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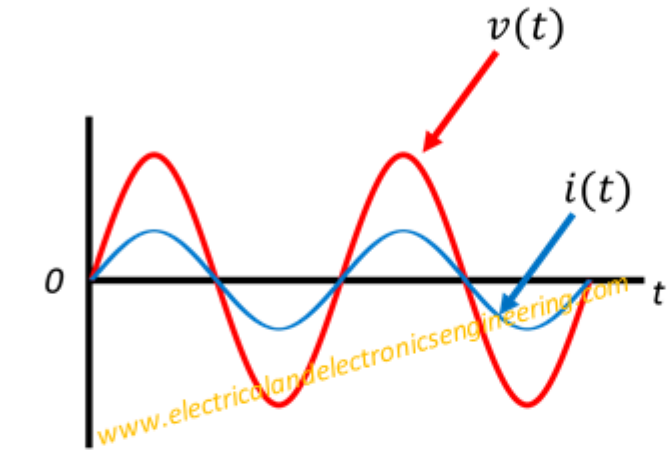

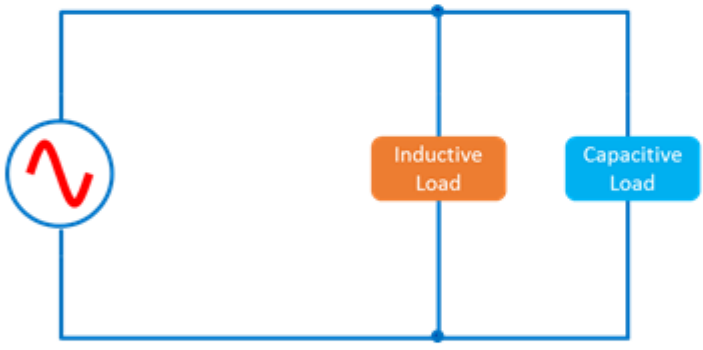

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A Step by Step Guide on

Power Factor

What is Power Factor

In Power factor is a fraction of apparent power that is actually supplying real power to the load

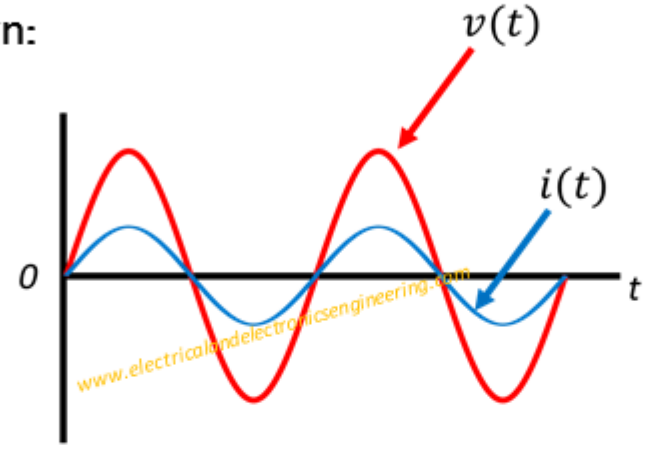
Power factor is ratio of real (P) to apparent power (S). Mathematically power factor is represented by cosθ, where

$$\cos\theta = \frac{P}{S}$$

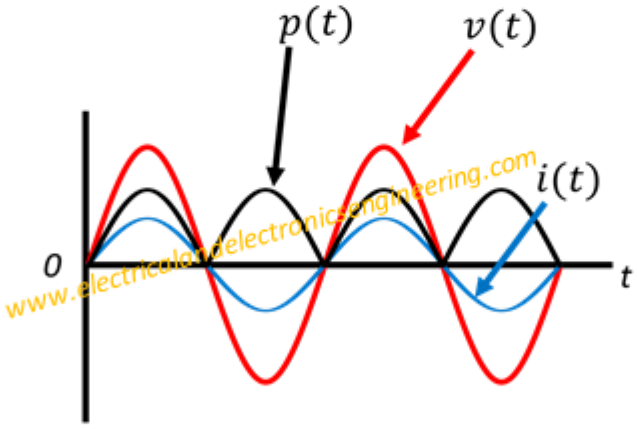
Contents:

AC Power to purely resistive load

Consider an ac source that is supplying a purely resistive load. The voltage v and current i for the load are drawn:



