Electrical Assignment-5

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2K19/A14/35

1. $\frac{di}{dt} = \frac{12}{0.01} = 1200 \text{ A/s}$

$e = \frac{Nd\phi}{dt} = \frac{1000 \times 6 \times 0.05}{10 \times 0.01}(1200) = \underline{7.2V}$

$M = \frac{\mu_0 \phi}{2} = 1000 \times \frac{60}{100} \times \frac{0.05 \times 10^{-3}}{5} = \underline{6 \times 10^{-3} H}$.

$L = \frac{N\phi}{i} = \underline{10 \text{ mH}}$

2. $N_1 = 1500$, $l_1 = 60 \text{ cm}$

$N_2 = 500$, $A = 20 \times 10^{4} \text{ m}^2$

a) $M_p = \frac{\mu_0 N_1 N_2 A}{l} = \frac{4\pi \times 10^{-7} \times 1500 \times 1500 \times 20 \times 10^{-4}}{60 \times 10^{-2}}$ $= \underline{3.14 \text{ mH}}$

b) $e = 3.14 \times 10^{-3} \times 250$
$= \underline{0.75V}$

3. $M = \frac{4\pi \times 10^{-7} \times 50 \times 505 \times 2 \times 10^{-4}}{5 \times 2 \times 10^{-2}} = 52.8 \ \mu\text{Am}^2$.

$e = \frac{M di}{dt} = 52.8 \times 10^{-6} \times 0.2 \times 5000$
$= \underline{0.0528 \text{ V}}$

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$$M_1 = \frac{\mu N_1 N_2 A_1}{l_1} = \frac{4\pi\times10^{-7}\times10^6\times\pi\times4\times10^{-4}}{4\times100\times10^{-2}} = \underline{0.888\ mH}$$

$$M_2 = \frac{\mu N_1 N_2 A_2}{l_2} = \frac{4\pi\times10^{-7}\times10^6\times\pi\times36\times10^{-4}}{400\times10^{-2}} = \underline{3.55\ mH}.$$

$$L_1 = \frac{\mu_0 N^2 A}{l} = \frac{4\pi\times10^{-7}\times10^6\times\pi\times9\times10^{-4}}{4} = \underline{0.888\ mH}$$

$$L_2 = 3.55\ mH$$

$$K = \frac{M}{\sqrt{L_1 L_2}} = \underline{0.5}.$$

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a) $M = \frac{N\phi}{i}$, $M_{12} = \frac{N_2\phi_{12}}{i} = \frac{1500\times\left(\frac{45}{100}\times0.05\right)}{5}$

$= 0.0675\ H$

4.5% of flux produced, by 1 unit current, $M_{12} = 0.0675 = 67.5\ mH$

$$L_1 = \frac{N_1\phi_1}{i_1} = \frac{12000\times0.05\times10^{-3}}{5} = \underline{0.12\ H}$$

$$L_2 = \frac{N_2\phi_2}{i_2} = \frac{15000\times0.075\times10^{-3}}{5} = \underline{0.225\ H}.$$

6

a) $$M = \frac{\mu_0\mu_r N_1 N_2 A}{l} = \frac{4\pi\times10^{-7}\times2000\times30\times6}{150\times10^{-2}}$$

$= \underline{0.302\ H}$

b) $$e = \frac{M di}{dt} = \frac{0.302\times10}{10^{-2}}$$

$= \underline{302\ V}.$

$\boxed{7}$ i) $\frac{V_1}{V_2} = \frac{13.8}{11.5} = 6/5$

$\frac{P_i}{P} = 1 - \frac{1}{n} = 1 - \frac{5}{6} = 1/6$

$P = 6P_i = 600$ KVA

ii) $\frac{V_1}{V_2} = \frac{13.8}{2.3} = 6$

$\frac{P_i}{P} = 1 - \frac{1}{6} = 5/6 \Rightarrow P = \frac{6}{5} P_i$

$= 6/5 \times 100 = 120$ KVA.

$\boxed{8}$ a) $R_1 = n^2 R_i$ $\quad n = \frac{N_2}{N_1} = 2$

$R_i = 4 \times 0.067 = 0.268\ \Omega$

b) $R_2' = \frac{R_2}{n^2} = \frac{0.232}{4} = 0.0582\ \Omega$

c) Total, $R_1 + R_2 = \underline{0.125\ \Omega}$

$\boxed{9}$ $I_c = I_0^2 (R_1 + R_2)$

$R_1 + R_2 = \frac{1.2 \times 10^3}{104} = 0.12\ \Omega$

$X_1 + X_2 = \sqrt{2^2 (R_1 + R_2)^2}$

$Z = \frac{V}{I} = 0.6\ \Omega.$

$X_1 + X_2 = \sqrt{0.36 - 0.0144} = \underline{0.587\ \Omega}.$

$\boxed{10}$

a) $\eta = \frac{V_2}{V_1} = \frac{25}{200} = 1/8$

$R_1' = n^2 R_1 = \frac{1}{64} \times 0.115 \times 10 = \underline{0.0179\ \Omega}$

