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Bsee 19047

Machines - A2

Q1
(a) $S = 50KVA$, $2400-240$, $60Hz$

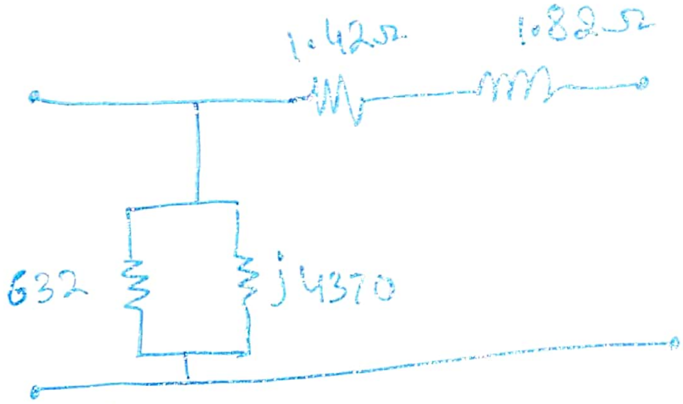
(i) $R_p = 0.72$, $X_p = j0.92$, $R_s = 0.007$, $X_s = j0.009$,
$R_c = 6.32$, $X_m = j43.7$, $a = \frac{2400}{240} = 10$

$R_s' = (0.007)(10^2) = 0.7\Omega$

$X_s' = (j0.009)(10^2) = j0.9\Omega$

$R_c' = (6.32)(100) = 632\Omega$, $X_m' = (j43.7)(100) = 4370j$

$R_{eq} = R_p + R_s' = 1.42\Omega$, $X_{eq} = X_p + X_s' = 1.82\Omega$

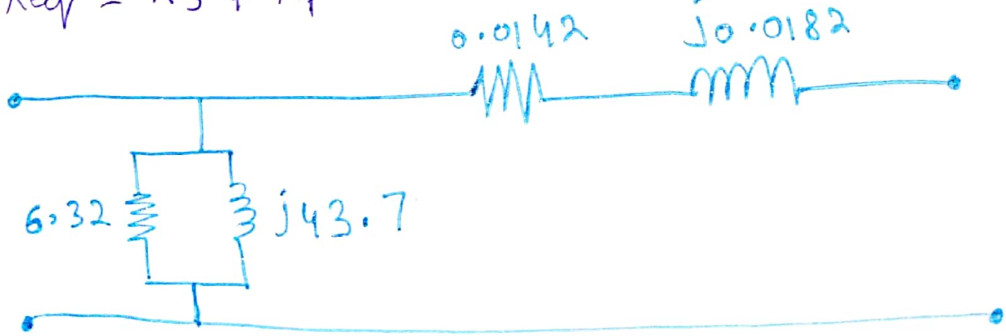


(ii) $R_p' = (0.72)/100 = 0.0072\Omega$

$X_p' = j0.92/100 = j0.0092\Omega$

$R_{eq} = R_s + R_p' = 0.0142\Omega$

$X_{eq} = X_s + X_p' = j0.0182\Omega$



(b) (i) $Z_\phi = 632 + j4370$, $|Z_\phi| = 4415.5\ \Omega$

$$I_H = \frac{V_H}{|Z_\phi|} = \frac{2400}{4415.5} , \quad \boxed{I_H = 0.54\ A}$$

(ii) $Z_\phi = 6.32 + j43.7$ $\quad |Z_\phi| = 44.155\ \Omega$

$$I_L = \frac{V_L}{|Z_\phi|} = \frac{240}{44.155} \quad \boxed{I_L = 5.43\ A}$$

Q:-2

(a) $S = 50\ KVA$, $V_H = 48V$, $I_H = 20.8A$, $P = 617W$

$$Z_{eq} = \frac{V_H}{I_H} = \frac{48}{20.8} , \quad Z_{eq} = 2.3\ \Omega$$

$$R_{eq} = \frac{P}{I_H^2} = \frac{\cancel{48}\ 617}{(20.8)^2} = 1.426\ \Omega$$

$$X_{eq} = \sqrt{|Z_{eq}|^2 - R_{eq}^2} = \sqrt{2.3^2 - 1.426^2} \Rightarrow 1.804$$

