## Assignment 1 - AC power

Forjanic Remy (511448), EEL1V.IB

#### Question 1

$$\begin{split} pf &= 0.75,\, f = 50 \mathrm{Hz}, V_{rms} = 230 \mathrm{V} \\ S &= \frac{511448}{100} = 5114.48 \mathrm{VA} \end{split}$$

Calculate 
$$I_{rms}$$
 
$$I_{rms} = \frac{S}{U_{rms}} = \frac{5114.48}{230} \approx 22.2 \mathrm{A}$$

$$\begin{aligned} & \textbf{Calculate } P \textbf{ and } Q \textbf{ of the load} \\ & P = U_{rms} \times I_{rms} \times cos(\varphi) \\ & = 230 \times 22.2 \times 0.75 \end{aligned}$$

$$pprox 3829.5 \mathrm{W}$$
  $S^2 = P^2 + Q^2$ 

$$\begin{array}{l} \Rightarrow Q = \sqrt{S^2 - P^2} \\ = \sqrt{5114.48^2 - 3829.5^2} \\ \approx 3390.1 \text{var} \end{array}$$

### Calculate ${\cal R}$ and ${\cal L}$ value of the load

$$R=rac{U_{rms}}{I_{rms}}=rac{230}{22.2}pprox 10.36\Omega$$

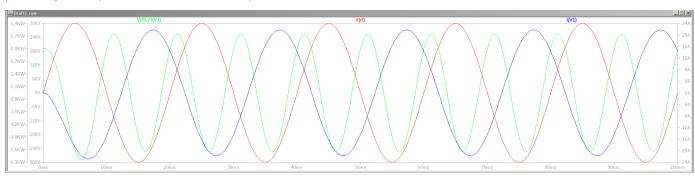
$$pf = rac{R}{|Z|}$$
 
$$\Rightarrow |Z| = rac{R}{pf}$$
 
$$= rac{10.36}{0.75} pprox 13.81\Omega$$

$$egin{aligned} X_L &= \sqrt{|Z|^2 - R^2} \ &= \sqrt{13.81^2 - 10.36^2} \ &pprox 9.13\Omega \end{aligned}$$

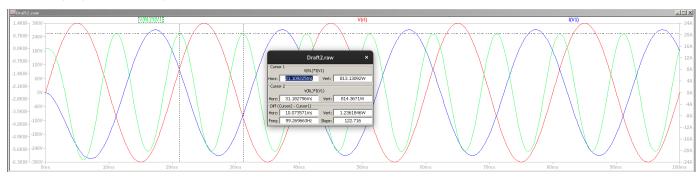
$$\begin{split} L &= \frac{X_L}{2\pi \times f} \\ &= \frac{9.13}{2\pi \times 50} \\ &\approx 29.06 \text{mH} \end{split}$$

### Question 2

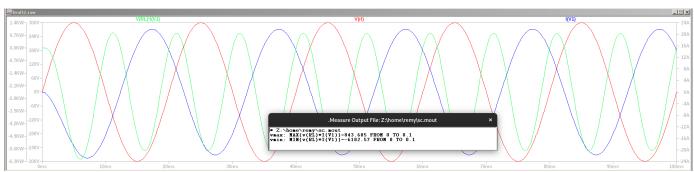
### plot the voltage across $\mathit{RL}$ , the source current and its instantaneous power



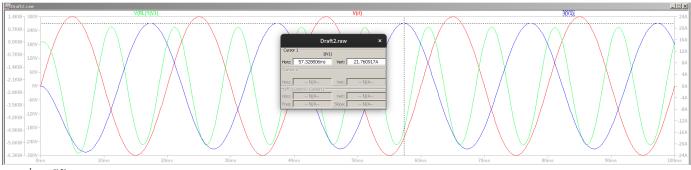
## What is the frequency of the instantaneous power?



What is the minimum and maximum instantaneous power?

