ECE 320 - Solution to Homework #7

DC to AC Converters, SCR's   Due Monday, February 25th, 2019

DC to AC

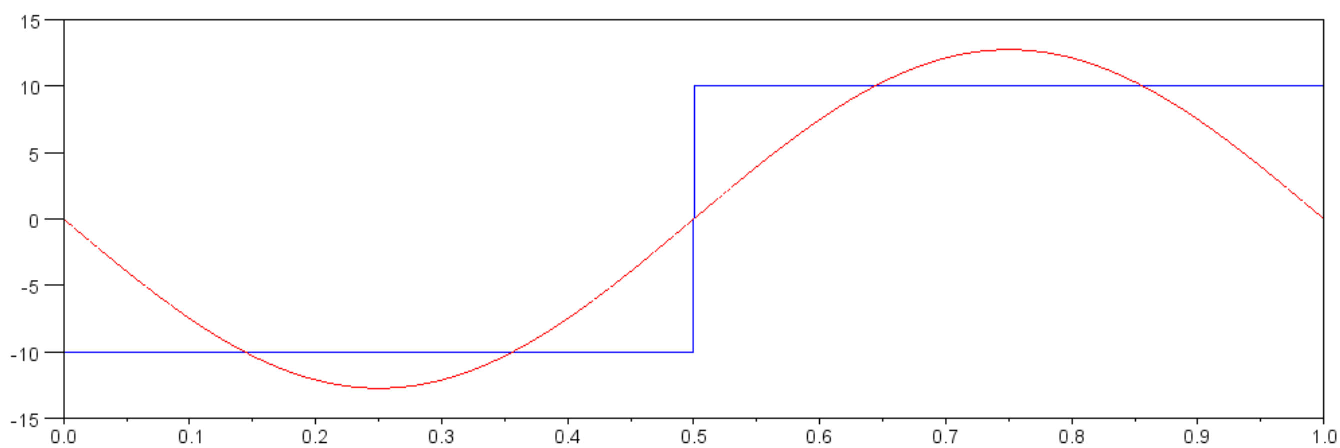
Problem 1-3) Find the efficiency of the following DC to AC converters.

i.e. find the percentage of the energy in the 1st harmonic

1) $$x(t) = \begin{cases} -10V & 0 < t < 0.5 \\ +10V & 0.5 < t < 1 \end{cases}$$

Find the 1st term in the Fourier Transform

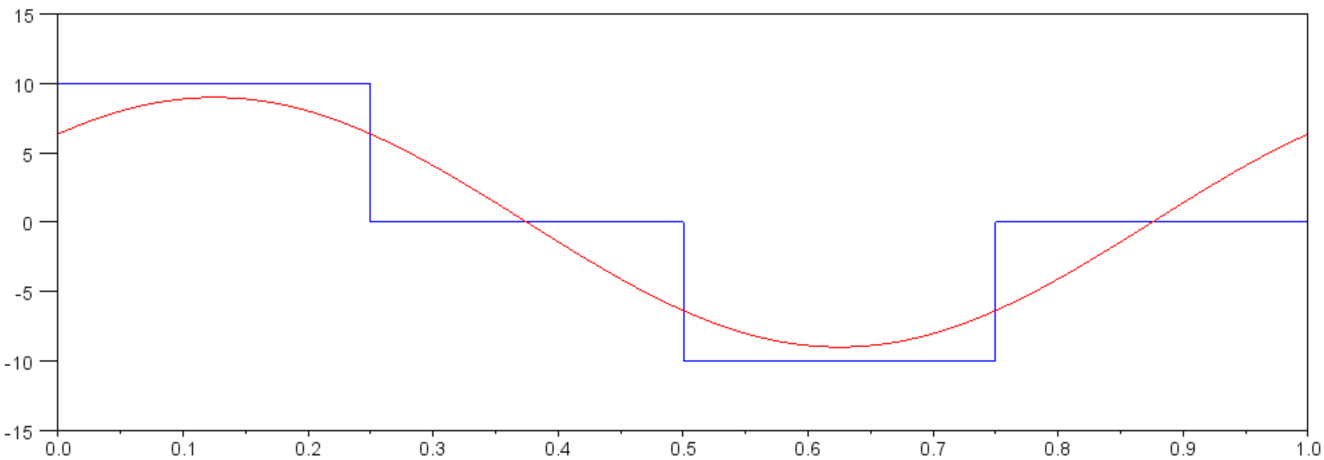
```
t = [0:0.0001:1]';

x = -10*(t<0.5) + 10*(t>0.5);

w0 = 2*pi;
c1 = 2*mean(x .* exp(-j*w0*t))

c1  = 0 + 12.731122i

eff = (0.5*abs(c1)^2) / mean(x.^2)

 eff  = 0.8104884


-->plot(t,x,t,real(c1)*cos(w0*t) - imag(c1)*sin(w0*t))
```



