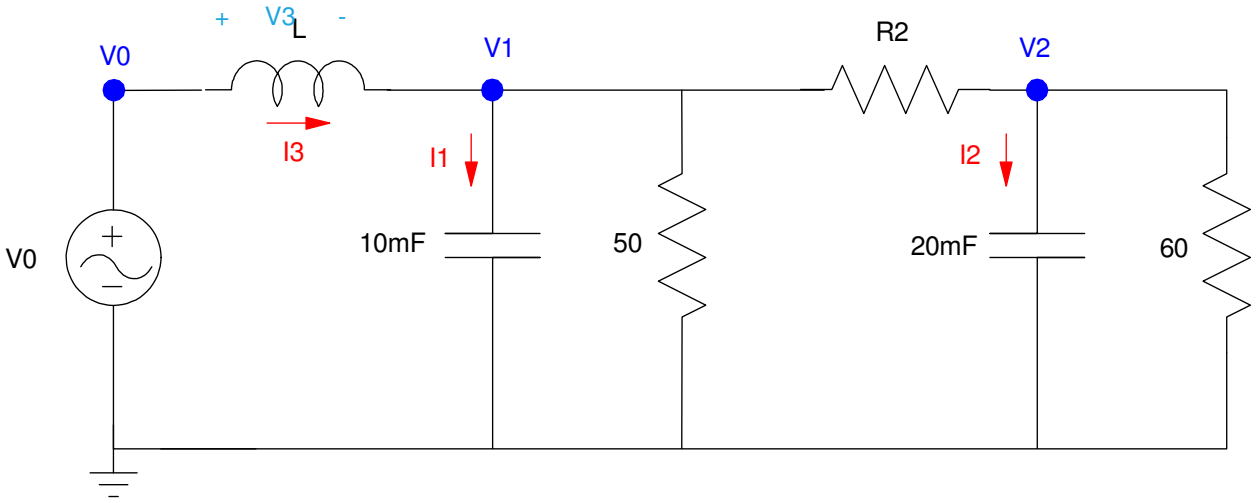
Circuits & Differential Equations

3) Write the differential equation which describes the following circuit. Assume

- L = your birth month (1..12) mH
- R2 = your birth date (1..31) Ohms

Note:

- $I = C\frac{dV}{dt}$
- $V = L\frac{dI}{dt}$



$$V_3 = L\frac{dI_3}{dt} = V_0 - V_1$$

$$I_1 = 0.01\frac{dV_1}{dt} = I_3 - \left(\frac{V_1}{50}\right) - \left(\frac{V_1 - V_2}{R_2}\right)$$

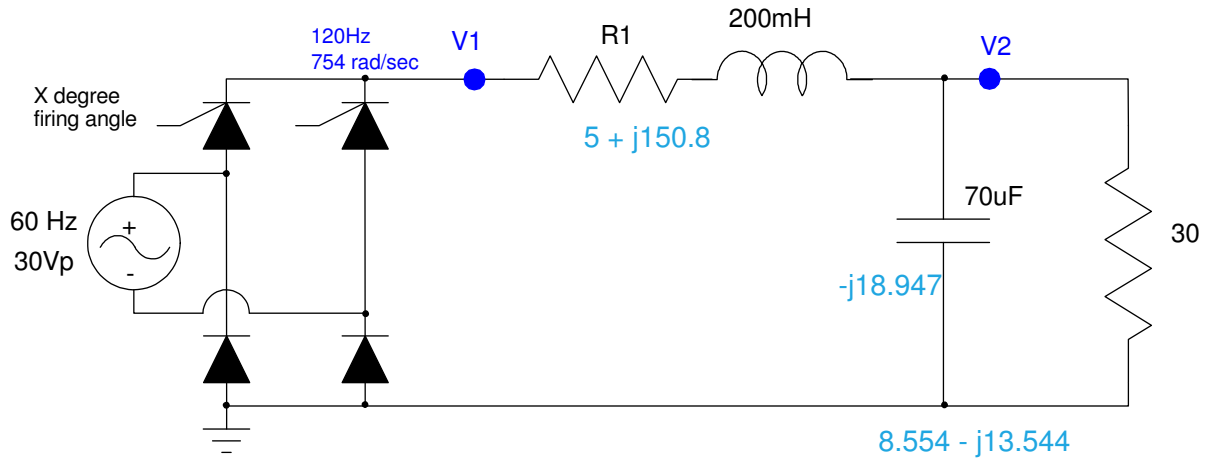
$$I_2 = 0.02\frac{dV_2}{dt} = \left(\frac{V_1 - V_2}{R_2}\right) - \left(\frac{V_2}{60}\right)$$

