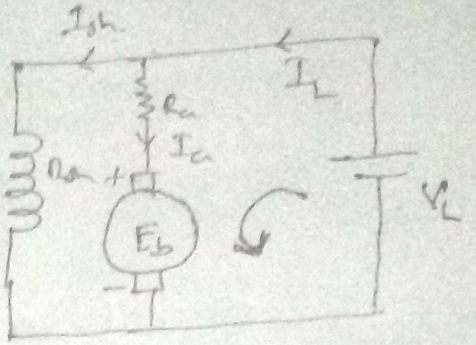
4b. $V_L = 250V \mid P=6 \mid Z=220$

$R_a = 0.2\Omega \mid I_L = 13.3A \mid A=2$

$N = 908$ RPM



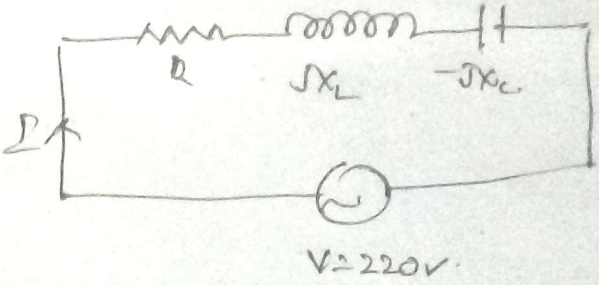
$+V_L - I_a R_a - E_b = 0$

$E_b = V_L - I_a R_a = 247.34V$

$E_b = \frac{N\phi ZP}{60A} \rightarrow \phi = \frac{E_b 60A}{NZP} = \frac{29680.8}{1198560} = 0.024 kWb$

5b. $R = 100\Omega \mid C = 25 * 10^{-6} F \mid L = 0.15 H$

$V = 220V \mid f = 50Hz$



$X_L = 2\pi fL = 47.1\Omega$

$X_C = \frac{1}{2\pi fc} = 127.38\Omega$

$1.337 + j1.07$

* $Z = R + j(X_L - X_C) = (100 - j80.28)\Omega$

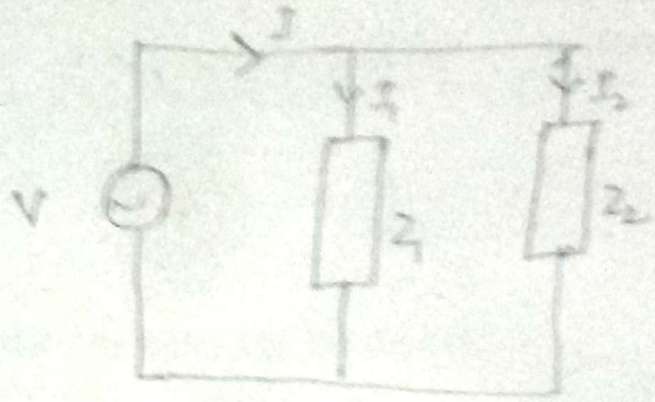
* $|I| = \frac{|V|}{|Z|} = \frac{220}{\quad}$ | $I = \frac{V}{Z} = 1.715 \angle 38.75° A$

* Complex power $(S) = VI^* = 294.14 - j235.4 = (P - jQ) VA$

* power factor $\cos\phi = \cos(38.75°) = 0.779$

6b. $V = 200\angle 0°\ V$

$f = 50\ Hz$.



$Z_1 = (150 - j157)\Omega$

$Z_2 = (100 + j110)\Omega$

* $I_1 = \frac{V}{Z_1} = 0.92\angle 46.39°\ A = 0.636 + j0.665\ A$

* $I_2 = \frac{V}{Z_2} = 1.34\angle -47.72°\ A = (0.90 - j0.99)\ A$.

* $J = I_1 + I_2 = 2.02\angle -3.82°\ A = (2.02 - j0.135)\ A$.

* power $S = VJ^* = (404 + j27)\ VA = (P + jQ)\ VA$.

7C. $p = 6$ | Y-connected | slots = 90 |

Cond/slot = 12 | $N_s = 1000$ rpm | $\Phi = 0.5\ Wb$ |

$k_w = 0.97$.

$E_p = 4.44 \Phi f T_p k_w$ | $E_L = \sqrt{3} E_p$.

$T_p = \frac{12 * 90}{6} = 180$. | $f = \frac{N_s p}{120} = 50\ Hz$.

$E_p = 19380.6\ V$ | $E_L = 33528.438\ V$

8c. $V_L = 400V \mid I_L = 10A \mid \cos\phi = 0.7$

$\hookrightarrow \phi = 45.57^\circ$

(a) connected;

$V_L = V_p = 400V$.

(i) $I_p = I_L/\sqrt{3} = 5.77A$.

(ii) $S = P + jQ = \sqrt{3} V_L I_L \cos\phi + j\sqrt{3} V_L I_L \sin\phi$.

$= (3997.27 + j2854.69)VA$

(iii) $Q = \sqrt{3} V_L I_L \sin\phi = 2854.69 VAR$.

9b. $\eta_{max} = \dfrac{x^* |V_2| |I_{2FL}| \cos\phi}{x^* |V_2| |I_{2FL}| \cos\phi + 2W_i} = 0.98$

$x^* = 1$

$|V_2| |I_{2FL}| = 25 * 10^3 VA$.

$\cos\phi = 1$.