81.04% Efficient DC to AC Converter

2) $$x(t) = \begin{cases} +10V & 0 < t < 0.25 \\ -10V & 0.5 < t < 0.75 \\ 0 & otherwise \end{cases}$$

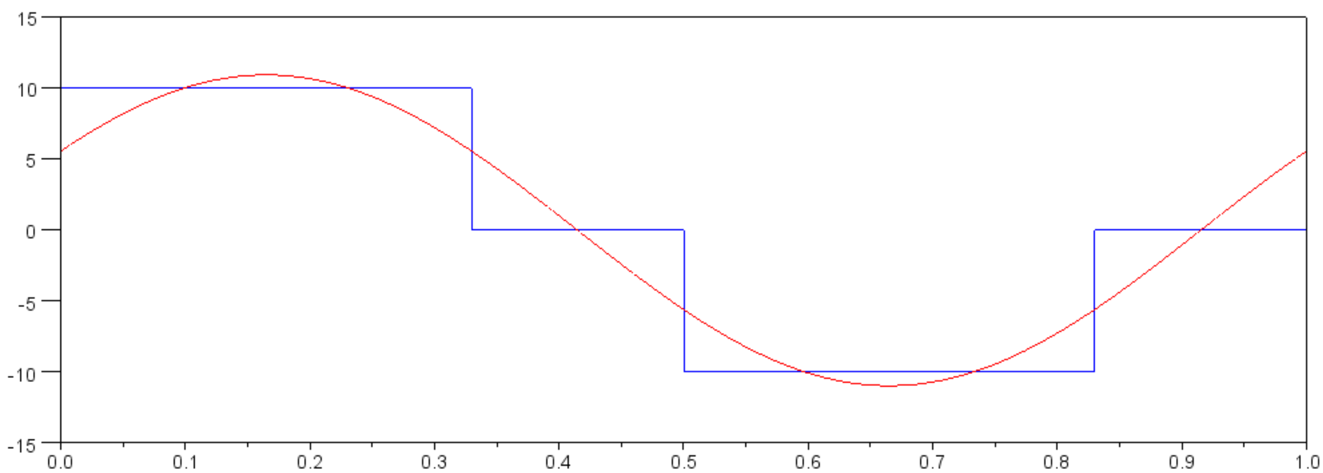
```
t = [0:0.0001:1]';

x = 10*(t<0.25) - 10*(t>0.5).*(t<0.75);

c1 = 2*mean(x .* exp(-j*w0*t))

 c1  =   6.365561 - 6.3635612i

eff = (0.5*abs(c1)^2) / mean(x.^2)

 eff  =   0.8103959

plot(t,x,t,real(c1)*cos(w0*t) - imag(c1)*sin(w0*t))
```



81.03% efficient DC to AC converter

3) $$x(t) = \begin{cases} +10V & 0 < t < 0.33 \\ -10V & 0.5 < t < 0.83 \\ 0 & otherwise \end{cases}$$

