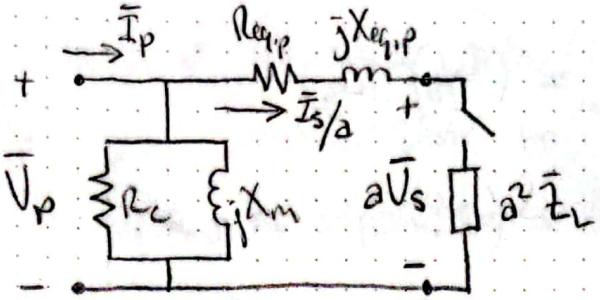
HW 3

3-2 (a)



$$R_{eq,p} = R_p + a^2 R_s$$

$$X_{eq,p} = X_p + a^2 X_s$$

$$a^2 = \left(\frac{V_p}{V_s}\right)^2 = \left(\frac{8000}{277}\right)^2 = (28.9)^2$$

$R_c = 250\,k\Omega$	$R_{eq,p} = 73.8\ \Omega$
$X_m = 30\,k\Omega$	$X_{eq,p} = 95\ \Omega$

c) assume rated load 20kVA @ 277 V w/ PF = 0.8 lag

What is V_p? VR?

Load Reg $|\bar{V}_p|_{FL} = \bar{V}_{drop} + a\bar{V}_{s_{FL}}$

$= \left(\frac{\bar{I}_s}{a}\right)(R_{eq,p} + jX_{eq,p}) + a\bar{V}_s$ ← V_p

$$\bar{I}_s = \frac{S_{rated}}{V_{s,rated} \angle \cos^{-1}(PF)} = \frac{20\,kVA}{277\,V \angle 36.9^\circ} = 72.2\,A \angle -36.9^\circ$$

$$\frac{\bar{I}_s}{a} = 2.5\,A \angle -37^\circ$$

$$|\bar{V}_p|_{FL} = (2.5\,A \angle -37^\circ)(73.8 + j95\,\Omega) + (8000\,V)$$
$$= 8290 \angle 0.54^\circ$$

$$VR = \frac{|\bar{V}_p|_{FL} - |\bar{V}_p|_{NL}}{|\bar{V}_p|_{NL}} \times 100\% = \boxed{3.63\%}$$

load regulated

d) What is η?

$$P_{core} = \frac{V_p^2}{R_{core}}$$

$$= \frac{(8290\,V)^2}{250\,k\Omega}$$

$$= 275\,W$$

$$P_{cu} = (I_s/a)^2 R_{eq,p}$$

$$= (2.5\,A)^2 (73.8\,\Omega)$$

$$= 461\,W$$

$$P_{out} = (20\,kVA)(0.8) = 16000\,W$$

$$\eta = \frac{P_{out}}{P_{out} + P_{loss}} \times 100\% = 96\%$$

HW 3

3-21 (b,c)

1-φ 10 kVA, 480/120 V Xfmr used as auto Xfmr tying 600-V distr to 480 V load.
Tested as conventional Xfmr on primary side (480 V)

OC-test

$V_{oc} = 480\,V$

$I_{oc} = 0.41\,A$

$P_{oc} = 38\,W$

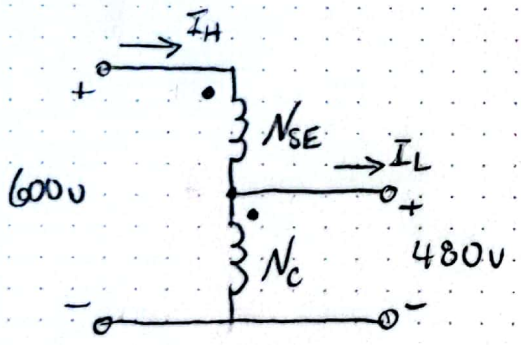
SC-test

$V_{sc} = 10.0\,V$

$I_{sc} = 10.6\,A$

$P_{sc} = 26\,W$

b) sketch 600/480 V step down



c) find kVA rating when used as auto Xfmr

$V_H = V_C + V_{SE}$ $\qquad V_C/V_{SE} = N_C/N_{SE} = \frac{480\,V}{(600-480)_V} = 4/1$

$$S_{IO} = S_W \frac{N_{SE} + N_C}{N_{SE}} = (10\,kVA)\frac{1+4}{1} = 50\,kVA$$

② 75 kVA 1-φ 7.2 kV–240 V distrb. Xfmr

Find eq. ckt

$V_{oc} = V_{rated} = 7.2\,kV$ $\quad I_{oc} = 250\,mA$ $\quad P_{oc} = 1500\,W$

$V_{sc} = 330\,V$ $\quad I_{sc} = I_{rated} = \frac{75\,kVA}{7.2\,kV} = 10.4\,A$ $\quad P_{sc} = 1600\,W$

Parallel Components

$\bar{Y}_{oc} = Y_{oc} \angle -\theta_{oc}$ $\quad Y_{oc} = \frac{I_{oc}}{V_{oc}} = 35\,\mu S$

$\bar{Y}_{oc} = 35\,\mu S \angle -34°$ $\quad \theta_{oc} = \cos^{-1}\left(\frac{P_{oc}}{I_{oc} V_{oc}}\right) = 33.6°$

$= 29 - j20\,\mu S$

$R_{core} = \frac{1}{G} = 34.5\,k\Omega$ $\quad X_m = \frac{1}{B} = 50\,k\Omega$

Series Components

$\bar{Z}_{sc} = \bar{Z}_{eqp} = R_{eqp} + jX_{eqp} = Z_{sc} \angle \theta_{sc}$

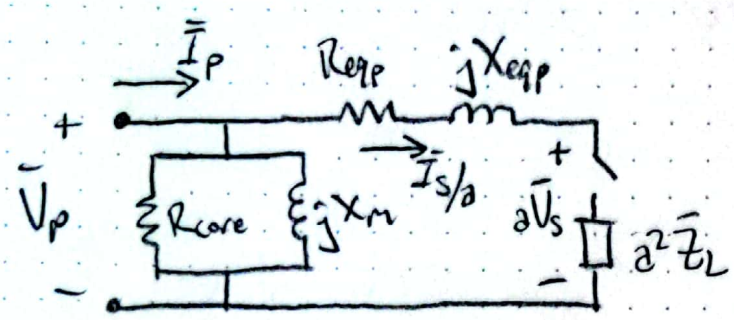
$Z_{sc} = \frac{V_{sc}}{I_{sc}} = 31.7\,\Omega$

$\theta_{sc} = \cos^{-1}\left(\frac{P_{sc}}{I_{sc} V_{sc}}\right) = 62°$

$Z_{sc} \angle \theta_{sc} = 31.7\,\Omega \angle 62° = 14.9 + j28\,\Omega$

$R_{eqp} = 15\,\Omega$ $\quad X_{eqp} = 28\,\Omega$

Primary-side Cantilever equivalent ckt:



$R_{core} = 34.5\ k\Omega$

$X_m = 50\ k\Omega$

$R_{eqp} = 15\ \Omega$

$X_{eqp} = 28\ \Omega$

FE Prob 1 — 50 kW load w/ PF = 0.77 lag

find Q_c → PF' = 0.95 lag

$$S_1 = \frac{50\,kW}{0.77} = 65\,kVA$$

$$Q = P\tan(\cos^{-1}(PF)) = 41\,kVA_r$$

$$Q' = P\tan(\cos^{-1}(PF')) = 16\,kVA_r$$

$$Q_c = Q' - Q = -25\,kVA_r$$

in parallel

(D)