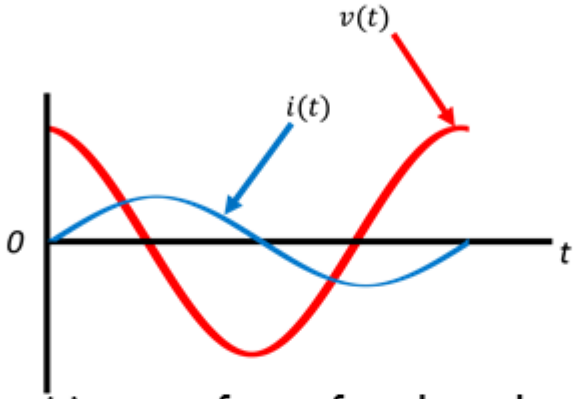
The power p(t) waveform for the above case is shown below:



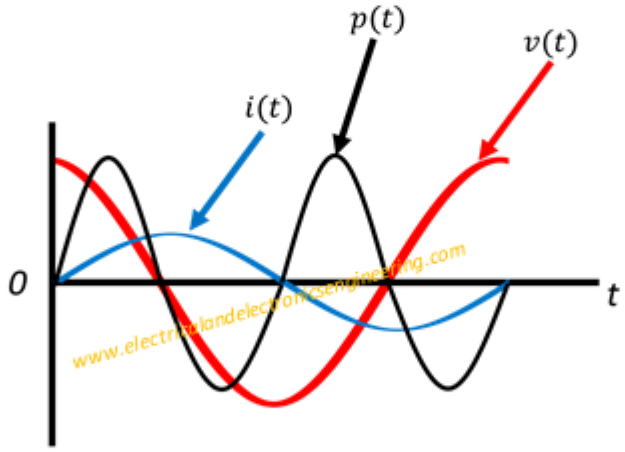
For a purely resistive load, the voltage and current are in series, and thus, the power at any instant is always positive. In electrical terms this positive power throughout the cycle indicates that power is continuously supplied to load.

AC Power to Inductive load

Now Consider an ac source that is supplying an inductive load. The voltage v and current I (lagging the voltage) for the load are drawn:



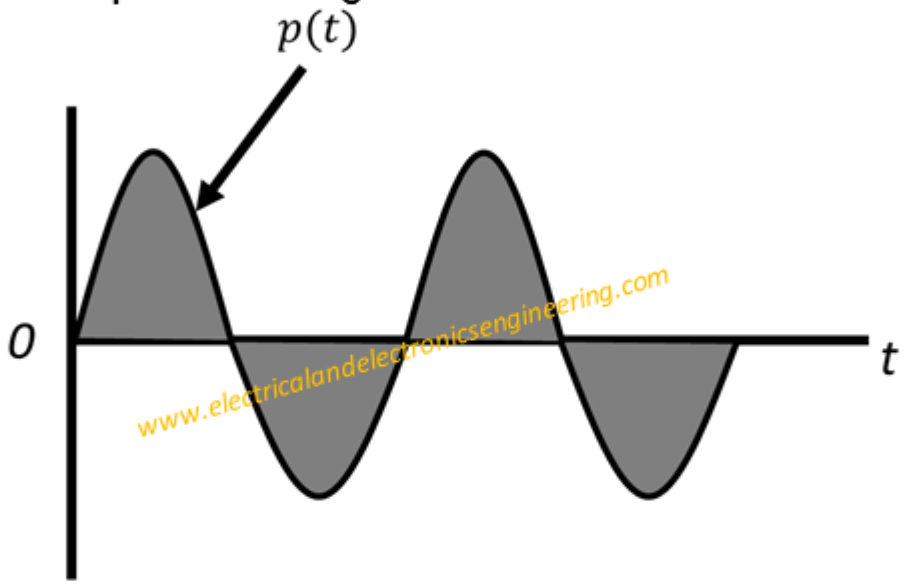
The power p(t) waveform for the above case is shown below:



To make things easier let's consider the power wave alone (next page)

AC Power to Inductive load

During first quarter the power flows to the inductance, while during second quarter power flows back, for third quarter again power flows to the inductor, and for fourth quarter it again flows back



This power that flows in and out of inductance is known as reactive power

Circuits containing both resistive and reactive (either inductive or capacitive loads or combined) have power that is neither active nor reactive, instead this is apparent power (S) which is sum of both powers.

This reactive power necessitates the concept of power factor in circuits

The Unity Leading and Lagging PF

The power factor defined as ratio of real to apparent power can either be unity, leading or lagging.

