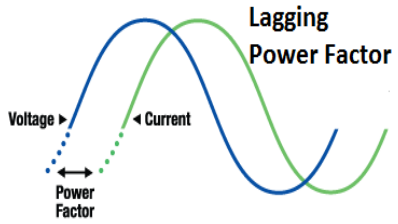
Power Factor Correction – Part 1

STUDY FOR FE

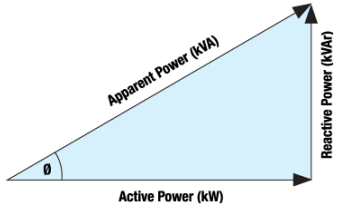
Power Factor basics:

- **Nature of Industrial Loads:** Mostly inductive, requiring a magnetic field for operation (e.g., motors, transformers).
- **Magnetic Field:** Necessary for inductive devices but does not perform useful work directly.
- **Power Supply Requirements:** Utilities must supply both reactive power (for the magnetic field) and active power (for useful work).
- **Power Factor (PF):** The ratio of real power (kW) to apparent power (kVA) is expressed as $PF = \frac{kW}{kVA} = cos\vartheta$
- **Leading PF:** Current leads voltage, indicating a capacitive circuit.
- **Lagging PF:** Current lags voltage, indicating an inductive circuit.



Power Triangle – Real and Reactive Power

- **Reactive Power:** Required to establish the magnetic field (vertical component).
- **Active Power:** Used to produce shaft horsepower (horizontal component).
- **Apparent Power:** The vector sum of reactive and active power, which is what the utility bills.



Power Factor correction

- **Purpose:** To improve the ratio of real power to apparent power in a power system.
- **Methods:**
  - **Capacitors:** Connected in parallel with inductive loads to counteract the inductive effects.
  - **Synchronous Condensers:** Over-excited synchronous motors running under no-load conditions to provide reactive power.

Mathematical Equations:

$$Q_{req} = \Delta Q = Q_1 - Q_2 = P(tan\vartheta_1 - tan\vartheta_2) \qquad C_{req} = \frac{\Delta Q}{\omega V_{line}^2}$$

Q – Reactive power
P – Real power
ϑ_1 – Initial power angle, ϑ_2 - Required power angle
C – Capacitance
$\omega = 2\pi f$ – Frequency (radians)
V – Voltage