Sol^n :- Tutorial - 7

Q.1

(i) The peak value of flux

$$\phi_m = \frac{E_1}{4.44 f N_1} = \frac{230}{4.44 \times 50 \times 30} = 0.034534\ Wb$$

$$\therefore B_m = \frac{\phi_m}{A} = \frac{0.034534}{250 \times 10^{-4}} = 1.3814 T$$

(ii) The voltage induced in secondry winding

$$E_2 = E_1 \times \frac{N_2}{N_1} = 230 \times \frac{350}{30} = 2683.33\ V$$

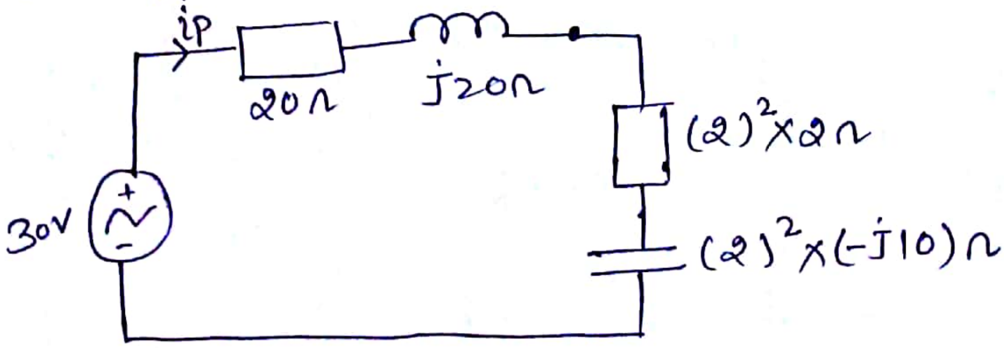
$$= 2.683\ kV$$

(iii) The primary current

$$I_1 = I_2 \left(\frac{N_2}{N_1}\right) = 100 \times \left(\frac{350}{30}\right) = 1166.67\ A$$

$$= 1.167\ kA$$

Q.2 Transforming the load impedance into primary



$$I_p = \frac{30\angle 0^\circ}{20 + j20 + 2^2(2 - j10)} = 0.872\angle 35.53^\circ A$$

$$\therefore I_L = 2 I_p = 2 \times 0.872 \angle 35.53^\circ$$

$$I_L = 1.74 \angle 35.53^\circ\ A$$

Q.3 Given $R_1 = 10\Omega$, $R_2 = 0.02\Omega$, $X_{e1} = 35\Omega$

the trans-ratio $K = \frac{250}{6600} = 0.0379$

the full load current, $I_2 = \frac{40000}{250} = 160A$

$\therefore R_{e2} = K^2 R_1 + R_2 = (0.0397)^2 \times 10 + 0.02$

$= 0.0343 \Omega$

and $X_{e2} = K^2 X_{e1} = (0.0379)^2 \times 35$

$= 0.0502 \Omega$

(a) For power factor, $\cos\phi = 1$; $\sin\phi = 0$, Hence:-

$\therefore$ % Regulation $= \dfrac{I_2 R_{e2} \cos\phi + I_2 X_{e2} \sin\phi}{V_{2(0)}} \times 100$

$= \dfrac{160 \times 0.0343 \times 1 + 0}{250} \times 100$

$= 2.195\%$

(b) for power factor, $\cos\phi = 0.8$ (lagging, ϕ positive)

$\sin\phi = \sqrt{1 - \cos^2\phi} = 0.6$

$\therefore$ % Reglation $= \dfrac{I_2 R_{e2} \cos\phi + I_2 X_{e2} \sin\phi}{V_{2(0)}} \times 100$

$= \dfrac{160 \times 0.0343 \times 0.8 + 160 \times 0.0502 \times 0.6}{250} \times 100$

$= 3.68\%$

(c) for power factor, $\cos\phi = 0.8$ (leading, ϕ negetive)

$\sin\phi = 0.6$

$\therefore$ % Regulation $= \dfrac{I_2 R_{e2} \cos\phi - I_2 X_{e2} \sin\phi}{V_{2(0)}} \times 100$

$= \cancel{-0.1721}$

$= \dfrac{160 \times 0.0343 \times 0.8 - 160 \times 0.0502 \times 0.6}{250} \times 100$

$= -0.172\%$

Q.4 (a) Using EMF equation

$$E_2 = 4.44 f N_2 \phi_m$$

$$N_2 = \frac{E_2}{4.44 f \phi_m} = \frac{250}{4.44 \times 50 \times 0.06} = 18.8 \approx 19 \text{ turns}$$

and

$$N_1 = \frac{E_1}{E_2} N_2 = \frac{5000}{250} \times 19 = 380 \text{ turns}$$

(b) At full load and 0.8 power factor

P_o = (KVA) × (power factor) = 150 × 0.8 = 120 kW

P_c = 1800 W = 1.8 kW and P_i = 1500 W = 1.5 kW

$$\therefore \eta = \frac{P_o}{P_o + P_c + P_i} \times 100 = \frac{120}{120 + 1.8 + 1.5} \times 100 = 97.3\%$$

(c) At half rated-KVA, the current is half the full load current, and hence output power is reduce by 0.5. Thus

P_o = 0.5 × (KVA) × (power factor)

= 0.5 × 150 × 1 = 75 kW

P_c = $(0.5)^2$ × (full-load copper loss)

= $(0.5)^2$ × 1800 W = 0.45 kW

Iron losses (fixed), P_i = 1500 W = 1.5 kW

$$\therefore \eta = \frac{P_o}{P_o + P_c + P_i} \times 100 = \frac{75}{75 + 0.45 + 1.5} \times 100$$

$$= 97.45\%$$

Q.5

Z = 65 × 12 = 780, A = P = 4

$$E = \frac{\phi Z N P}{60 A} = \frac{0.02 \times 780 \times 1200 \times 4}{60 \times 4}$$

$$= 312 \text{ V}$$

Q.6 $E = \frac{\phi Z N P}{60 A} = K N$ {for constant ϕ)

$$\frac{E_2}{E_1} = \frac{N_2}{N_1}$$

$$E_2 = \frac{600}{500} \times 180 = 216 V$$