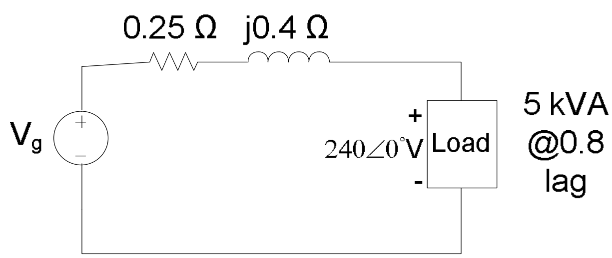
Homework Set #26

DUE Thursday, May 17, 2012

1. Assume that power is transmitted to a load at 240V without using a transformer as shown in the circuit below. Find the real power lost in the feeder and the efficiency of the system.



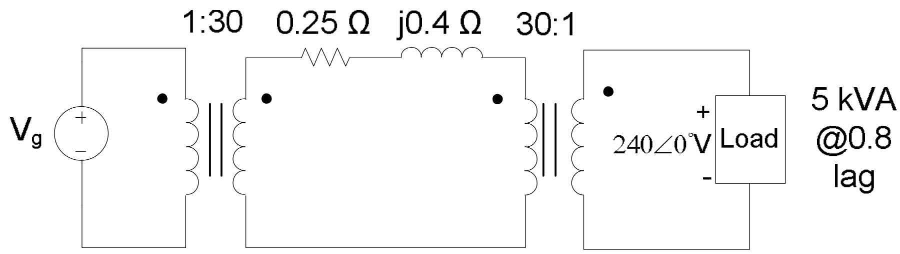
$$|I| = \frac{S}{V} = \frac{5 \text{ x } 10^3}{240} = 20.83 \text{ A}$$

The power lost in the feeder is: $P_L = I^2R = 20.83^2 \text{ x } 0.25 = 108.5 \text{ W}$

The efficiency is:

$$\eta = \frac{5 \text{ x } 10^3 \text{ x } 0.8}{5 \text{ x } 10^3 \text{ x } 0.8 + 108.5} = 97.4 \text{ \%}$$

2. Suppose that the power was delivered to the load but a step-up and step-down transformer was used to reduce the current in the line. Find the real power lost in the feeder and the efficiency when a 30:1 transformer is used as shown in the circuit below. If power costs 6cents/kW how much money can you save in one year?



Because the load power and load voltage are unchanged the load current I is unchanged and remains at 20.83 A, but the feeder current I_F is reduced because it is in the high voltage part of the circuit.

$I_F = 0.0333 \times \mathbf{I} = 0.694$ A

The power lost in the feeder is: $P_L = I_F^2 R = 0.694^2 \times 0.25 = 0.12$ W

The efficiency is:

$$\eta = \frac{5 \times 10^3 \times 0.8}{5 \times 10^3 \times 0.8 + 0.12} = 100\ \%$$

The cost of the losses is: $\$_L = 0.108 \times 8760 \times 0.06 = \$57/yr$

3. Now consider the effect of a non-ideal transformer used in both the step-up and step-down transformers. Assume the transformers used have the following equivalent circuit parameters, referred to the high voltage side: R = 15 Ω, X = 50 Ω, Rc = 150 kΩ, Xm = 100 kΩ. Compute the real power lost in the system (include both coil loss and core loss along with the loss in the line) and the overall efficiency of the system.