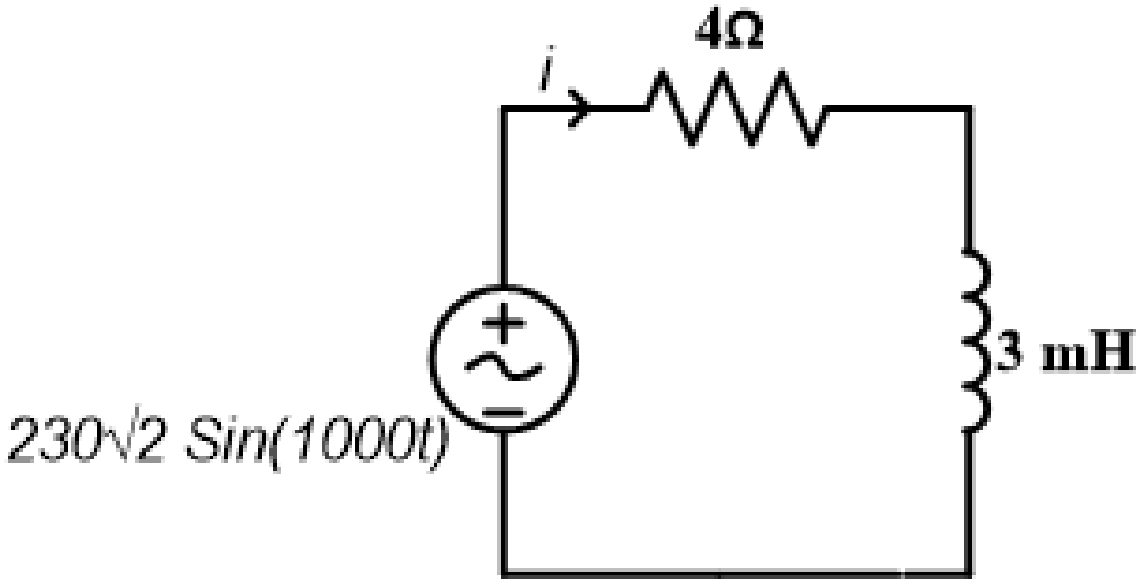
Lecture 10

AC Power

Power Factor Improvement

EXAMPLE

Estimate real, reactive powers and pf



Given, $V_m \angle \theta = 230\sqrt{2} \angle 0^0$, $Z = 4 + j3 = 5 \angle \tan^{-1}(3/4) = 5 \angle 36.87^0$

Then, $I_m \angle \phi = 230\sqrt{2} \angle 0 \,/\, 5 \angle 36.87^0 = 46\sqrt{2} \angle -36.87^0$

$\theta = 0^0$ but $\phi = -36.87^0$ => $\theta - \phi = 36.87^0$

Power Factor = $\cos(\theta - \phi) = \cos(36.87^0) = 0.8$ lagging

Real Power, $P = \frac{1}{2} \times 230\sqrt{2} \times 46\sqrt{2}\cos(36.87^0)$

$= V \times I \times \cos(36.87^0) = 230 \times 46 \times 0.8 = 8464$ W

Real power = $P = I^2 R = 46 \times 46 \times 4 = 8464$ W

Apparent Power $|S| = VxI = P/\cos(\theta - \phi) = 10580$ VA

Also, $|S| = V \times I = 230 \times 46 = 10580$ VA

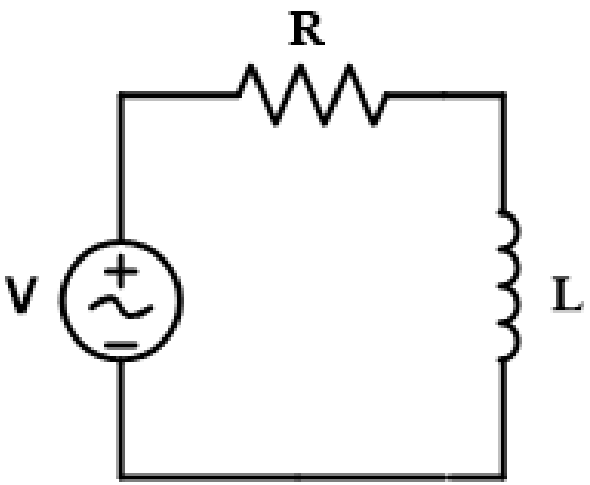
Reactive Power Q = VxIxSin(36.87) = 6348 VAR