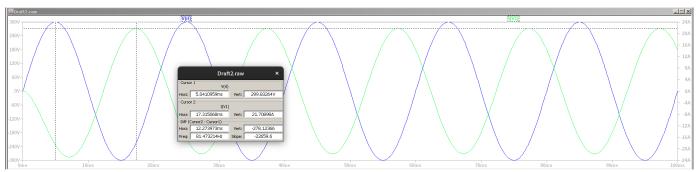


### Also determine $I_{rms}$ using the simulation plots



 $I_{rms}=rac{I_{peak}}{\sqrt{2}}=rac{21.76}{\sqrt{2}}pprox15.38\mathrm{A}$ 

### Verify by using the simulation plots, the power factor



 $\Delta t = 12.27 \mathrm{ms}$ 

 $\varphi = 2\pi \times f \times \Delta t = 2\pi \times 50 \times 12.27 \times 10^{-3} \approx 3.85 \mathrm{rad}$ 

 $pf=\cos(\varphi)=\cos(3.85)\approx 0.76$ 

#### Question 3

# Calculate C when pf=0.9 lagging

pf = 0.9

 $arphi = \cos^{-1}(0.9) = 0.451 \mathrm{rad}$ 

 $Q = U_{rms} * I_{rms} * sin(\varphi) = 2225$ 

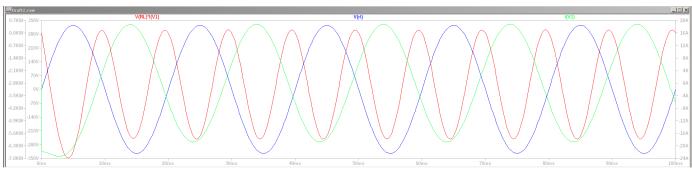
 $Q_L=rac{U_{rms}^2}{X_L}=5794 {
m var}$ 

 $Q_C = Q_L = 2225 - 5794 = -3559 \text{var}$ 

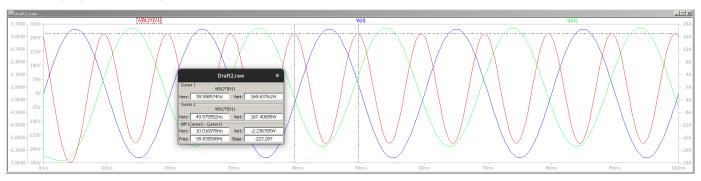
 $X_C=rac{U_{rms}^2}{Q_C}=14.86\Omega$ 

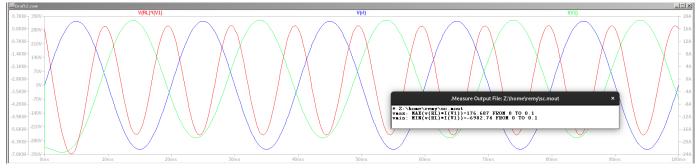
 $C = \frac{1}{X_C*100\pi} = \frac{1}{14.86*100\pi} = 214.2 \mu F$ 

# plot the voltage across $\mathit{RL}_{i}$ the source current and its instantaneous power



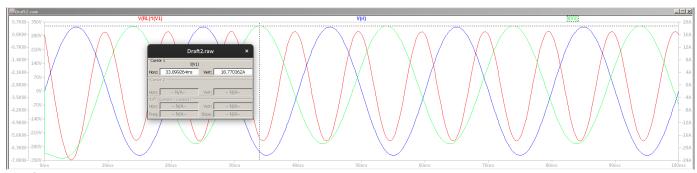
## What is the frequency of the instantaneous power?





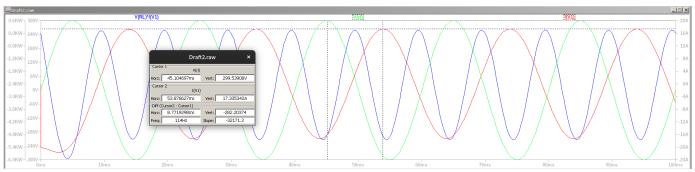
 $f\approx 100 {\rm Hz}$ 

# Also determine $I_{rms}$ using the simulation plots $% \left\{ 1,2,\ldots,n\right\}$



 $I_{rms}=rac{I_{peak}}{\sqrt{2}}=rac{18.77}{\sqrt{2}}pprox13.27\mathrm{A}$ 

# Verify by using the simulation plots, the power factor



 $\Delta t = 8.77 \mathrm{ms}$ 

 $arphi = 2\pi imes f imes \Delta t = 2\pi imes 50 imes 8.77 imes 10^{-3} pprox 2.77 {
m rad}$ 