$R_{net} = 0.0155 + 0.0179 = \underline{0.0334\ \Omega}$

b) Total drop on full load $= I_1 R_1 + I_2 R_2$

$I_1 = \frac{40 \times 10^3}{2000} = 20\ A.$

$I_2 = \frac{40 \times 10^3}{250} = 160\ A.$

$\because$ Total drop $= 20 \times 1.15 + 160 \times 0.0155.$

$= \underline{25.48\ V}.$

c) $P_c = I_1^2 R_1 + I_2^2 R_2$

$= (20)^2 \times 1.15 + (160)^2 \times 0.0155$

$= \underline{856.8\ W}$

$\boxed{11}$ $P_c = I^2 (R_1 + R_2) = (200)^2 (0.9 + 0.3) = \underline{48\ KW}$

$Z = \sqrt{(R_1+R_2)^2 + (X_1+X_2)^2} = \underline{5.26\ \Omega}$

$= \sqrt{(1.2)^2 + (5.13)^2}$

$V = IZ = 200 \times 5.26 = 1052\ V$

$\tan\theta = \frac{R_1+R_2}{X_1+X_2} = 0.234.$

$\phi = \tan^{-1}(0.234) = \underline{13.17^\circ}.$

Power factor → $\cos(13.17°) = \underline{0.97}$

13 $X = \sqrt{z^2 - (R_1 + R_2)^2} = 9\Omega$

$\eta = \frac{E_2}{E_1} = \frac{6600}{330} = 20$

$V_2 = 20 * V_1 = 20 \times 330 = \underline{6600\,V}$

Regulation → $IR\cos\theta + IX\sin\theta$

$I = \frac{100 \times 10^3}{6600} = 15.15\ A$

$= 15.15\,(4.36 \times 0.8 + 9 \times 0.6)$

$= \underline{134\ V}$

$V_2' = V_2 + 134$

$= 6600 + 134 = \underline{6734\ V}$

(15) a) $\eta = \frac{x VI\cos\theta}{\eta\, VI\cos\theta + P_i + P_c}$

At 25% load output, $\frac{VI}{4} = \frac{150}{4} = 37.5\ kW$

$P_c = \frac{P_i}{x^2} = \frac{1400}{16} = 87.5\ W$

$\eta = \frac{37.5 \times 10^3}{37.5 \times 10^3 + 1400 + 87.5} \times 100 = \underline{96.18\%}$

At 33% load output, $1500 \times \frac{33}{100} = 49.5\ kW$

$P_c = \frac{1400}{(3.03)^2} = 152.5\,W$.

$$\eta = \frac{49500}{49500 + 152.5 + 1400} \times 100 = \underline{97\%}$$

At full load,

$$\eta = \frac{150 \times 10^3}{150 \times 10^3 + 1400 + 1600} \times 100 = 98\%.$$

$\boxed{16}$ a) full load $= \eta = \dfrac{25 \times 10^3}{25 \times 10^3 + 350 + 400} \times 100 = \underline{97.08\%}$

b) half load

$$\eta = \frac{25 \times 10^3 \times 0.5}{25 \times 10^3 \times 0.5 + 350 + 87.5} \times 100 = \underline{96\%}$$

c) load $= xP = \sqrt{\dfrac{P_i}{P_c}} \times P = \sqrt{\dfrac{350}{400}} \times 25\text{ KVA}$

$= 23.4$ KVA

At max efficiency,

$P_i = P_c = 350$ W.

$\boxed{17}$ $\eta_{max} = 0.98 = \dfrac{15K}{15K + 2x}$ $x = 153$ W

12 hours → 2Kw at 0.5 (power factor)

KVA $= 2/0.5 = 4$. $P_c = P_i/x^2 = 153 \times (4/15)^2$

$= \underline{10.88\text{ W}}$

Next 6 hours, 12KW at 0.8 pf

KVA $= \dfrac{12}{0.8} = 15$, $P_c = 153 \times \left(\dfrac{15}{15}\right)^2 = 153$ W

Next 6 hours, 18 KW at 0.9 pf, KVA $= \dfrac{18}{0.9} \times 1 = 20$.

$P_c = 153 \times \left(\dfrac{20}{15}\right)^2 = \underline{272\text{ W}}$

$$\%\eta = \frac{(12 \times 2 + 6 \times 12 + 6 \times 18) \times 10^3}{10.88 + 12 + 153 \times 6 + 2 + \underbrace{2 \times 6 \times 24 \times 153}_{P_i}} = \underline{97.5\%}$$