Unity

For a purely resistive load the angle θ is zero and PF is unity. (Since current and voltage are in phase)

Lagging

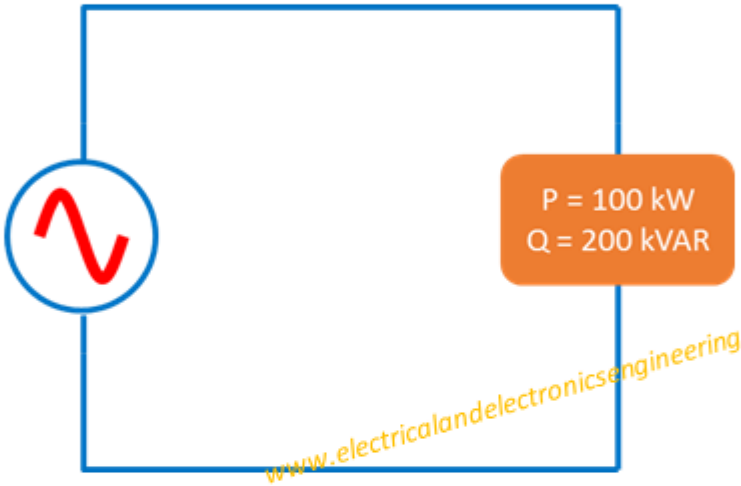
Fore a circuit containing inductance and resistance the power factor is lagging in nature (Since the current lags voltage in an inductive circuit)

Leading

Fore circuit containing a capacitor and resistor, the power factor is leading in nature (Since the current leads voltage in a capacitive circuit)

Example 1

A 220 V single phase generator supplies current to a load containing 100 kW active load and 200 kVAR inductive load. Find the power factor.



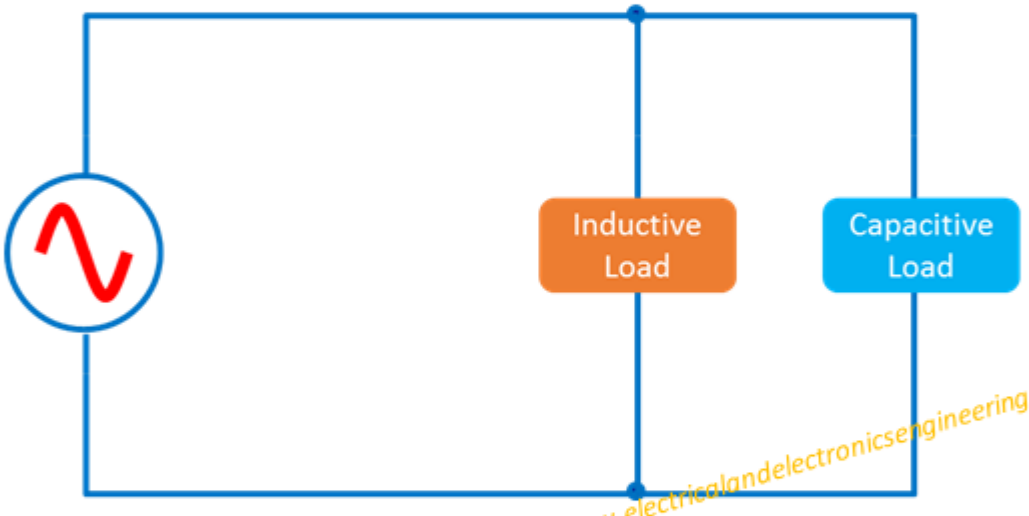
Solution:

$$S = \sqrt{P^2 + Q^2} = \sqrt{(100)^2 + (200)^2} = 223\ kVA$$

$$\text{Power Factor} = \frac{P}{S} = \frac{100}{223} = 0.44$$

Power Factor Correction

Practically, all electrical loads are inductive in nature. Since Inductive loads have lagging power factor. The reactive component due to inductive loads can be corrected by adding capacitor in nature.



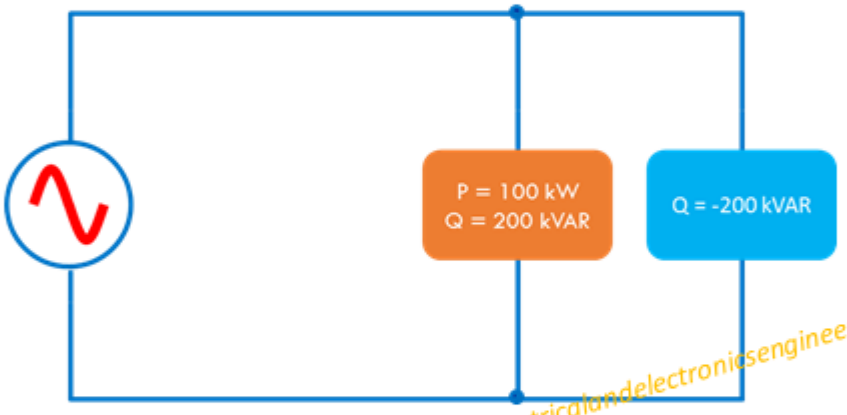
Technically, the practice of cancelling one reactive component by adding an opposite load it circuit is known as power factor correction.

