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FACULTY OF ENGINEERING & TECHNOLOGY

Electrical Machine-1

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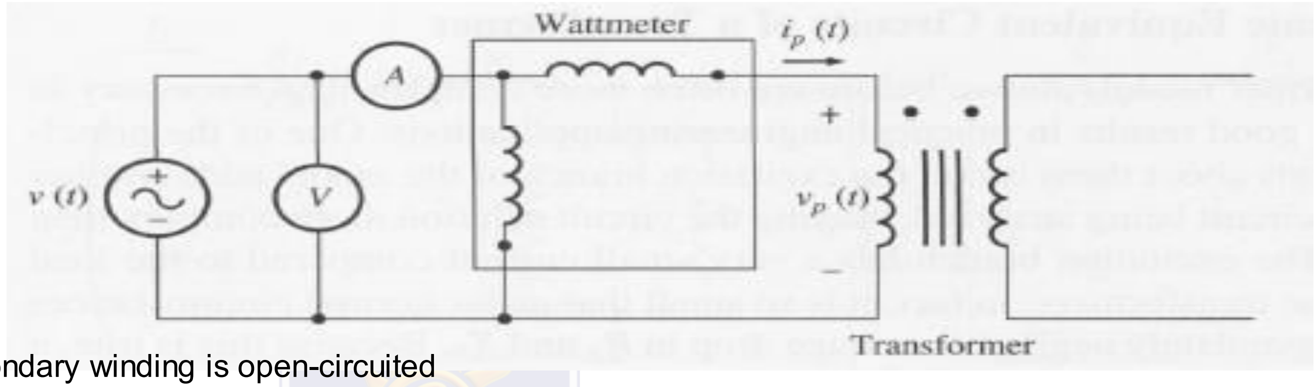
SINGLE PHASE TRANSFORMER

Circuit Parameters: Open-Circuit Test



- Transformer's secondary winding is open-circuited
- Primary winding is connected to a full-rated line voltage. All the input current must be flowing through the excitation branch of the transformer.
- The series elements R_p and X_p are too small in comparison to R_C and X_M to cause a significant voltage drop, so essentially all the input voltage is dropped across the excitation branch.
- Input voltage, input current, and input power to the transformer are measured.

Circuit Parameters

The magnitude of the excitation admittance:

$$|Y_E| = \frac{I_{oc}}{V_{oc}}$$

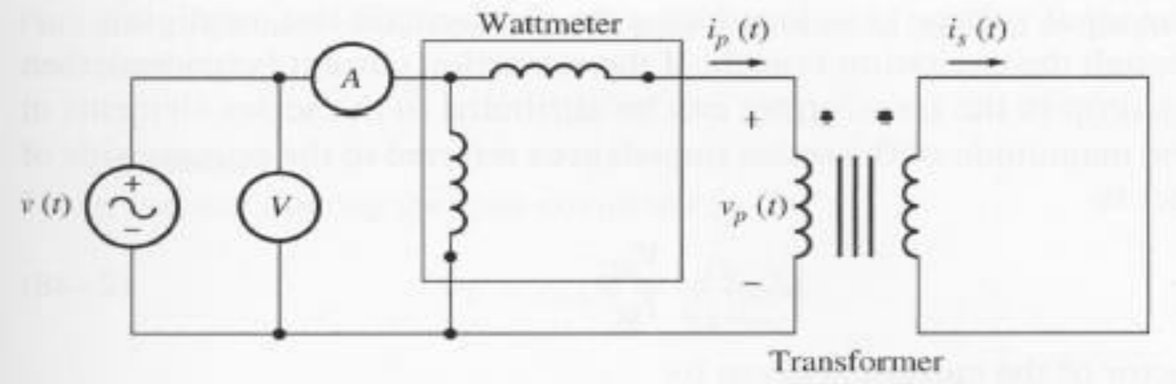
The open-circuit power factor and power factor angle:

$$PF = \cos\theta = \frac{P_{oc}}{V_{oc} I_{oc}} \quad or, \ \theta = \cos^{-1}\left[\frac{P_{oc}}{V_{oc} I_{oc}}\right]$$

The power factor is always lagging for a transformer, so the current will lag the voltage by the angle q. Therefore, the admittance Y_E is:

$$Y_E = \frac{1}{R_C} - j\frac{1}{X_M} = \frac{I_{oc}}{V_{oc}} \angle -\cos^{-1}(PF)$$

Circuit Parameters: Short-Circuit Test



- Transformer's secondary winding is short-circuited
- Primary winding is connected to a fairly low-voltage source.
- The input voltage is adjusted until the current in the short-circuited windings is equal to its rated value.
- Input voltage, input current, and input power to the transformer are measured.
- Excitation current is negligible, since the input voltage is very low. Thus, the voltage drop in the excitation branch can be ignored. All the voltage drop can be attributed to the series elements in the circuit.

The magnitude of the series impedance: $|Z_{SE}| = \frac{V_{sc}}{I_{sc}}$

The short-circuit power factor and power factor angle:

$$PF = \cos\theta = \frac{P_{sc}}{V_{sc} I_{sc}} \quad or,\ \theta = \cos^{-1}\left[\frac{P_{sc}}{V_{sc} I_{sc}}\right]$$

Therefore the series impedance is:

$$Z_{SE} = R_{eq} + jX_{eq}$$
$$= \left(R_p + a^2 R_s\right) + j\left(X_p + a^2 X_s\right) = \frac{V_{sc}}{I_{sc}} \angle \cos^{-1}(PF)$$

It is possible to determine the total series impedance, but there is no easy way to split the series impedance into the primary and secondary components. These tests were performed on the primary side, so, the circuit impedances are referred to the primary side.