$25 * 10^3 = 0.98 (25 * 10^3) + 1.96 W_i$

$W_i = 255W$.

$x^* = \sqrt{\dfrac{W_i}{(W_{cu})_{FL}}} \Rightarrow (W_{cu})_{FL} = 255W$.

CASE (i):- $x_1 = 0.75 \mid \cos\phi_1 = 0.9. \mid \eta_1 = ?$

$\eta_1 = \dfrac{x_1 |V_2| |I_{2FL}| \cos\phi_1}{x_1 |V_2| |I_{2FL}| \cos\phi_1 + W_i + x_1^2 (W_{cu})_{FL}} = 97.33\%$.

CASE (ii) :— $x_2 = 0.5 \mid \cos\phi_2 = 0.8 \mid \eta_2 = ?$

$$\eta_2 = \frac{x_2 |V_2| |I_{2FL}| \cos\phi_2}{x_2 |V_2| |I_{2FL}| \cos\phi_2 + W_i + x_2^2 (W_{cu})_{FL}} = 96.91\%$$

CASE (iii) :— $x_3 = 0.25 \mid \cos\phi_2 = 0.6 \mid \eta_3 = ?$

$$\eta_3 = \frac{x_3 |V_2| |I_{2FL}| \cos\phi_3}{x_3 |V_2| |I_{2FL}| \cos\phi_3 + W_i + x_3^2 (W_{cu})_{FL}} = 93.26\%$$

9C. $P = 6 \mid f = 50Hz \mid S_{NL} = 0.01 \mid S_{FL} = 0.03$

(i) $N_s = \frac{120f}{P} = 1000 RPM.$

(ii) $(N_r)_{NL} = (1 - S_{NL}) N_s = 990 RPM$

(iii) $(N_r)_{FL} = (1 - S_{FL}) N_s = 970 RPM$

(iv) $(f_r)_{NL} = Sf = f = 50Hz$ @ standstill

(v) $(f_r)_{FL} = (S_{FL}) f = 1.5Hz.$

10C. Rating $= 20KVA = 20 * 10^3 VA \mid N_1 = 1000 \mid N_2 = 2500 \mid a = 0.01 m^2$

$V_1 = E_1 = 550V \mid$

(6)

(i) $V_1 = E_1 = 4.44 \phi_m f N_1$

$$\phi_m = \frac{V}{4.44 f N_1} = 0.0024 \text{ Wb}$$

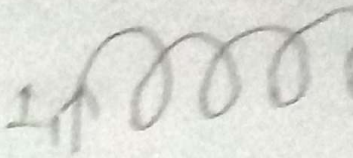
$$B_m = \frac{\phi_m}{a} = 0.2477 \text{ T}$$

(ii) $$\frac{E_1}{E_2} = \frac{N_1}{N_2} \rightarrow E_2 = E_1\left(\frac{N_2}{N_1}\right) = 1375 \text{ V}$$

(iii) $V_1 I_{1FL} = V_2 I_{2FL} = 20 \times 10^3 \text{ kVA}$.

$I_{1FL} = 36.36 \text{ A}$ | $I_{2FL} = 14.54 \text{ A}$.

1c. $I_1 = 10A \mid \Delta t = 0.01\,s \mid$ N = 15



(i) Self inductance ; $L = \frac{N\phi_1}{I_1} = 0.15H$

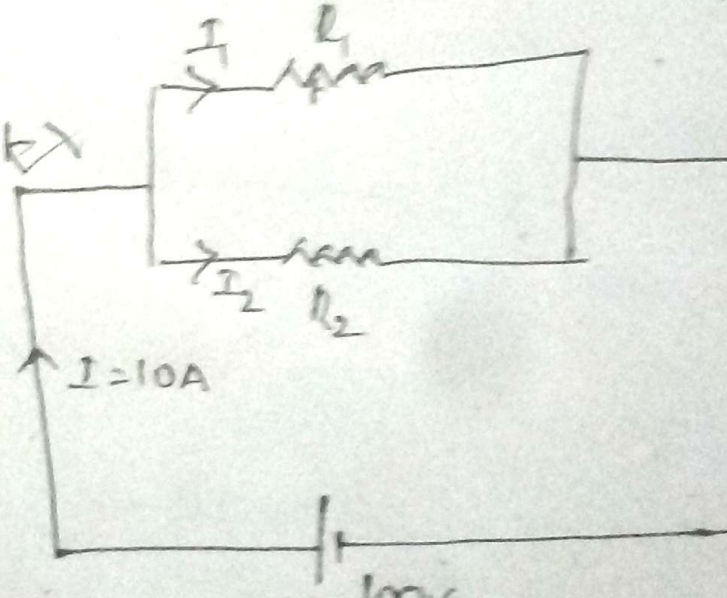
(ii) Induced emf ; $E = L\frac{\Delta I}{\Delta t}$ | $\Delta I = 10 - 0$, $\Delta t = 0.01s$

$E = 300V$

2b. CASE (i):

$P_1 = \frac{V^2}{R_1} = VI_1 = 600W$

$I = I_1 + I_2 \mid I_1 = 6A \mid I_2 = 4A$



$R_1 = \frac{V}{I_1} = 16.66\Omega \mid R_2 = \frac{V_2}{I_2} = 25\Omega$

CASE (ii):

$I = \frac{V}{R_1 + R_2} = 2.40A$