Basic Electrical Engineering (TEE 101)

Lecture 24: Apparent Power, Active Power, and Reactive Power

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Content

This lecture covers:

- **Apparent Power**
- **Active Power**
- **Reactive Power**

Apparent Power

Apparent Power is also known as the total power (or source power). This power is delivered by source to load.
It is given by *"The product of the RMS value of the source voltage (V) and source current (I)"*.
Hence, it is the total power that appears to be transferred between the source and load.

Consider an inductive circuit in which circuit current *I* lags behind the applied voltage *V* by φ°.

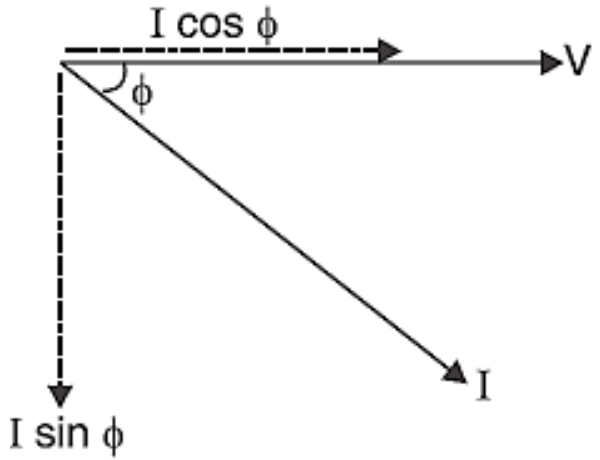
The current *I* can be resolved into two rectangular components *viz*.(*i*) *I* cosφ in phase with *V*.
(*ii*) *I* sinφ ; 90° out of phase with *V*.

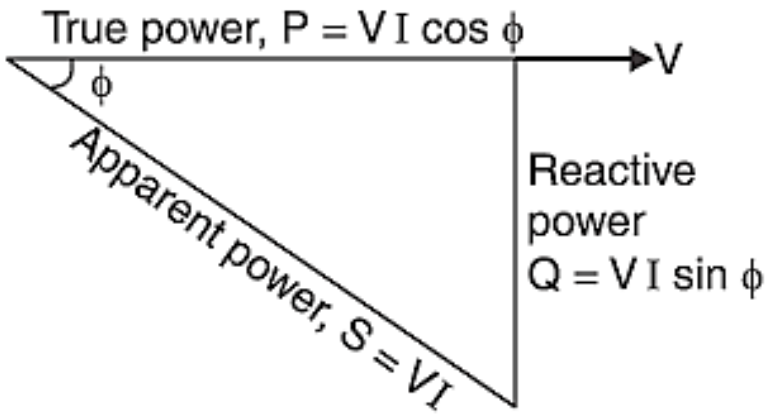
Apparent power, $S = V \times I = VI$

It is measured in volt-amperes (VA).

Apparent power has two components:

Active power (P) and Reactive power (Q)





Total power is related to **active** and **reactive power** as: Total Power (S) = [Active Power (P)] + j [reactive power (Q)]

$$S = P + jQ$$

True Power

True power in AC circuits is that electrical power which is actually consumed in the circuit

True Power is also known as the ACTIVE power.

It is given by: *"The product of voltage (V) and component of total current in phase with voltage (I cosφ) is equal to true power"*

True power, *P* = Voltage × Component of total current in phase with voltage

$$= V \times I \cos\varphi$$

True power, P = *VI*cosφ

It is measured in watts (W).

True power is useful component of apparent power.

The component Icosφ is called in-phase component or watt-ful component

It may be noted that it is the true power which is used for producing torque in motors and supply heat, light etc. It is used up in the circuit and cannot be recovered.

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Reactive Power

The component of apparent power which is neither consumed nor does any useful work in the circuit is called reactive power.

The power consumed (or true power) in *L* and *C* is zero because all the power received from the source in one quarter-cycle is returned to the source in the next quarter-cycle. This circulating power is called reactive power.

It is given by: *"The product of voltage (V) and component of total current 90° out of phase with voltage (I sinφ) is equal to reactive power"*

Reactive power, Q = Voltage × Component of total current 90° out of phase with voltage

$$= V \times I \sin\varphi$$

Reactive power, Q = $VI\sin\varphi$

It is measured in Volt-Ampere Reactive (Var).

The current and voltage in *L* or *C* are 90° out of phase. Therefore, current 90° out of phase with voltage contributes to reactive power.

The component $I \sin\varphi$ is called the reactive component (or wattless component)

It does no useful work in the circuit and merely flows back and forth in both directions in the circuit.

