SOLUTIONS TUTORIAL-12

1.

$B_m = 1.3\ wb/m^2$ $V_1 = 33KV$ $V_2 = 11KV$

$A = 1m^2$ $N_1 = ?$ $N_2 = ?$ emf/turn = ?

$f = 50Hz$, 1ϕ trf

$\phi = B \times A$

$= 1.3 \times 1m^2 = 1.3 wb.$

$emf_1 = 4.44 f \phi_m N_1$

ideal tranf condition assumed ∵ emf not given

$33K = 4.44 \times 50 \times 1.3 \times N_1$

$N_1 = 114$ (take whole number).

$$\frac{11KV}{33KV} = \frac{N_2}{N_1}$$

$N_2 = 38$

$$emf/turn = 33K/114 = \frac{11K}{38} = \underline{\underline{289.5V}}.$$

2.

$N_1 = 38$ $V\Sigma = 5MVA$ (TOTAL power).

$N_2 = 114$

$$I_1 = \frac{5 \times 10^6}{33 \times 10^3} = 151.5A$$

$$I_2 = \frac{N_1}{N_2} \times I_1 = \frac{151.5}{3} = 50.5A.$$

3.

$I_0 = 7.6\,A$ $\quad$ Constant loss $= 6.5\,KW$

Primary voltage $= 33\,KV.$ $= V_1 I_0 \cos\phi_0$

$$I_W = I_0 \cos\phi_0 = \frac{6.5\times10^3}{33\times10^3} = 0.197A.$$

$$I_\mu = \sqrt{I_0^2 - I_W^2} = \sqrt{(7.6)^2-(0.197)^2}$$

$$\simeq 7.6\,A \quad (7.597\,A).$$

If $\cos\phi_0 = 0.2$

$$I_W = I_0\cos\phi_0 = 7.6\times0.2 = 1.52A$$

$$I_\mu = I_0 \sin\phi_0 = 7.6\,(0.979) = 7.45A$$

4.