Example 2

Improve Power Factor to unity in Example 1.

Solution:

In previous case the inductive reactive power is 200 kVAR. For improving power factor to unit we need to completely cancel this power. For this add a capacitive power of 200 kVAR in parallel.



Now

$$S = \sqrt{P^2 + Q^2} = \sqrt{(100)^2 + (200 - 200)^2} = 100$$

$$\text{Power Factor} = \frac{P}{S} = \frac{100}{100} = 1$$

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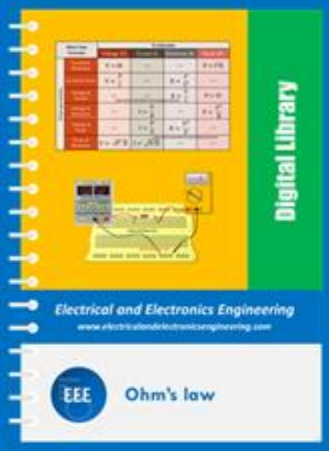

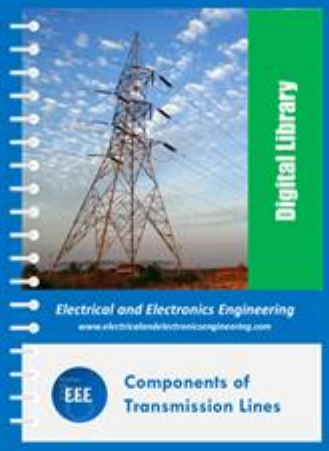

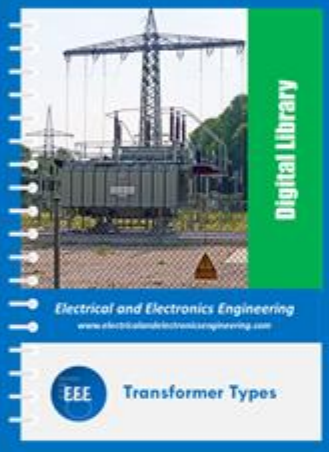

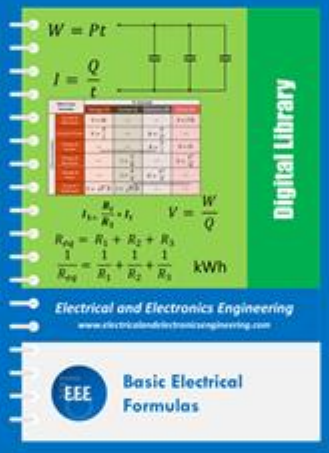

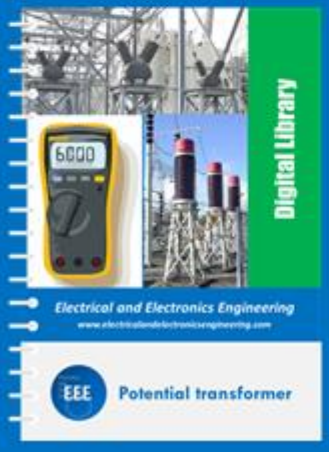

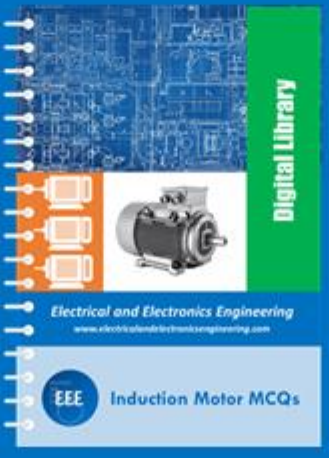

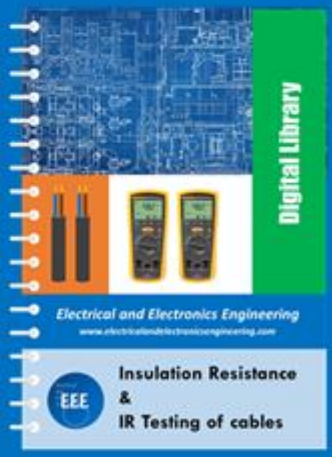

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