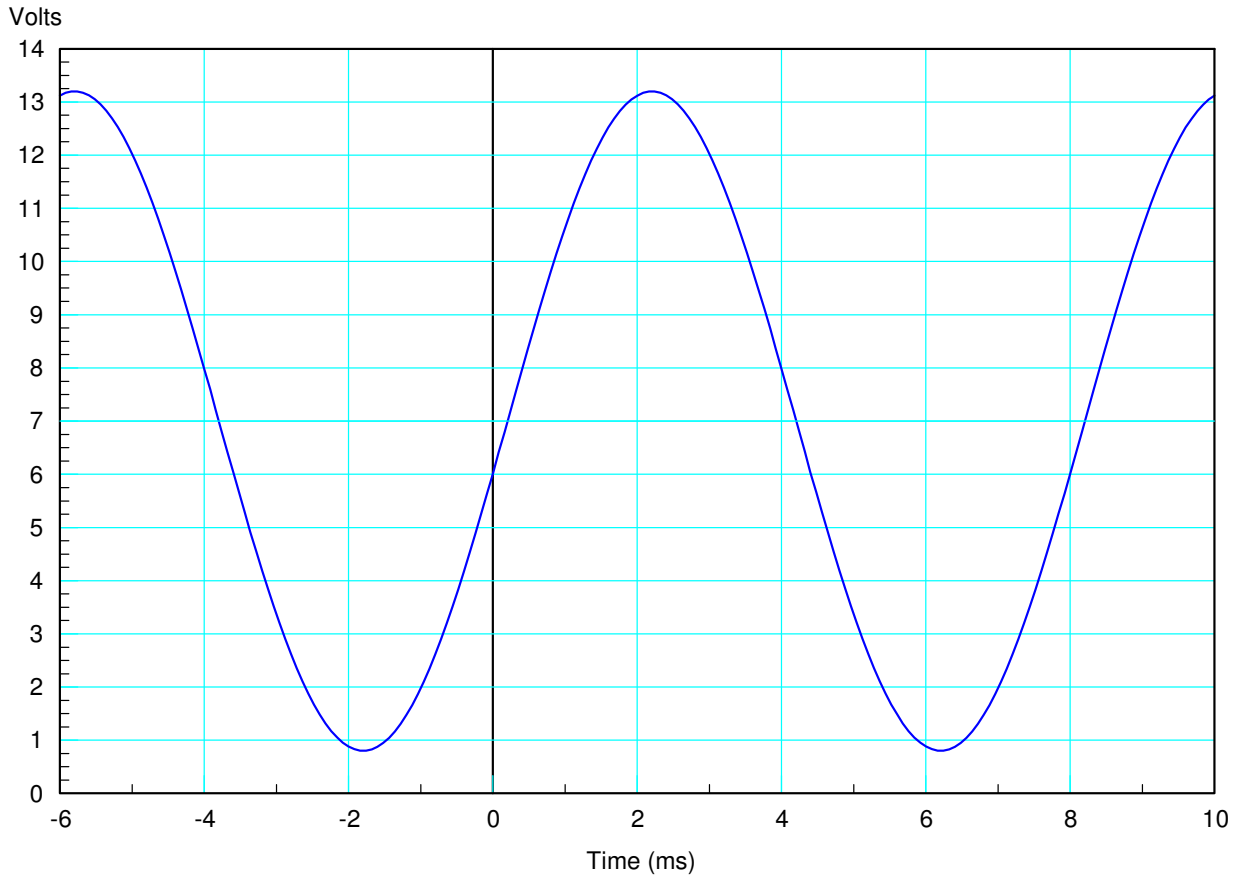
ECE 320 - Quiz #6 - Name _____

DC to AC, SCT, Boolean Logic. March 5, 2020

1) Determine the Fourier transform for the following waveform (i.e. express the signal in terms of constants and sinusoids):