$$P = PF \times S = (0.8)(50K) , \quad \boxed{P = 40KW}$$

$$P_{loss} = I_H^2 \times R_{eq} = (20.8^2)(1.426) . \quad P_{loss} = 616.9 = 617W$$

$$P_{loss} = 617 + 166 \Rightarrow 803\ W$$

$$P_{in} = 40000 + 803 = 40803\ W$$

$$\eta = \frac{P_{out}}{P_{in}} = \frac{40K}{40.803K} \times 100 , \quad \boxed{\eta = 98\%}$$

$$VR = \frac{2400 - (20.8\angle -36.8)(1.426 + j1.82) - 2400}{2400 - (20.8\angle -36.8)(1.426 + j1.82)} \times 100$$

$$\boxed{VR = 2\%}$$

(b) PF = 1 , P = 50 kW , $\theta = 0°$

$$I_H = \frac{P}{V} = \frac{50000}{2400} = 20.83\ A$$

$$VR = \frac{R\{2400 + (20.83)(1.42 + j1.82)\} - 2400}{R\{2400 + (20.83)(1.42 + j1.82)\}} \times 100$$

$$\boxed{VR = 1.2\ \%}$$

Q:- 3

(a) $V_H = V_{ab} + V_{bc} = V_{ab} + V_L \Rightarrow 240 + 2400$

$$\boxed{V_H = 2640\ V}$$

(b) $I_R = \frac{S}{V_R} = \frac{50\,kVA}{240}$, $\boxed{I_R = 208.3}$ A

$P = V_H I_R = 2640 \times 208.3$ $\boxed{P = 550\ kVA}$

$I_L = \frac{2640}{2400} \times 208.3$ $\boxed{I_L = 229\ A}$

(c) from question 2, $\boxed{P_{loss} = 803\,W}$

$P_{in} = (0.8) \times (550 \times 10^3) + 803$ $\boxed{P_{in} = 440803\ W}$

$P_{out} = (0.8)(550000) = 440000\,W$

$\eta = \frac{P_{out}}{P_{in}} \times 100\% = \frac{440000}{440803} \times 100$ $\boxed{\eta = 99.8\ \%}$

Q:- 4 $S = 50KVA$, $V_H = 2400v$, $V_L = 240v$

$I_H = \frac{S}{V_H} = \frac{50KVA}{2400}$, $I_H = 20.83A$

$I_L = \frac{S}{V_L} = \frac{50KVA}{240}$, $I_L = 208.3A$

$\frac{V_H}{V_L} = \frac{2400}{240} = \boxed{a = 10}$

$Z_H = \frac{2400}{20.83}$, $\boxed{Z_H = 115.2\Omega}$

$Z_L = \frac{240}{208.3}$, $\boxed{Z_L = 1.152\Omega}$

(a) $I_{\phi_L} = \frac{5.41}{208.3}$, $\boxed{I_{\phi_L} = 26mPu} = 26\times10^{-3}$ per unit

$I_{\phi_H} = \frac{\frac{5.41}{10}}{20.83}$, $\boxed{I_{\phi_H} = 26mPu} = 26\times10^{-3}$ per unit

(b) $Z_{eq}(H) = \frac{1.42 + 1.82j}{115.2}$, $\boxed{Z_{eq_H} = 0.0123 + 0.0158j}$

per unit

$Z_{eq}(L) = \frac{0.0142 + 0.0182j}{1.152}$, $\boxed{Z_{eq_L} = 0.0123 + 0.0158j}$

per unit

Q5 $S = 10KVA$

(a)