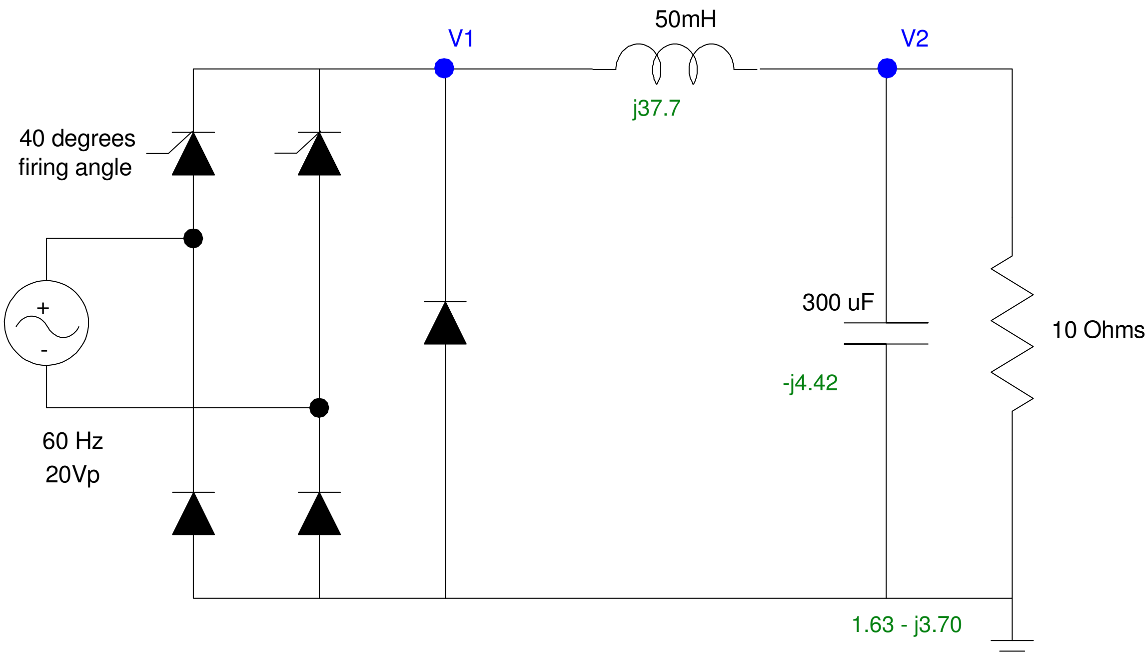
```
x = 10*(t<0.33) - 10*(t>0.5).*(t<0.83);

c1 = 2*mean(x .* exp(-j*w0*t))

 c1  =  5.579147 - 9.4304409i

eff = (0.5*abs(c1)^2) / mean(x.^2)

 eff  =  0.9097750

plot(t,x,t,real(c1)*cos(w0*t) - imag(c1)*sin(w0*t))
```



90.97% efficient DC to AC converter

SCR

4) Assume a firing angle of 40 degrees. Determine the votlage at V1 and V2 (DC and AC)



DC Analysis: If you ignore the -0.7V offset

$$V_{avg} = \frac{V_p}{\pi}(1 + \cos\theta)$$

If you include it

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

$$V_{avg} = \left(\frac{19.3V}{\pi}\right)(1 + \cos(40^0)) - 0.7$$

$$V_{avg} = 10.14V$$

$$V_{1dc} = V_{2dc} = 10.14V$$

AC Analysis

$$V_{1pp} = 19.3V$$

$$V_{2pp} = \left(\frac{1.63 - j3.70}{(1.63 - j3.70) + j37.30}\right)(19.3V_{pp})$$

$$V_{2pp} = 2.319V_{pp}$$

5) Modify this circuit so that the votlage at V2 is 5.00V (DC) with 250mVpp ripple.