$$x(t) = 7.00 + 6.2\cos(785t - 99^0)$$



DC: max = 13.2V, min = 0.8V, average = 7.00V

AC: Vpp = 12.4Vpp Vp = 6.2

Period = 8ms

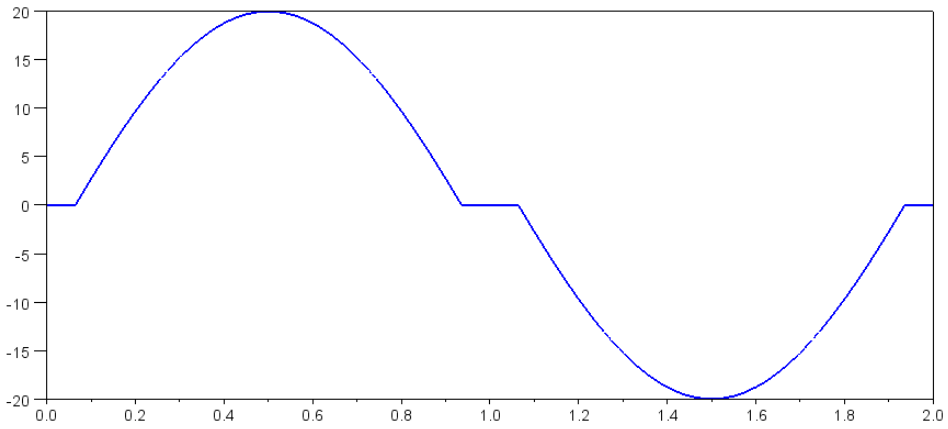
f = 1/period = 125Hz

w = 2 pi f = 785 rad/sec

Delay = 2.2ms

$\phi = \left(\frac{2.2ms}{8ms}\right) 360^0 = 99^0$ delay (negative phase)

2) A DC to AC converter outputs the following waveform:



Determine the efficiency of this DC to AC converter (i.e. the percentage of the energy in the first harmonic)

efficiency = 0.984

The Fourier coefficients are as follows:

```
a1 = 2*mean(x .* exp(-j*pi*t))          Energy = 1/2 | V | ^2
 a1  =    -18.657842i                          173.91W

a2 = 2*mean(x .* exp(-j*2*pi*t))
 a2  =    0                                    0 W

a3 = 2*mean(x .* exp(-j*3*pi*t))
 a3  =    + 1.9940369i                         1.988W

a4 = 2*mean(x .* exp(-j*4*pi*t))
 a4  =    0                                    0W

a5 = 2*mean(x .* exp(-j*5*pi*t))
 a5  =  + 1.0688105i                           0.571W

a6 = 2*mean(x .* exp(-j*6*pi*t))
 a6  =  0                                      0W

a7 = 2*mean(x .* exp(-j*7*pi*t))
 a7  =   + 0.6376461i                          0.203W


                                  Total =     176.67W
```