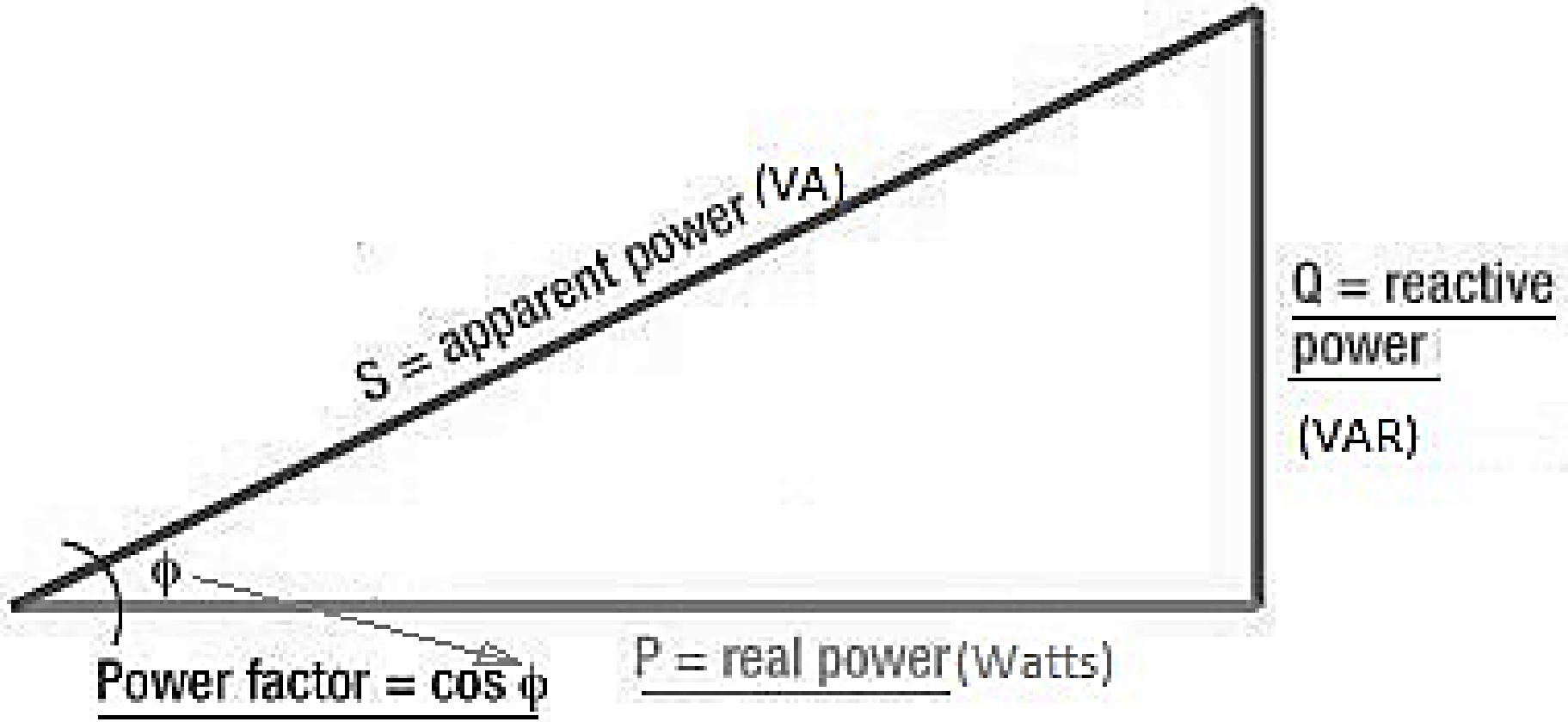
Summary

Power Type	Remarks
Apparent Power (S)	This is the power produced and delivered by the source to load. It is also known as Total power and is measured in Volt-amperes (VA). **[S = VI]**
Active Power (P)	This is useful power of the source. It is measured in Watts (W). It is also known as True power or Real Power. **[P = VIcosφ = Scosφ]**
Reactive Power (Q)	This is stored power and is not consumed by the circuit. It is measured in Volt-ampere-reactive (VAr) It is the virtual power (or imaginary power) in the electric circuit present due to the reactive components. **[Q = VIsinφ = Ssinφ]**

Total power is related to **active** and **reactive power** as: Total Power (S) = [Real Power (P)] + j [reactive power (Q)]

$$S = P + jQ \qquad |S| = \sqrt{P^2 + Q^2}$$

Component	Power Type Associated to the component	Mathematical Formula	Remarks
Resistor (R)	Active Power	VIcosφ	Resistor has **ZERO** reactive power
Inductor (L) and Capacitor (C)	Reactive Power	VIsinφ	Inductor and capacitor have **ZERO** active power.



$P = S \cos \phi$

$Q = S \sin \Phi$

$S = \sqrt{P^2 + Q^2}$

Relation between Real,Reactive,Apparent Powers

Thank You