

Example. For a single phase transformer with the following per unit parameters, determine the input voltage, the steady state energy efficiency, and the voltage regulation. The load is 1.00 per unit with a 0.92 power factor lagging.

$$j := \sqrt{-1} \quad \text{lagging} := 1$$

$$R_1 := 0.015 \quad X_1 := 0.05 \quad N := 5$$

$$R_C := 250 \quad X_M := 30$$

$$\text{pf} := 0.92 \cdot \text{lagging} \quad \theta := \text{acos}(\text{pf}) = 23.074 \text{ deg}$$

$$V_L := Z_L := 1.00 \cdot e^{j \cdot \theta}$$

Find the load current.

$$I_L := \frac{V_L}{Z_L} = 0.92 - 0.392i$$

Find the input current by the current law (a node equation..

$$I_1 := \frac{V_L}{R_C} + \frac{V_L}{j \cdot X_M} + I_L = 0.924 - 0.425i$$

Calculate the input voltage from a loop equation.

$$V_1 := V_L + (R_1 + j \cdot X_1) \cdot I_1 = 1.035 + 0.04i$$

$$|V_1| = 1.036 \quad \arg(V_1) = 2.203 \text{ deg}$$

Calculate power out and power in.

$$P_L := \operatorname{Re}(V_L \cdot \overline{I_L}) = 0.92$$

$$P_1 := \operatorname{Re}(V_1 \cdot \overline{I_1}) = 0.94$$

Energy efficiency.

$$\eta := \frac{P_L}{P_1} = 0.979$$

Voltage regulation.

$$V_{\text{reg}} := \frac{|V_1| - |V_L|}{|V_L|} = 0.036$$