

Problem 1. The following data were taken for a 25kVA, 7200/240V transformer:

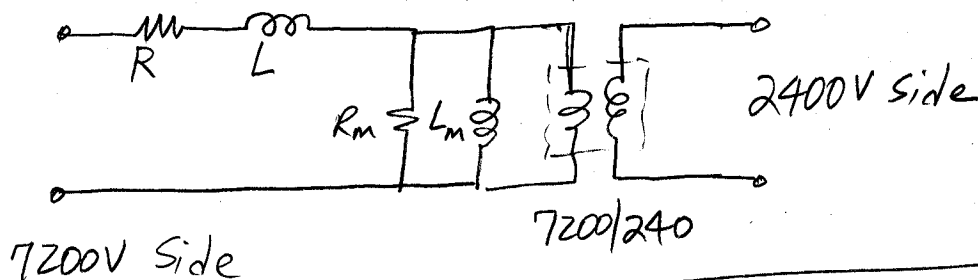
- Short Circuit Test: 240V side short-circuited, 7200V side energized at reduced voltage. The measurements (on the 7200V side) are  $I_{rms} = 3.47A$  (i.e., rated current),  $V_{rms} = 216V$ ,  $P = 335W$ ,  $Q = 669VAr$ .
- Open Circuit Test: 7200V side open-circuited, 240V side energized. The measurements (on the 240V side) are  $V_{rms} = 240V$  (i.e., rated voltage),  $I_{rms} = 2.08A$ ,  $P = 171W$ ,  $Q = 469VAr$ .

Draw the transformer equivalent circuit with all four circuit parameters (i.e.,  $R$ ,  $L_l$ ,  $L_m$ ,  $R_m$ ) shown on the 7200V side.

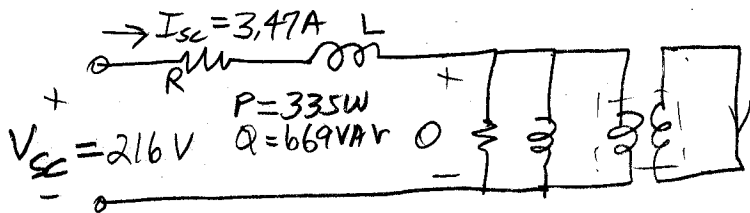
Problem 2. Bergen 5.18

Problem 3. Bergen 5.19 (use  $S_{B3\phi} = 100MVA$ ,  $V_{BLL} = 161kV$  in transmission lines)

25KVA Transformer



Short Ckt Test



$$I_{sc}^2 R = P$$

$$R = \frac{P}{I_{sc}^2} = \frac{335}{(3.47)^2} = 27.8 \Omega$$

$$I_{sc}^2 \omega L = Q$$

$$L = \frac{Q}{I_{sc}^2 \omega} = \frac{669}{(3.47)^2 (120\pi)}$$

$$L = 0.1474 H$$

Check,  $Z = R + j\omega L = 27.8 + j55.6 \Omega$

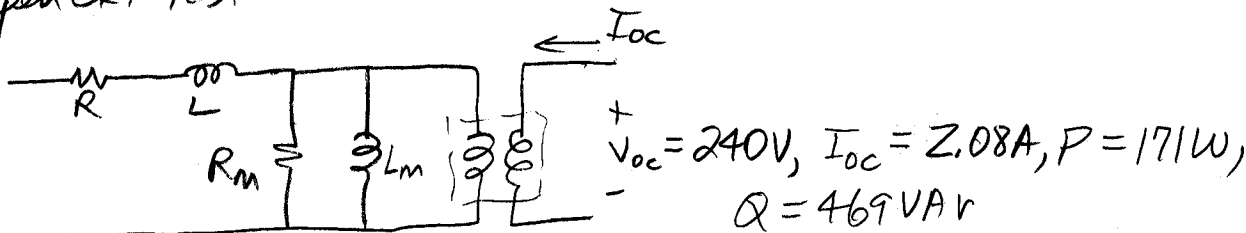
$$\tilde{I}_{sc} = \frac{\tilde{V}_{sc}}{Z} = \frac{216 \angle 0}{62.2 \angle 63.4^\circ}$$

$$\tilde{I}_{sc} = \frac{3.47}{OK} \angle -63.4^\circ A$$

$$S = V_{sc} I_{sc}^* = (216 \angle 0)(3.47 \angle -63.4) = 750 \angle 63.4 VA = 336 \angle 63.4^\circ VA$$

W      VAR  
OK

Open Ckt Test



$$P = \frac{[V_{oc} (\frac{7200}{240})]^2}{R_m}, \quad R_m = \frac{[240 (\frac{7200}{240})]^2}{171} = 303 K\Omega$$

$$Q = \frac{[V_{oc} (\frac{7200}{240})]^2}{\omega L_m}, \quad L_m = \frac{[240 (\frac{7200}{240})]^2}{(469)(120\pi)} = 293 H$$

Check  $Z_m = R_m \parallel j\omega L_m$

$$Y_m = \frac{1}{R_m} + \frac{1}{j\omega L_m} = 3.30 \times 10^{-6} - j9.05 \times 10^{-6}, \quad Z_m = Y_m^{-1} = 103.8 K\Omega \angle 70.0^\circ$$

HW4, cont

Reflect  $Z_m$  to 240V side

$$Z_m = (103,8 \text{ k}\Omega / 70,0^\circ) \left(\frac{240}{7200}\right)^2 = 115,3 / 70,0^\circ \Omega$$

$$\tilde{I}_{oc} = \frac{\tilde{V}_{oc}}{Z_m} = \frac{240 / 0}{115,3 / 70,0} = 2,09 / -70,0^\circ \text{ A OK}$$

$$S = V_{oc} I_{oc}^* = (240 / 0)(2,09 / -70,0) = 502 / 70,0^\circ$$

$$= \underset{\text{W}}{171,7} + j \underset{\text{VAR}}{471,7} \quad \text{OK}$$

Comments - For the short ckt test, it took  $\frac{216\text{V}}{7200\text{V}} = 0,0300 \text{ pu}$  voltage to get rated current (1 pu)

This means that the series impedance of the transformer is 0,0300 pu on the transf. base. The  $\frac{X}{R}$  ratio is  $\frac{0,1474(120\text{M})}{27,8} = 2,00$

For the open circuit test, the current drawn was 2,08A. The rated current of the transf. on the 240V side is  $\frac{25000}{240} = 104,2 \text{ A}$ .

Thus, the pu magnetizing current is

$$\frac{2,08 \text{ A}}{104,2 \text{ A}} = 0,020 \text{ pu}$$

The full-load P losses of the transf. would be

$$\left(\frac{25000}{7200}\right)^2 (27,8) + \frac{(7200)^2}{303 \text{ k}\Omega} = 335 + 171 = 506 \text{ W}$$

(335W as measured in S.C. test)   
 (About 2% of 25000)   
 171W, as meas. in O.C. test   
 Rated current on 7200V side