$$\eta = \frac{173.91W}{176.67W} = 0.984$$

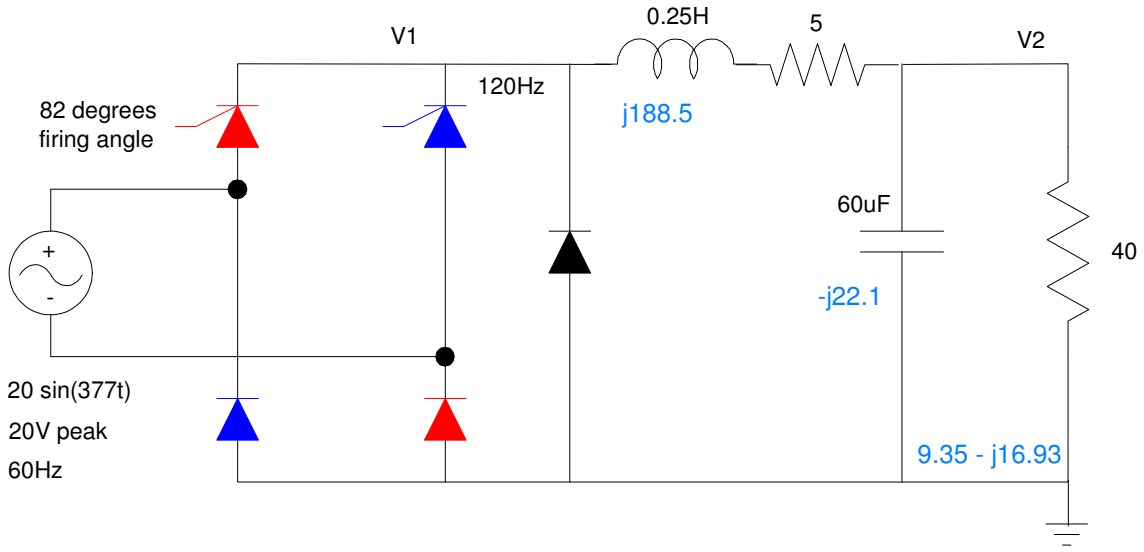
SCR: Analysis

3) Determine the voltages at V1 and V2 for the following AC to DC converter. Assume a firing angle of 82 degrees

V1		V2	
DC mean(V1)	AC (V1pp)	DC mean(V2)	AC (V2pp)
6.298 V	**19.3 Vpp**	**5.599 V**	**2.168 Vpp**

Note: the relationship between firing angle and the DC voltage is

$$V_{avg} = \left(\frac{19.3}{\pi}\right)(1+\cos\theta) - 0.7$$



DC: $V_1 = 6.298V$

$$V_2 = \left(\frac{40}{40+5}\right)V_1 = 5.599V$$

AC: max(V1) = 18.6V

min(V1) = -0.7V

$$V_1 = 19.3V_{pp}$$

$$V_2 = \left(\frac{(9.35-j16.93)}{(9.35-j16.93)+(5+j188.5)}\right)19.3V_{pp}$$

$$V_2 = 2.168V_{pp}$$

SCR Design

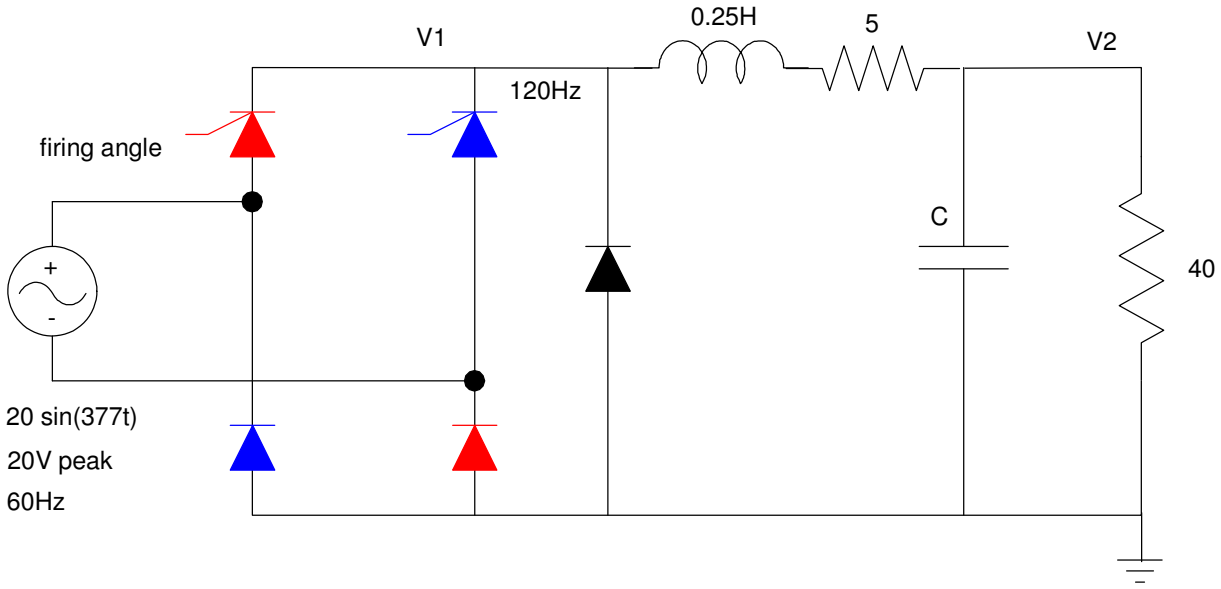
4) Design an AC to DC converter so that

- The output (V2) is 5.00V (DC)
- With a ripple of 1Vpp (AC)