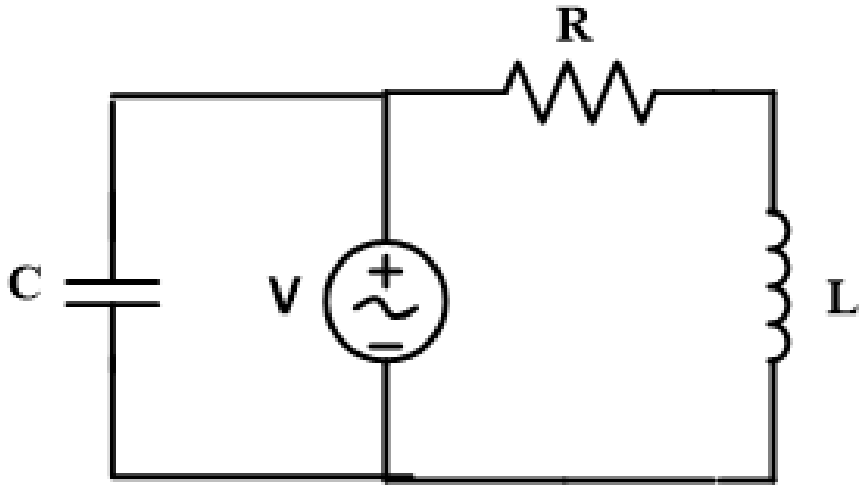
Also, $P \times \tan(\theta - \phi) = 8464 \times 0.75 = 6348$ VAR