The voltage at V1 is approximately

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

$$5.00V = \left(\frac{19.3V}{\pi}\right)(1+\cos\theta) - 0.7$$

$$\theta = 94.14^0$$

To get a ripple of 250mVpp, change L and C. Pick L to reduce the ripply by 10x (arbitrary)

$$|j\omega L| = 10R$$

$$754L = 100\Omega$$

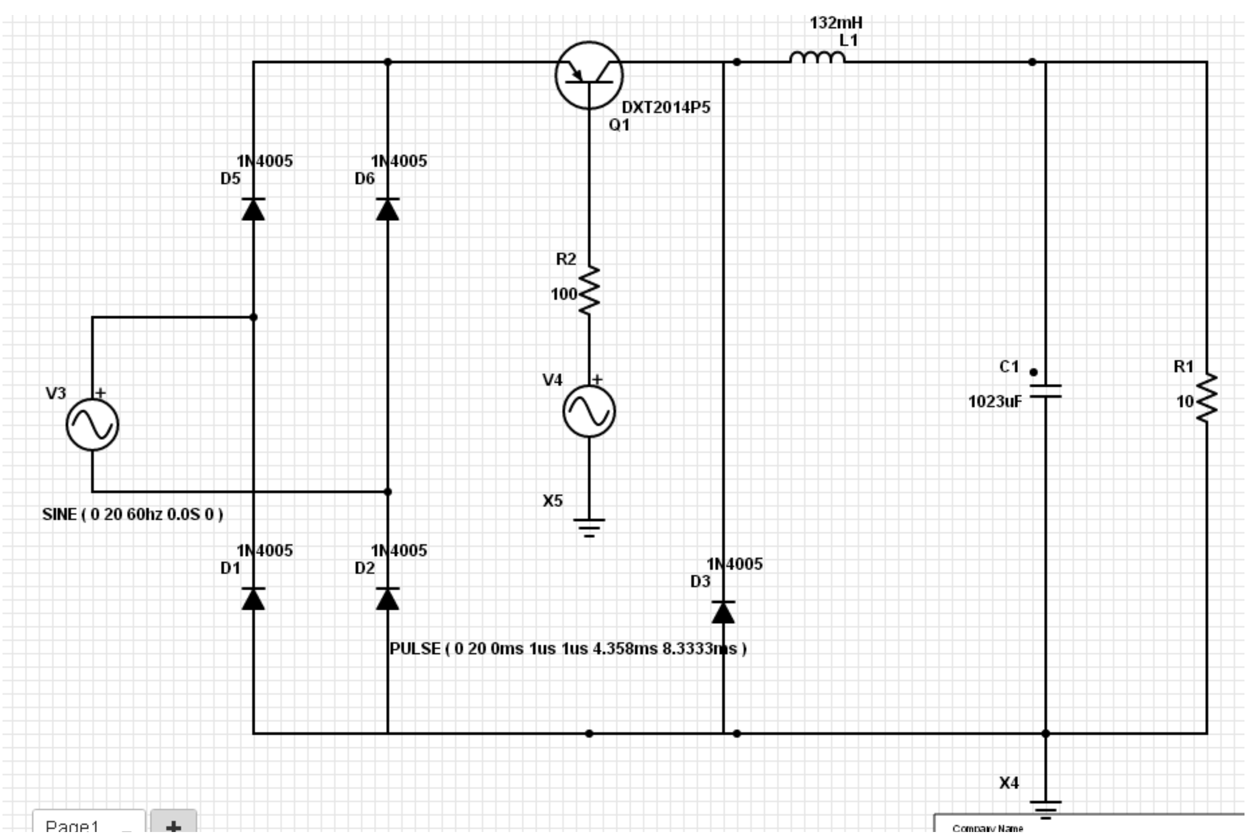
$$L = 132mH$$

This brings the ripple down to 1.93Vpp. To bring it down to 250mVpp, choose C so that

