Chapter:10

(Measurement of Single Phase Power)

Lecture-1

Derive the equation (P=EI Cos θ)

According to Joules law, the instaneaneous power at any moment is the same as in a DC circuit.

$$P(t) = V(t) \cdot I(t)$$

Average power = Time average of the power over one period.

$$\text{i.e. } P_{av} = \frac{1}{T}\int_0^T P(t)\,dt$$

$$= \frac{1}{T}\int_0^T V(t) \cdot I(t)\,dt$$

For current driven circuit,

$$V(t) = V_{max}\sin(\omega t + \phi) = ZI_{max}\sin(\omega t + \phi)$$

$$\text{and } I(t) = I_{,max}\sin(\omega t)$$

So,

$$P_{av} = \frac{1}{T}\int_0^T \left[ZI_{max}\sin(\omega t + \phi)\right] \cdot \left[I_{,max}\sin(\omega t)\right] dt$$

$$= \frac{ZI_{max}^2}{T}\int_0^T \sin(\omega t + \phi) \cdot \sin(\omega t)\,dt$$

$$= \frac{ZI_{max}^2}{T}\int_0^T \left[\sin(\omega t)\cos\phi + \cos(\omega t)\sin\phi\right] \cdot \sin(\omega t)\,dt$$

$$= \frac{ZI_{max}^2}{T}\left[\cos\phi\int_0^T \sin^2\omega t\,dt + \sin\phi\int_0^T \sin(\omega t)\cos(\omega t)\,dt\right]$$

$$= \frac{ZI_{max}^2}{T}\left[\cos(\phi) \times \frac{T}{2} + \sin\phi \times 0\right]$$

$$= \frac{ZI_{max}^2}{2}\left[\cos(\phi)\right.$$

Circuit Diagram Connecting Wattmeter in a Single Phase Circuit:

- Wattmeter's are generally used to measure power in the circuits. A wattmeter principally consists of two coils, one coil is called the current coil, and the other the pressure or voltage coil. A diagrammatic representation of a wattmeter connected to measure power in a single phase circuit is shown in Fig. 9.42.

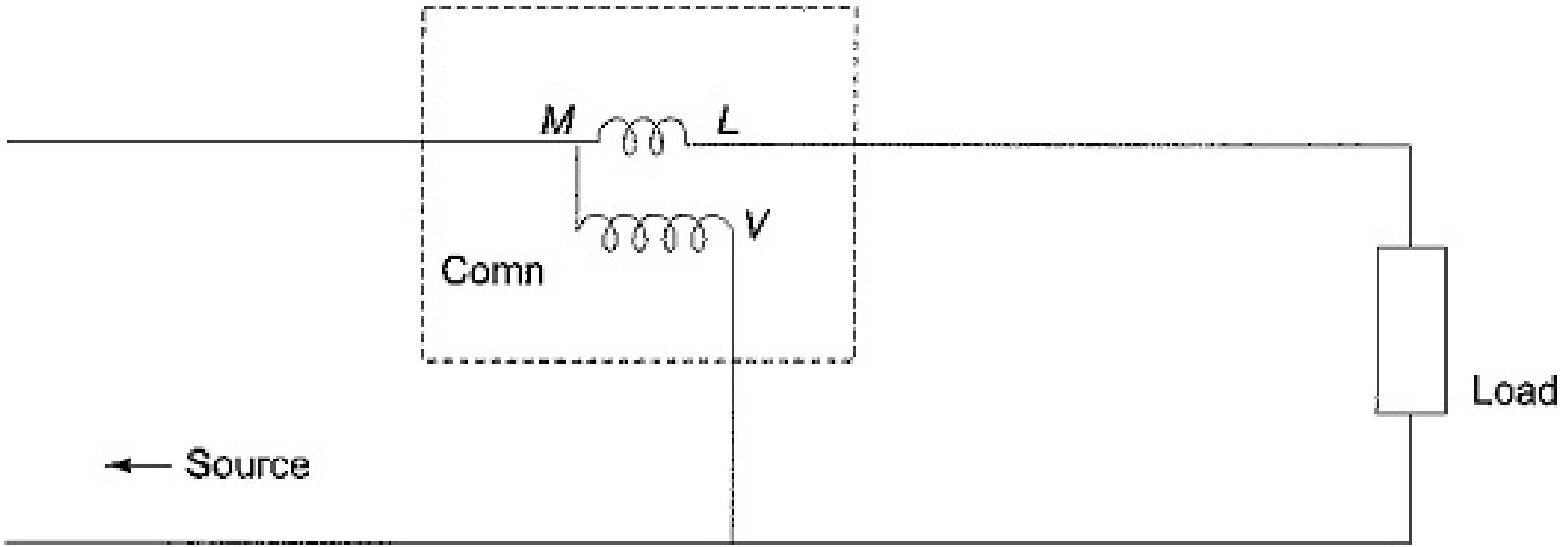

Fig. 9.42

- The coil represented with less number of turns between M and L is the current coil, which carries the current in the load and has very low impedance. The coil with more number of turns between the common terminal and V is the pressure coil, which is connected across the load and has high impedance.

- The load voltage is impressed across the pressure coil. The terminal M denotes the mains side, L denotes load side, common denotes the common point of current coil and pressure coil, and V denotes the second terminal of the pressure coil, usually selected as per the range of the load voltage in the circuit. From the figure, it is clear that a wattmeter has four terminals, two for current coil and two for potential coil. When the current flow through the two coils, they set up magnetic fields in space.