Reactive power = $Q = I^2 X_L = 46 \times 46 \times 3 = 6348$ W

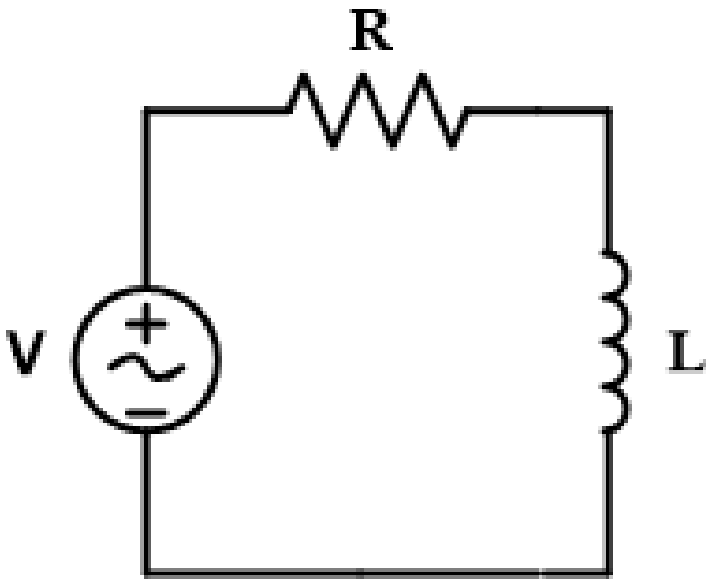
Power Factor Improvement

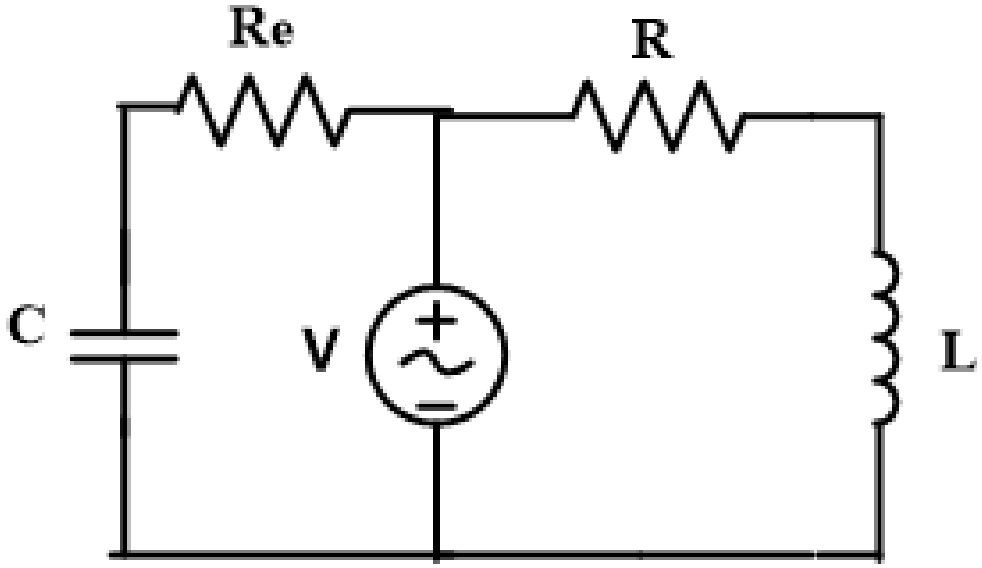
Power Factor to be 0.9 lagging from 0.8 lagging





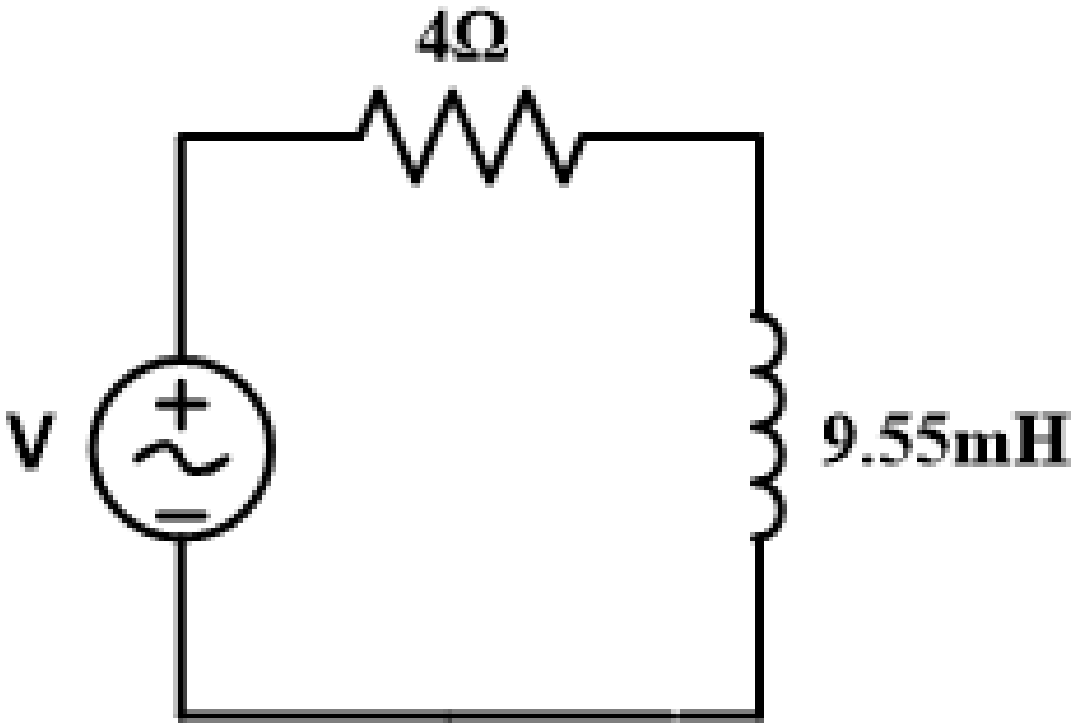
Power Factor Improvement





Power Factor Improvement

$v = 20\sqrt{2}\sin(\omega t)$ where f = 50 Hz



Power Factor to be 0.9 lagging

Given values in rms:

$V = 20\ L0^0$ and $Z = 4+j3 = 5\ \angle 36.87^0$

Then, $I = V/Z = 4\ \angle -36.87^0$

The power factor angle is: $\theta-\phi = 36.87^0$

PF is: $\cos(0-(-36.87^0)) =$ **0.8 lagging.**

Real power = $P= I^2 R= VI\cos(36.87^0) = 20x4x0.8= 64$ W

Reactive power=$Q = I^2 X_L = VI\sin(36.87^0) = 48$ VAR

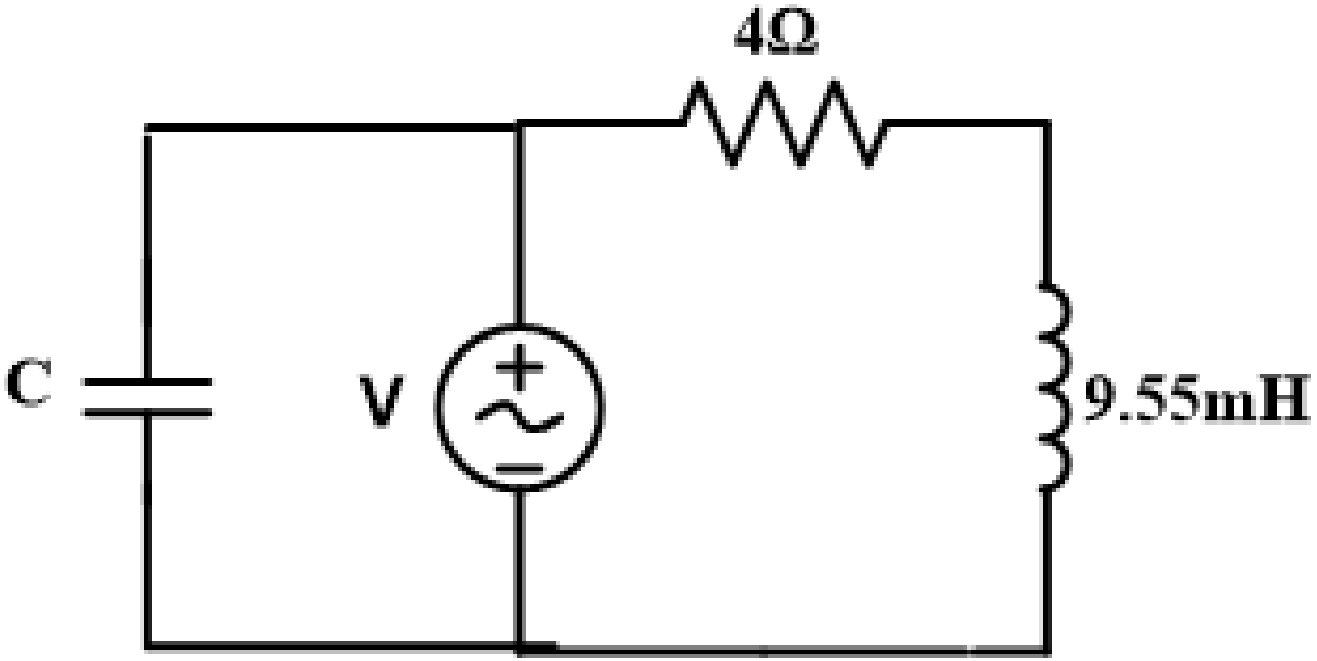
For Power Factor to be 0.9 lagging

Real power remains same => VI = 64/0.9 = 71.11 VA

$\cos(\phi_n) = \mathbf{0.9 \Rightarrow \phi_n = 25.84^0}$

Reactive power has to be => VI sin(**25.84^0**) = 31 VAR

For improving the power factor, following scheme is adopted.



The capacitor has to generate

$Qc = (48 - 31) = 17$ VAR

$Qc = V^2 / Xc = 17 \Rightarrow \omega C V^2 = 17$

$C = 17/(2x\pi x50x400) = 135.3\ \mu F$