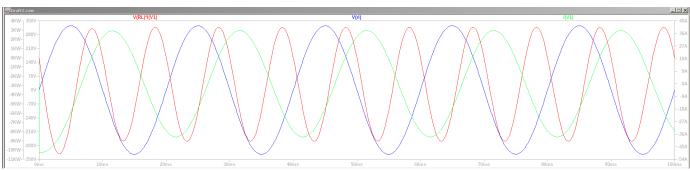
 $pf = \cos(arphi) = \cos(2.77) pprox 0.93$ 

### Question 4

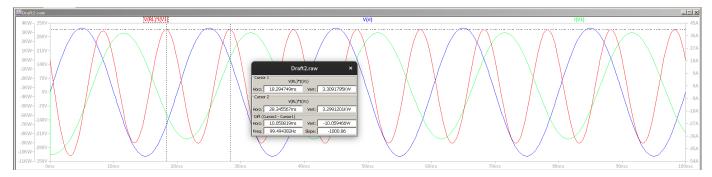
# Calculate C when pf=0.9 leading

$$\begin{split} \varphi &= -\cos^{-1}(0.9) = -0.451 \\ Q &= U_{rms} * I_{rms} * \sin(\varphi) = -2225 \text{var} \\ Q_L &= \frac{U_{rms}^2}{X_L} = 5794 \text{var} \\ Q_C &= Q - Q_L = 2225 - 5794 = -8019 \text{var} \\ X_C &= -\frac{U_{rms}^2}{Q_C} = 6.60 \Omega \\ C &= \frac{1}{X_C * 100 \pi} = 482.5 \mu F \end{split}$$

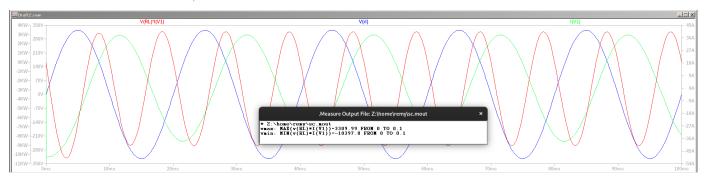
# plot the voltage across $\mathit{RL}$ , the source current and its instantaneous power



What is the frequency of the instantaneous power?

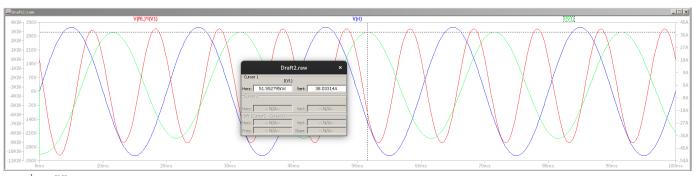


What is the minimum and maximum instantaneous power?



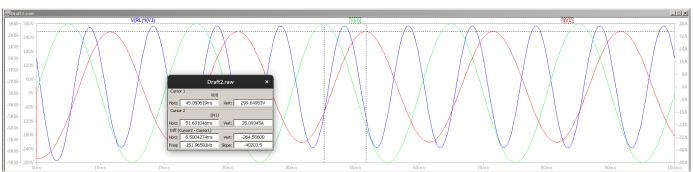
 $f\approx 100 {\rm Hz}$ 

# Also determine $I_{rms}$ using the simulation plots



 $I_{rms}=rac{I_{peak}}{\sqrt{2}}=rac{38.03}{\sqrt{2}}pprox26.89\mathrm{A}$ 

# Verify by using the simulation plots, the power factor



 $\Delta t = 6.58 \mathrm{ms}$ 

 $\varphi = 2\pi \times f \times \Delta t = 2\pi \times 50 \times 6.58 \times 10^{-3} \approx 2.07 \mathrm{rad}$ 

 $pf = \cos(\varphi) = \cos(2.07) \approx 0.48$