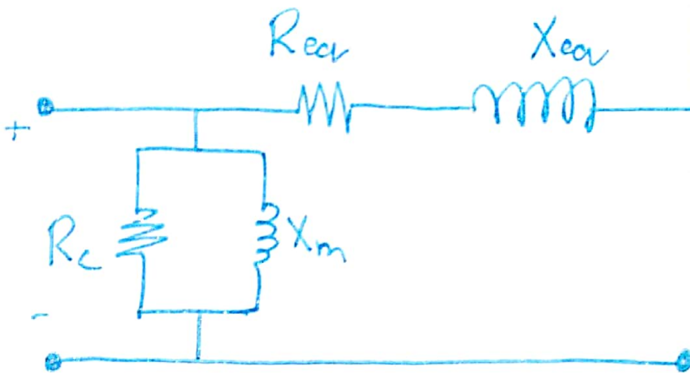
$$R_{eq} = \frac{P_{sc}}{I_{sc}^2} = \frac{120}{(22.2)^2}$$

$$\boxed{R_{eq} = 0.243\,\Omega} \quad —(1)$$

$$Z_{eq} = \frac{V_{sc}}{I_{sc}} = \frac{9.65}{22.2}$$

$$\boxed{Z_{eq} = 0.4346\,\Omega} \quad —(2)$$

$$X_{eq} = \sqrt{Z_{eq}^2 - R_{eq}^2} = \sqrt{(.4346)^2 - (0.243)^2}, \quad \boxed{X_{eq} = 0.36\,\Omega}$$



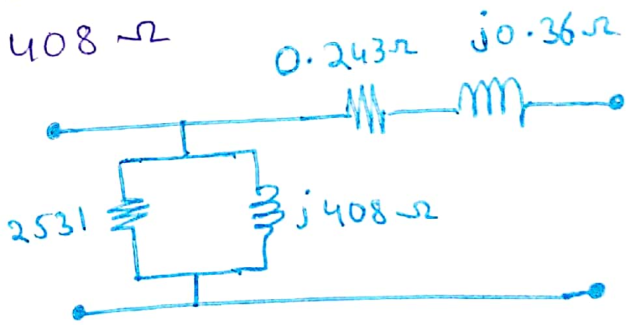
$$\cos\phi = \frac{P_{oc}}{V_{oc} I_{oc}} = \frac{80}{120 \times 4.2} = 0.159, \quad \theta = 80.85^\circ$$

$$R_c' = \frac{120}{4.2 \times 0.159}, \quad \boxed{R_c' = 180\,\Omega} \quad X_m' = \frac{120}{4.2 \times (\sin(80.85^\circ))}$$

$$\boxed{X_m' = 29\,\Omega}, \quad a = \frac{450}{120} = 3.75$$

$$R_c = R_c' \times a^2 = 180 \times (3.75)^2 = 2531\,\Omega$$

$$X_m = X_m' \times a^2 = 29 \times (3.75)^2 = 408\,\Omega$$



$$I = \frac{10K}{120} = 83.3A$$

$$\eta = \frac{P_{out}}{P_{in}} = \frac{120 \times 83.3 \times 0.8}{120 \times 83.3 \times 0.8 + 80 + 120} \times 100\% \qquad \boxed{\eta = 97.56\%}$$

$$VR = \frac{450 + \left|(83.3\angle{-36.9^\circ})(0.243 + j0.36)\right| - 450}{R\left[(83.3\angle{-36.9^\circ})(0.243 + j0.36)\right]} \times 100\%$$

$$\boxed{VR = 7.06\%}$$

(c) $I = \frac{83.3}{2} = 41.67A$

$\eta = \frac{P_{out}}{P_{in}} \times 100 \Rightarrow \frac{120 \times 41.67 \times 0.8}{120 \times 41.67 \times 0.8 + 80 + 30} \times 100$