V1 (DC)	Firing Angle	C	V2 (DC)
5.265 V	**88.306 deg**	**130uF**	**5.00 V**

Note: the relationship between firing angle and the DC voltage is

$$V_{avg} = \left(\frac{19.3}{\pi}\right)(1+\cos\theta) - 0.7$$



DC:

$$V_2 = 5.00V = \left(\frac{40}{40+5}\right)V_1$$

$$V_1 = 5.625V = \left(\frac{19.3}{\pi}\right)(1+\cos\theta) - 0.7$$

$$\theta = 88.306^0$$

AC:

C = 60uF produced 2.168Vpp at V2

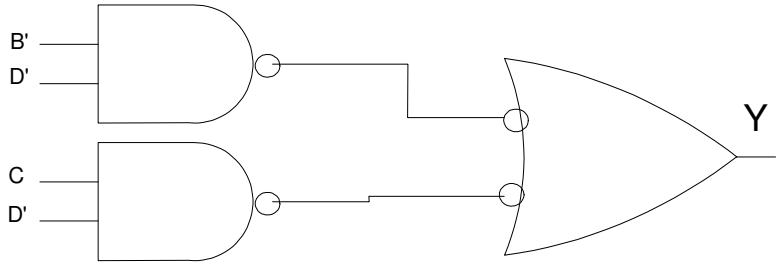
For 1Vpp

$$C = \left(\frac{2.168V_{pp}}{1.00V_{pp}}\right)60\mu F = 130\mu F$$

5) Design a circuit to implement the following logic using NAND gates (i.e. circle the ones)

e(A,B,C,D)		CD			
		00	01	11	10
AB	00	1	0	0	1
	01	0	0	0	1
	11	x	x	x	x
	10	1	0	x	x

$$y = \overline{B}\overline{D} + C\overline{D}$$



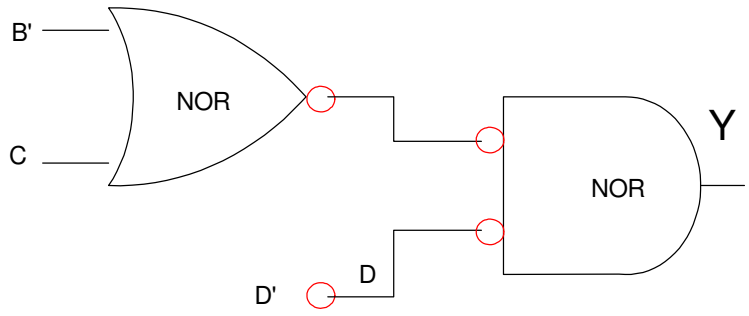
6) Design a circuit to implement the following logic using NOR gates (i.e. circle the zeroes)

e(A,B,C,D)		CD			
		00	01	11	10
AB	00	1	0	0	1
	01	0	0	0	1
	11	x	x	x	x
	10	1	0	x	x

$$\overline{Y} = D + B\overline{C}$$

using DeMorgan's theorem

$$Y = \overline{D}\left(\overline{B} + C\right)$$



Bernie Sanders Bonus!!! Did the following events come before or after Bernie Sanders was born? (Sept 1941):

- The invention of the transistor — before **after** — *1951 Bell Labs, USA*
- The first wind energy plant — **before** after — *1931, USSR*
- The first programmable computer — **before** after — *May 1941, Germany*