Tutorial Sheet - 02.

Q1. Rating = 100 KVA
V_1 = 4000 V
V_2 = 200 V
f = 50 Hz
N_2 = 100

(a) I_1, I_2 = ?
(b) N_1 = ?
(c) ϕ_m = ?

(a) $I_1 = \frac{V_A}{V_1}$

$= \frac{100 \times 1000}{4000}$

$= 25$ A

$I_2 = \frac{V_A}{V_2}$

$= \frac{100 \times 1000}{200}$

$= 500$ A

(b) $\frac{V_2}{V_1} = \frac{N_2}{N_1}$

or $N_1 = \frac{V_1}{V_2} \times N_2$

$= 2000$

(c) from emf equation of primary side

$V_1 = 4.44 f N_1 \phi_m$

$\phi_m = \frac{V_1}{4.44 f N_1} = 9.01 \text{ mwf}$

=

Q3

$Z_1 = 14,400\Omega$

$Z_2 = 400\Omega$

turns ratio

$\frac{N_1}{N_2} = ?$

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

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

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

or

$\frac{N_1}{N_2} = \left(\frac{Z_1}{Z_2}\right)^{1/2}$

$= 6$

So, $\boxed{N_1 : N_2 = 6 : 1}$

Q4

$\frac{N_1}{N_2} = \frac{5}{1}$, $Z_2 = 900\Omega$

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

a)

$$Z_1 = \left(\frac{5}{1}\right)^2 \times 900$$

$$= 22,500\ \Omega$$

Q5

$V_1 = 4500\,V$

$V_2 = 225\,V$

$f = 50\,Hz$

$\frac{\mathcal{E}}{N} = 15\,V$

$B_m = 1.4\,T$

(a) $N_1, N_2 = ?$

(b) $a = ?$

$$\frac{V_2}{V_1} = \frac{\mathcal{E}_2}{\mathcal{E}_1} = \frac{N_2}{N_1}$$

$$\frac{\mathcal{E}_2}{N_2} = \frac{\mathcal{E}_1}{N_1} = 15$$

let $\mathcal{E}_2 = V_2$, $\mathcal{E}_1 = V_1$

So, $\frac{V_2}{N_2} = 15$

$$N_2 = \frac{V_2}{15}$$

Similarly,

$$\frac{V_1}{N_1} = 15$$

or $N_1 = \frac{V_1}{15} = 300$

(b) from emf equation,

$V_1 = 4.44 f N_1 \phi_m$

$\phi_m = \frac{V_1}{4.44 f N_1} = 0.0675$

$B_m = \frac{\phi_m}{a}$

$a = \frac{\phi_m}{B_m} = \frac{0.0675}{1.4}$

$= 0.048 \ m^2$

Q6) $V_1 = 110V$, $V_2 = 11V$

$N_2 = 20$, $N_1 = ?$

$\frac{V_2}{V_1} = \frac{N_2}{N_1}$

So, $N_1 = \frac{V_1}{V_2} \times N_2$

$= \frac{110}{11} \times 20 = 200$

$\frac{V_2'}{V_2} = \frac{N_2'}{N_1}$

$N_2' = \frac{V_2'}{V_1} \times N_1$

$= \frac{33}{110} \times 200$

$= 60.$

no. of extra turns

$= N_2' - N_2$

$= 60 - 20 = \boxed{40}$

Q/ $V_1 = 2400\ V$

$V_2 = 400\ V$

$I_0 = 0.5\ A$

$P_c = 400\ W$

$I_m = ?,\ I_c = ?$

We know that at no-load condition,

$P_c = V_1 I_0 \cos\phi_0$

or, $\cos\phi_0 = \frac{P_c}{V_1 I_0} = \frac{400}{2400 \times 0.5}$

$= 0.33$

So,

$I_c = I_0 \cos\phi_0$

$= 0.5 \times 0.33 = 0.165$

$I_m = I_0 \sin\phi_0$

$= \begin{cases} 0.471\ A \\ I_0\sqrt{1-\cos^2\phi_0} \end{cases}$

Q8/ $N_1 = 600$

$N_2 = 150$

$R_1 = 0.25\ \Omega$

$R_2 = 0.01\ \Omega$

$X_1 = 1.0\ \Omega$

$X_2 = 0.04\ \Omega$

(a) $R_{e_1} = ?$

(b) $X_{e_1} = ?$

(c) $Z_{e_1} = ?$

(d) $\phi_1 = ?$

$$K = \frac{N_2}{N_1} = \frac{100}{600} = \frac{1}{4}$$

(a) $$R_{e_1} = R_1 + \frac{R_2}{K^2} = 0.25 + \frac{0.01}{(1/4)^2}$$

$$= 0.41\Omega$$

(b) $$X_{e_1} = X_1 + \frac{X_2}{K^2} = 1.0 + \frac{0.64}{(1/4)^2}$$

$$= 1.64\Omega$$

(c) $$Z_{e_1} = \sqrt{R_{e_1}^2 + X_{e_1}^2}$$

$$= \sqrt{(0.41)^2 + (1.64)^2}$$

$$= \sqrt{(.16) + (2.68)} = 1.68$$

(d) $$\phi_1 = \cos^{-1}\left(\frac{R_{e_1}}{Z_{e_1}}\right)$$

or

$$\tan^{-1}\left(\frac{X_{e_1}}{R_{e_1}}\right)$$