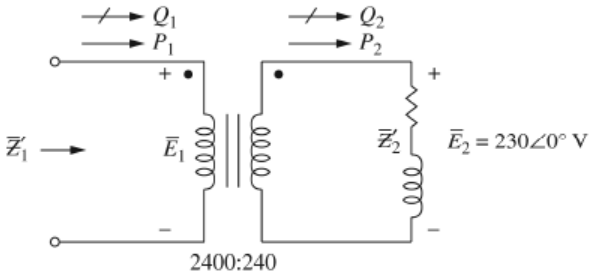
Homework 3 Solutions

3.4



(a) $E_1 = \dfrac{N_1}{N_2} E_2 = \dfrac{2400}{240}(230) = 2300\,\text{V}$

(b) $\bar{S}_2 = \bar{E}_2 \bar{I}_2^*; \bar{I}_2 = \left(\dfrac{\bar{S}_2}{\bar{E}_2}\right)^* = \left[\dfrac{60\times10^3\angle\cos^{-1}0.8}{230\angle 0°}\right]^* = 260.9\angle -36.87°$

$$\bar{Z}_2 = \frac{\bar{E}_2}{\bar{I}_2} = \frac{230\angle 0°}{260.9\angle -36.87°} = 0.8817\angle 36.87°\,\Omega$$

$$= 0.705 + j.529\,\Omega$$

(c) $\bar{Z}_1' = \left(\dfrac{N_1}{N_2}\right)^2 \bar{Z}_2 = 100\bar{Z}_2 = 88.17\angle 36.87°\,\Omega$

(d) $P_1 = P_2 = 60(0.8) = 48\,\text{kW}$

$Q_1 = Q_2 = 48\tan(36.87°) = 36\,\text{kVAR}$

3.23 Select a common base of 100MVA and 22kV on the generator side; Base voltage at bus 1 is 22kV; this fixes the voltage bases for the remaining buses in accordance with the transformer turns ratios. Using Eq. 3.3.11, per-unit reactances on the selected base are given by

$$G: X = 0.18\left(\frac{100}{90}\right) = 0.2;\ T_1: X = 0.1\left(\frac{100}{50}\right) = 0.2$$

$$T_2: X = 0.06\left(\frac{100}{40}\right) = 0.15;\ T_2: X = 0.06\left(\frac{100}{40}\right) = 0.15$$

$$T_3: X = 0.064\left(\frac{100}{40}\right) = 0.16;\ T_4: X = 0.08\left(\frac{100}{40}\right) = 0.2$$

$$M: X = 0.185\left(\frac{100}{66.5}\right)\left(\frac{10.45}{11}\right)^2 = 0.25$$

For Line 1, $Z_{BASE} = \dfrac{(220)^2}{100} = 484\,\Omega$ and $X = \dfrac{48.4}{484} = 0.1$

For Line 2, $Z_{BASE} = \dfrac{(110)^2}{100} = 121\,\Omega$ and $X = \dfrac{65.43}{121} = 0.54$

The load complex power at 0.6 Lagging *pf* is $\overline{S}_{L(3\phi)} = 57\angle 53.13°\,\text{MVA}$

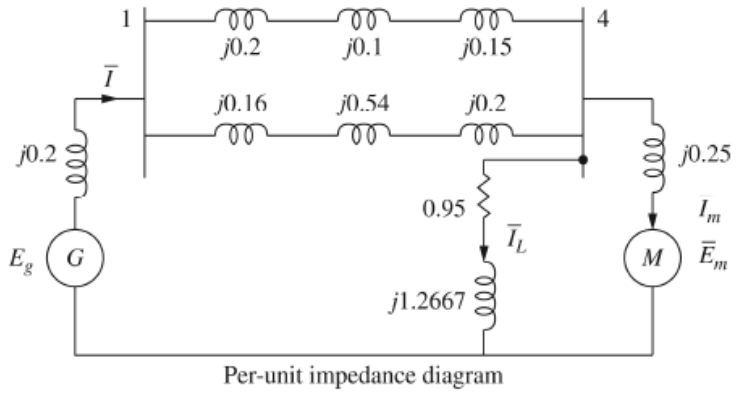
$\therefore$ The load impedance in OHMS is $\overline{Z}_L = \dfrac{(10.45)^2}{57\angle -53.13°} = \dfrac{V_{LL}^2}{\overline{S}^*_{L(3\phi)}}$

$$= 1.1495 + j1.53267\,\Omega$$

The base impedance for the load is $(11)^2/100 = 1.21\,\Omega$

$\therefore$ Load Impedance in pu $= \dfrac{1.1495 + j1.53267}{1.21} = 0.95 + j1.2667$

The per-unit equivalent circuit is shown below:



Per-unit impedance diagram