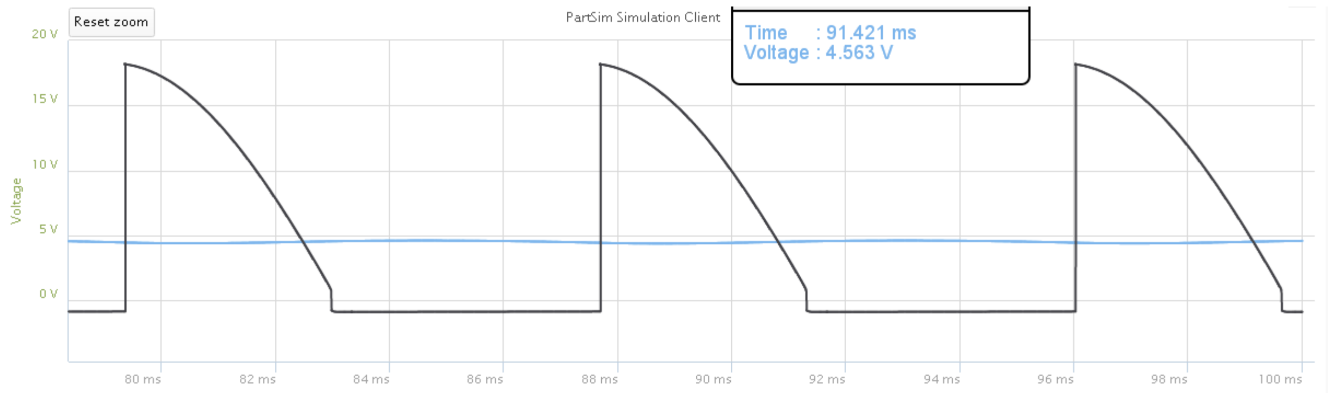
$$\left|\frac{1}{j\omega C}\right| = \left(\frac{0.250V}{1.93V}\right) \cdot 10\Omega$$

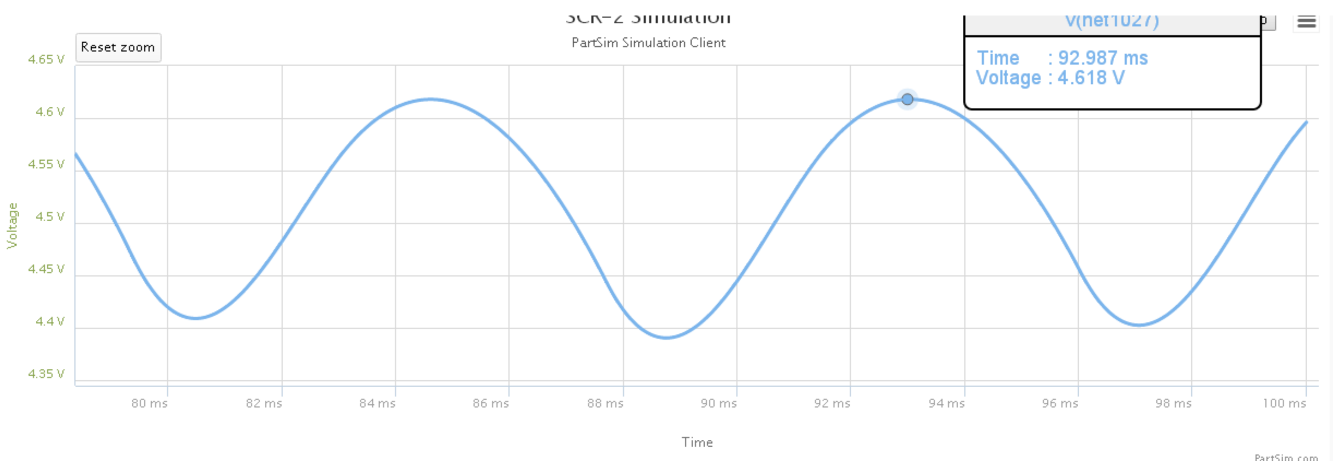
$$\frac{1}{754 \cdot C} = 1.295\Omega$$

$$C = 1023\mu F$$



6) Check your answer for problem #5 in PartSim





	V2 (DC)	V2(AC)
Calculated	5.00 V	250mVpp
Simulated	4.50 V	228mVpp