SCR (4 diode version)

4) SCR: Analysis. Determine the votlages at V1 and V2 (both DC). Assume

- R1 = your birth month (1..12)
- X = 10 + your birth date (11..41 degree firing angle)

Firing Angle day + 10	V1		V2	
	DC	AC (V1pp)	DC	AC (V2pp)
24 degrees	**16.047 V**	**42.202 Vpp**	**13.755 V**	**4.902 Vpp**



$$V_1(DC) = \left(\frac{2}{\pi}\right) \cdot 30V \cdot \cos(24^0) - 1.4$$

$$V_1(DC) = 16.047V$$

$$V_2(DC) = \left(\frac{30}{30+5}\right) V_1(DC)$$

$$V_2(DC) = 13.755V$$

$$V_1(AC) = 30(1 + \sin(24^0)) = 42.202V_{pp}$$

$$V_2(AC) = \left(\frac{(8.554 - j13.544)}{(8.554 - j13.544) + (5 + j150.8)}\right) \cdot V_1(AC)$$

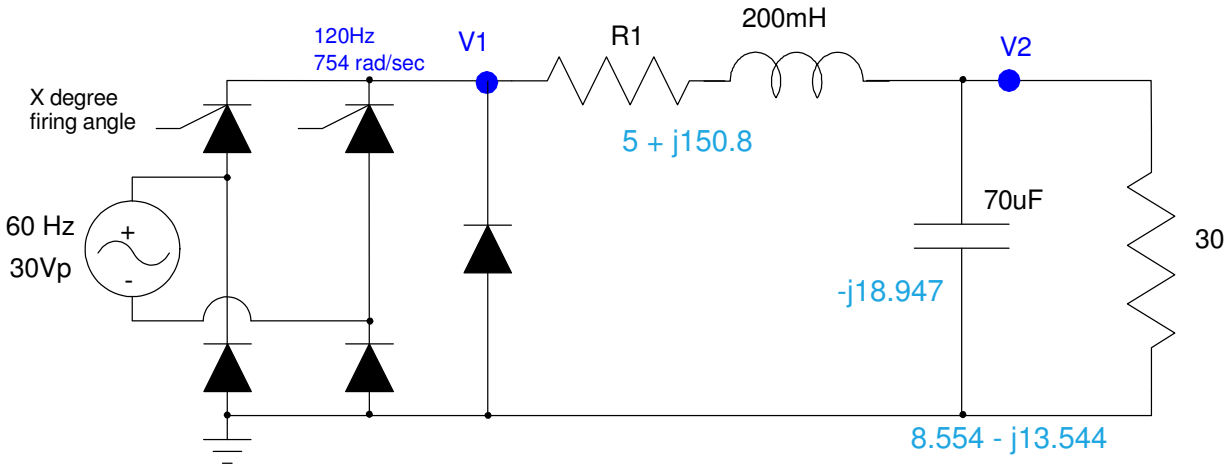
$$V_2(AC) = 4.902V_{pp}$$

SCR (5 diode version)

5) SCR: Analysis. Determine the votlages at V1 and V2 (both DC). Assume

- R1 = your birth month (1..12)
- X = 10 + your birth date (11..41 degree firing angle)