$\boxed{\eta = 97.3\ \%}$

Q:-6

$S = 150\ MVA$, $15 - 200\ KV$

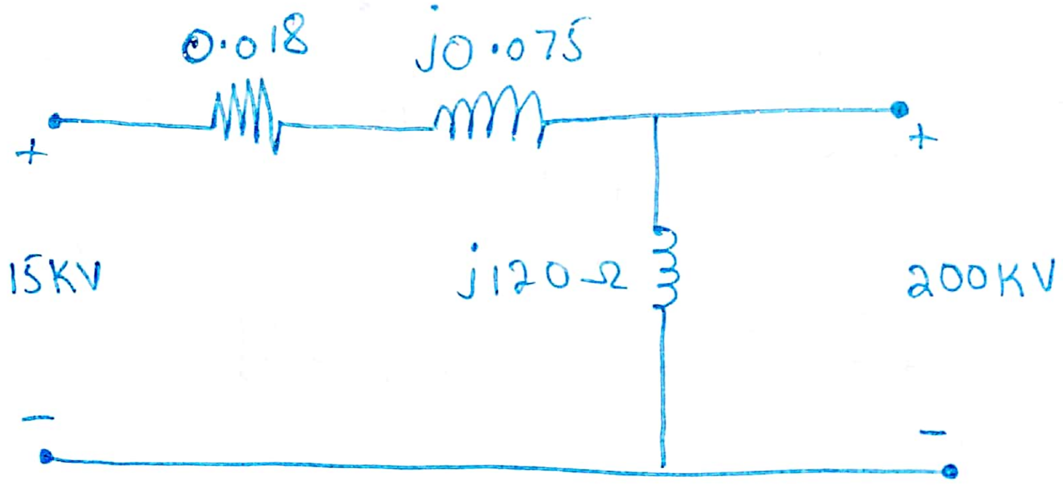
(a) $R = 1.2\%$, $X = 5\%$, $X_m = 80j\ pu$

$Z_{base} = \frac{V_{base}}{I_{base}} = \frac{V_{base}}{\frac{P}{V_{base}}} = \frac{(V_{base})^2}{P} = \frac{15^2}{150} = 1.5$

$R = \left(\frac{1.2 \times 1.5}{100}\right)$, $R = 0.018\ \Omega$

$X = \left(\frac{5 \times 1.5}{100}\right)$, $X = 0.075\ \Omega$, $X_m = (80 \times 1.5)$

$X_m = 120$



(b) $I = \frac{150M}{15K} = 10KA = 10000\angle -36.86°$

$$VR = \frac{R\{15000 + (10000\angle -36.86°)(0.018 + j0.015)\} - 15000}{R\{15000 + (10000\angle -36.86°)(0.018 + j0.015)\}} \times 100\%$$

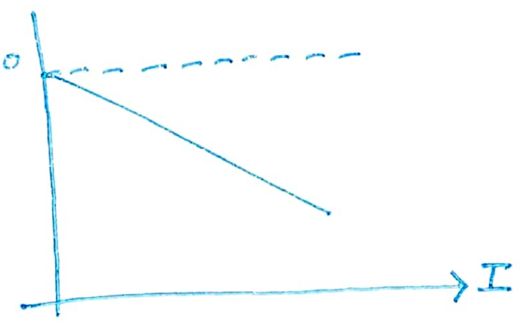
$$\boxed{VR = 3.85\%}$$

(c) Copper loss $= P_{copper} = (I^2)(R) = (10000)^2 \times (0.018)$

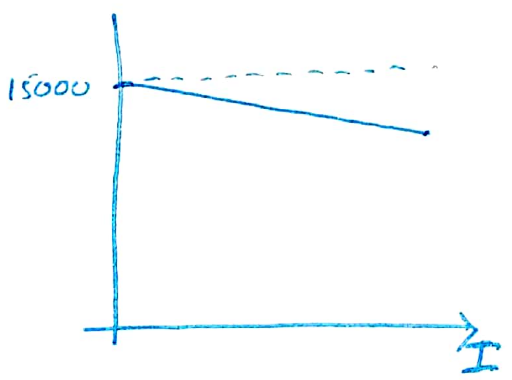
$$\boxed{P_{copper} = 1.8MW}$$

~~Copper~~ Core losses will be minimum let's say it will be zero because of no current flowing through the core {laminated core bars of transfo

(d) 0.8 lagging PF: →



unity (1) PF:



0.8 leading PF