$VI = 100\,kVA$ $\quad$ $11KV/415V$ $\quad$ Prim h.v side cu loss $= 680W$

L.v cu loss $= 480\,W$ $\quad$ $X_{TOT.} = 48.4\,\Omega$

$R_1, R_2, R_{TOT} = ?$ $\quad$ $x_1, x_2 = ?$

$$I_1^2 R_1 = 680$$

$$I_1 = \frac{100\times10^3}{11\times10^3}$$

$$= 9.1\,A$$

$$\therefore R_1 = \frac{680}{(9.1)^2} = 7.5\,\Omega$$

$$I_2^2 R_2 = 480$$

$$I_2 = \frac{100\times10^3}{415} = 240.1\,A$$

$$R_2 = \frac{480}{(240.1)^2} = 0.0083\,\Omega$$

$$R_2' = 0.0083\left(\frac{11\times10^3}{415}\right)^2$$

$$= 5.83\,\Omega.$$

Given $\dfrac{R_1+R_2'}{R_2'} = \dfrac{x_1+x_2'}{x_2'}$

$$\frac{7.5+5.83}{5.83} = \frac{48.4}{x_2'} \Rightarrow$$

$$x_2' = 21.2\,\Omega$$

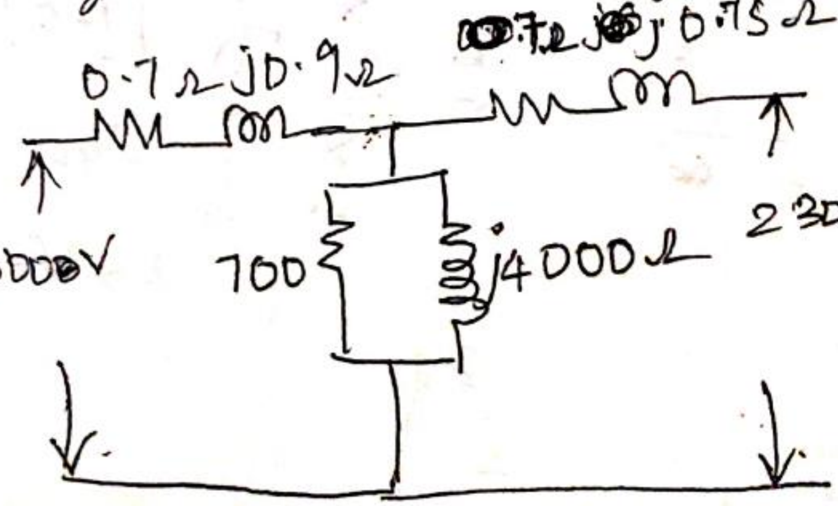
$$x_1 = 27.23\,\Omega$$

$$x_2 = 21.2\left(\frac{415}{11\times10^3}\right)^2$$

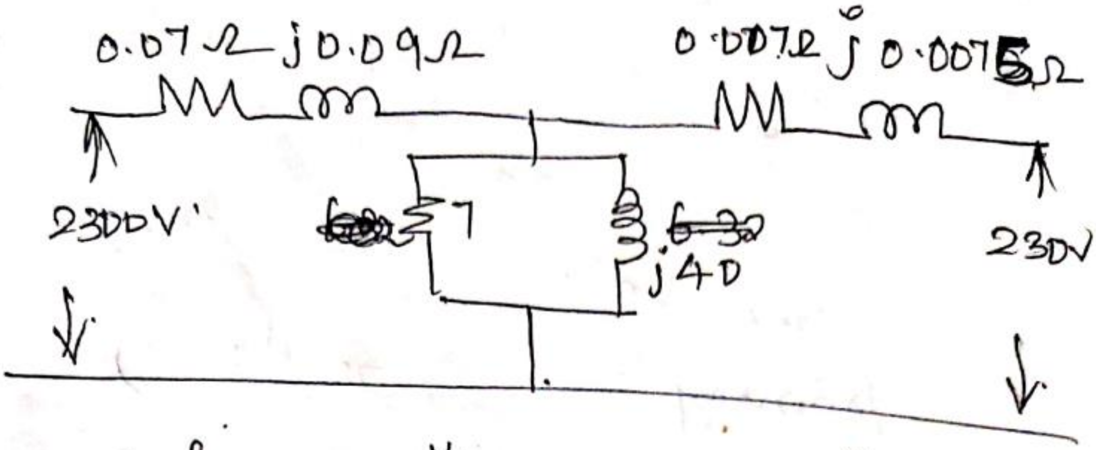
$$= 0.03\,\Omega$$

5.

a) high voltage side.



(b) Low voltage side.



$$\left(\frac{N_1}{N_2}\right)^2 \qquad \frac{V_1}{I_1} = Z_1 \qquad \frac{V_2}{V_1} = \frac{N_2}{N_1}$$

$$\frac{\frac{N_1}{N_2}(V_2)}{\frac{N_2}{N_1} I_2} = Z_1 \qquad \frac{I_1}{I_2} = \frac{N_2}{N_1}$$

$$\left(\frac{N_1}{N_2}\right)^2 Z_2 = Z_1.$$

$$Z_2 = \left(\frac{N_2}{N_1}\right)^2 Z_1$$

6.

$$\frac{N_1}{N_2} = \frac{5}{1}$$

$$R_2' + j X_2' = \left(\frac{N_1}{N_2}\right)^2 (2 + j4)$$

$$= 50 + j100 \Omega$$

$$I_1 = \frac{V_1}{R_2' + jX_2'} = \frac{120}{50 + j100 \Omega} = \frac{120}{111.8 \angle 63.43}$$

$I_1 = 1.07 \angle -63.43$ (lagging current due to short ckt.)

rms.

$I_2 = 5(1.07) = 5.37$ A rms.

7.

7) 2300/230V short ckt test.

$\boxed{50 KVA = \text{Total power} = VI}$

50V 20A 600W

Open test

230V, 5A 160W.

$$Z_{eq} = \frac{50}{20.0} = 2.5 \Omega$$

$$R_{eq} = \frac{600}{20^2} = 1.5 \Omega$$

$$X_{eq} = \sqrt{2.5^2 - 1.5^2} = 2 \Omega.$$

At full load current on H.V. side

$$I_1 = \frac{50 \times 10^3}{2300} = 21.74 \text{ A}$$

Power delivered for load $= 0.8 \times 50 \times 10^3$

$= 40$ KW

η at full load

Cu loss $= 21.74^2 (1.5) = 708.9414$W

core loss $= 160$W

Total loss $= 708.9 + 160 = 868.9$W

$$\eta = \frac{o/p}{i/p} = \frac{40K}{40K + 868.9} \times 100\% = 97.9\%$$

η at $\frac{1}{2}$ load.

$I_{full\ load} = 21.74$

$\frac{1}{2}$ load $= \frac{21.74}{2}$

$$\text{cu loss} = \left(\frac{21.74}{2}\right)^2 1.5$$

$$= 177.24\ W.$$

$\text{coreloss} = 160W$

$\text{Tot. loss} = 177.24 + 160 = 337.23W$

$$\eta = \frac{40K}{40K + 337.23} = 99.16\%$$