Firing Angle day + 10	V1		V2	
	DC	AC (V1pp)	DC	AC (V2pp)
24 degrees	**17.146 V**	**29.3 Vpp**	**14.697 V**	**3.403 Vpp**



$$V_1(DC) = \left(\frac{29.3V}{\pi}\right)(1+\cos(24^0)) - 0.7$$

$$V_1(DC) = 17.146V$$

$$V_2(DC) = \left(\frac{30}{30+5}\right)V_1(DC)$$

$$V_2(DC) = 14.697V$$

$$V_1(AC) = 29.3V_{pp}$$

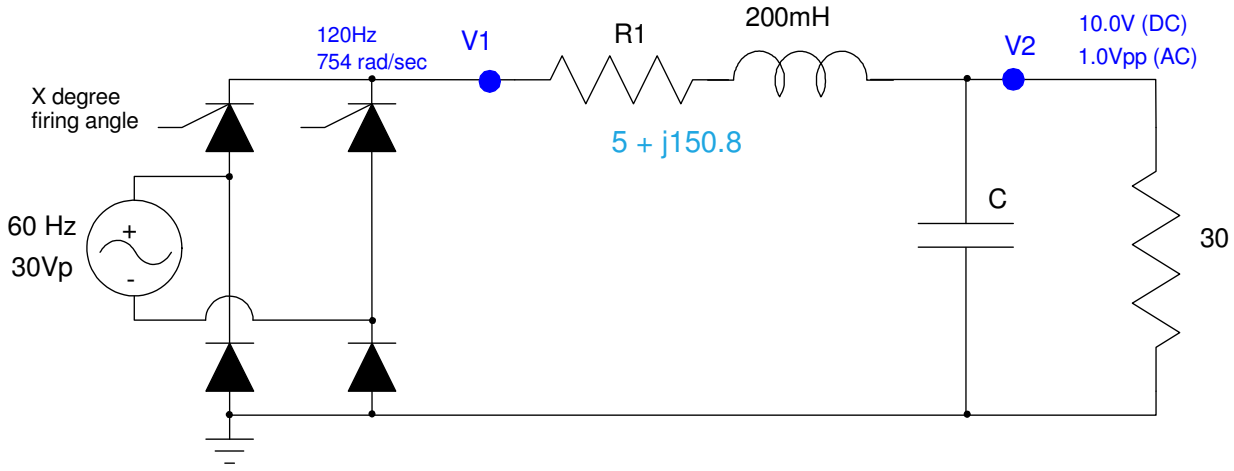
$$V_2(AC) = \left(\frac{(8.554-j13.544)}{(8.554-j13.544)+(5+j150.8)}\right)\cdot V_1(AC)$$

$$V_2(AC) = 3.403V_{pp}$$

6) SCR Design. Determine the firing angle and C so that

- V2(DC) = 10.00V
- V2(AC) = 1.00Vpp
- R1 = Your Birth Month (1..12)

V1(DC)	Firing Angle	C	R1 Month (1..12)
11.667 V	**46.828 degrees**	**444.5 uF**	**5 Ohms**



$$V_1(DC) = \left(\frac{30+5}{30}\right) 10.00V = 11.667V$$

$$V_1(DC) = \left(\frac{2}{\pi}\right) \cdot 30V \cdot \cos(\theta) - 1.4$$

$$\theta = 46.828^0$$

$$V_1(AC) = 30(1 + \sin(46.828^0)) = 51.879V_{pp}$$

If C = 0

$$V_2(AC) = \left(\frac{30}{30+(5+j150.8)}\right) \cdot 51.879V_{pp} = 10.054V_{pp}$$

To bring this down to 1.00Vpp

$$\left|\frac{1}{j\omega C}\right| = \left(\frac{1V_{pp}}{10.054V_{pp}}\right) 30\Omega = 2.984\Omega$$

$$C = 444.5\mu F$$