

3-3 A 1000-VA, 230/115-V transformer has been tested to determine its equivalent circuit.

Open-circuit test	Short-circuit test
$V_{OC} = 230 \text{ V}$	$V_{SC} = 11.2 \text{ V}$
$I_{OC} = 0.95 \text{ A}$	$I_{SC} = 5.0 \text{ A}$
$P_{OC} = 80 \text{ W}$	$P_{SC} = 20.1 \text{ W}$

All data given were taken from the primary side of the transformer.

a. Find the equivalent circuit of this transformer referred to the low-voltage side of the transformer.

➤ Also, find the equivalent circuit referred to the high-voltage side.

a) The turns ratio is (3-5) $a = V_P / V_S = 230 / 115 = 2$.

Open circuit test (High Side)

$$\text{Per (3-50), } Y_E = |Y_E| = \frac{I_{oc}}{V_{oc}} = \frac{0.95}{230} = 0.004130435 \text{ S.}$$

$$\text{Per (3-51), } \text{PF}_{oc} = \frac{P_{oc}}{V_{oc} I_{oc}} = \frac{80}{230(0.95)} = 0.36613 \text{ lagging.}$$

$$\text{Per (3-52), } \theta = \theta_{ZE} = \cos^{-1} \left(\frac{P_{oc}}{V_{oc} I_{oc}} \right) = \cos^{-1}(0.3661) = 68.52269^\circ.$$

Per (3-53), put the magnitude and phase together to get

$$\bar{Y}_E = Y_E \angle -\theta_{ZE} = 0.00413 \angle -68.523^\circ \text{ S} = 0.001512287 - j0.003843628 \text{ S.}$$

$$\text{Per (3-49), } \bar{Y}_E = \frac{1}{R_C} - j \frac{1}{X_M} = 0.001512287 - j0.003843628 \text{ S. Calculate:}$$

$$\underline{R_C = \frac{1}{0.001512287} = 661.25 \Omega} \quad \& \quad \underline{X_M = \frac{1}{0.003843628} = 260.17 \Omega}$$

Short circuit test (High Side)

$$\text{Per (3-54), } Z_{SE} = |Z_{SE}| = \frac{V_{sc}}{I_{sc}} = \frac{11.2}{5.0} = 2.24 \Omega.$$

$$\text{Per (3-55), } \text{PF}_{sc} = \frac{P_{sc}}{V_{sc} I_{sc}} = \frac{20.1}{11.2(5.0)} = 0.35893 \text{ lagging.}$$

Per (3-52), $\theta = \theta_{SE} = \cos^{-1} \left(\frac{P_{sc}}{V_{sc} I_{sc}} \right) = \cos^{-1} (0.35893) = 68.96559^\circ$.

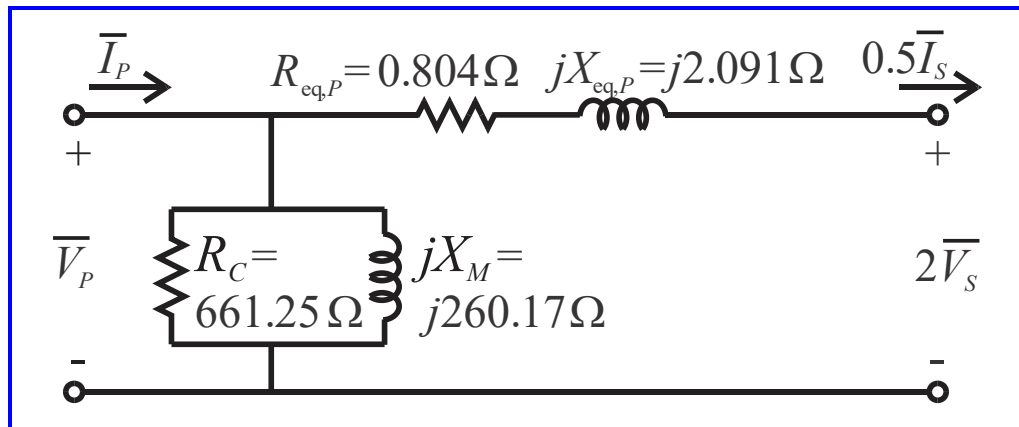
Per (3-57), put the magnitude and phase together to get

$$\bar{Z}_{SE} = Z_{SE} \angle \theta_{SE} = 2.24 \angle 68.9656^\circ \Omega = 0.804 + j2.09074 \Omega.$$

Per (3-58), $\bar{Z}_{SE} = 0.804 + j2.0907 \Omega = R_{eq,P} + jX_{eq,P}$

$$\Rightarrow \underline{R_{eq,P} = 0.804 \Omega} \text{ \& } \underline{X_{eq,P} = 2.091 \Omega}.$$

Approximate Primary (High Side) Equivalent Circuit



To move/refer impedances to the secondary side of the transformer, use (3-17) $Z_L = Z_L' / a^2$. Here, $a^2 = 2^2$, so $Z_L = Z_L' / 4$, i.e., divide all impedances by 4.

Approximate Secondary Equivalent (Low Side) Circuit

