EE 330/330L Energy Systems (Spring 2012) Quiz #3

Name Key A

Instructions: Open book. Place answers in indicated spaces & show all work for credit.

A 220 KVA, 8000/240 V, 60 Hz single-phase transformer has a per-unit resistance of 1.1%, per-unit reactance of 4%, per-unit core loss resistance of 85, and per-unit magnetizing reactance of 22. Determine the turns ratio, base impedance, and approximate transformer circuit model referred to the secondary side. A load is supplied the rated voltage and load at a *pf* of 0.825 lagging. Determine the RMS phasor load current and load power. Use load voltage as phase reference.

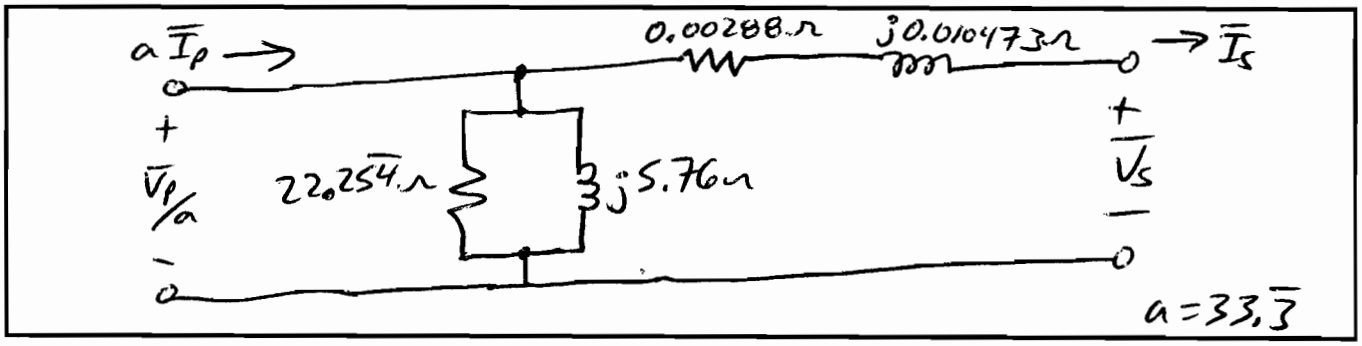
$V_{base} = 240\ V_{rms}$, (2-57) $Z_{base} = \frac{V_{base}^2}{S_{base}} = \frac{240^2}{220\times10^3} = 0.26\overline{18}\ \Omega$

$R_{eq,s} = R_{eq,pu}\, Z_{base} = 0.011(0.26\overline{18}) = 0.00288\ \Omega$

$X_{eq,s} = X_{eq,pu}\, Z_{base} = 0.04(0.26\overline{18}) = 0.0104727\ \Omega$

$R_{c,s} = R_{c,pu}\, Z_{base} = 85(0.26\overline{18}) = 22.25\overline{4}\ \Omega$ $X_{m,s} = X_{m,pu}\, Z_{base} = 22(0.26\overline{18}) = 5.76\ \Omega$

Secondary side approximate transformer circuit model



$a = \frac{V_p}{V_s} = \frac{8000}{240} = 33.\overline{3}$

$I_L = \frac{S_{rated}}{V_{rated}} = \frac{220\times10^3}{240} = 916.\overline{6}\ A_{rms}$

$\theta = \cos^{-1} pf = \cos^{-1} 0.825 = 34.4115^\circ = \theta_V - \theta_I \Rightarrow \theta_I = -34.4115^\circ$

$P_L = S_L(pf) = V_L I_L \cos\theta = 220\times10^3(0.825) = 181.5\ KW$

turns ratio = $33.\overline{3}$ base impedance = $0.26\overline{18}\ \Omega$ $\bar{I}_L = 916.\overline{6}\angle -34.4^\circ\ A_{rms}$ $P_L = 181.5\ KW$