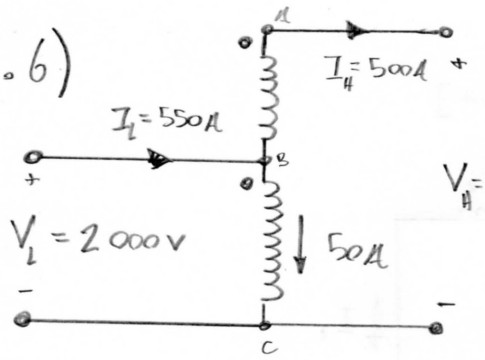
ELEC-344 Assignments #2 Thomas Bement 24099822

2.6)



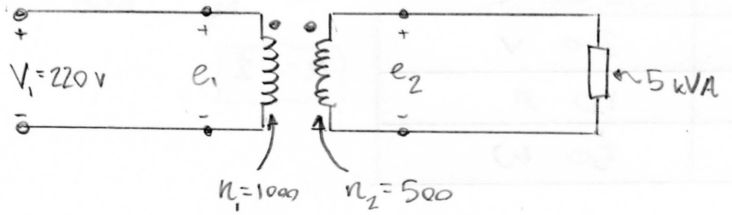
$$KVA = \frac{VA}{1000} = \frac{VI}{1000}$$

$V_H = 2200V$

$$KVA_L = \frac{2000(550)}{1000} = \boxed{1100\ KVA}$$

$$KVA_H = \frac{2200(500)}{1000} = \boxed{1100\ KVA}$$

2.9)



$$a = \frac{n_1}{n_2} = \frac{1000}{500} = 2$$

$$a = \frac{V_1}{V_2} \Rightarrow V_2 = \frac{V_1}{a}$$

a) $V_2 = \frac{V_1}{a} = \frac{220}{2} = \boxed{110V}$

b) $kVA = \frac{VA}{1100} = \frac{VI}{1000} = 5 \Rightarrow I = \frac{1000\ kVA}{V} = \frac{1000(5)}{110} = 45.\overline{45}\ A$

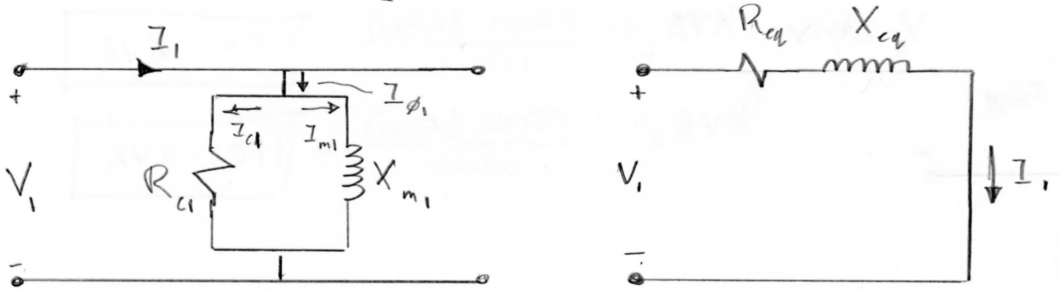
$$Z_{l,2} = \frac{V_2}{I_2} = \frac{110}{45.\overline{45}} = \boxed{2.42\ \Omega}$$

c) $Z_{l,1} = Z_2 a^2 = 2.42(2^2) = \boxed{9.68\ \Omega}$ ← equal! →

$$I_1 = \frac{I_2}{a} = \frac{45.\overline{45}}{2} = 22.\overline{72}\ A \Rightarrow Z_{l,1} = \frac{V_1}{I_1} = \frac{220}{22.\overline{72}} = \boxed{9.68\ \Omega}$$

Problem 1)

a)



$f = 60$ Hz

$\omega = 2\pi f = 120\pi$

$N_1 = 400$

$N_2 = 200$

	Open circuit	Closed circuit
V	120 V	20 V
I	1 A	10 A
P	30 W	50 W

$a = \frac{N_1}{N_2} = \frac{400}{200}$

$\boxed{a = 2}$

$P_{oc} = \frac{V_{oc}^2}{R_{c_1}} = 30\ w \Rightarrow R_{c_1} = \frac{V_{oc}^2}{P_{oc}} = \frac{120^2}{30} = \boxed{480\ \Omega}$

$I_{c1} = \frac{V_{oc}}{R_{c1}} = \frac{120}{480} = \boxed{0.25\ A}$, $P = I_{c1}^2 R_{c1} = 0.25^2(480) = 30w$ ✓

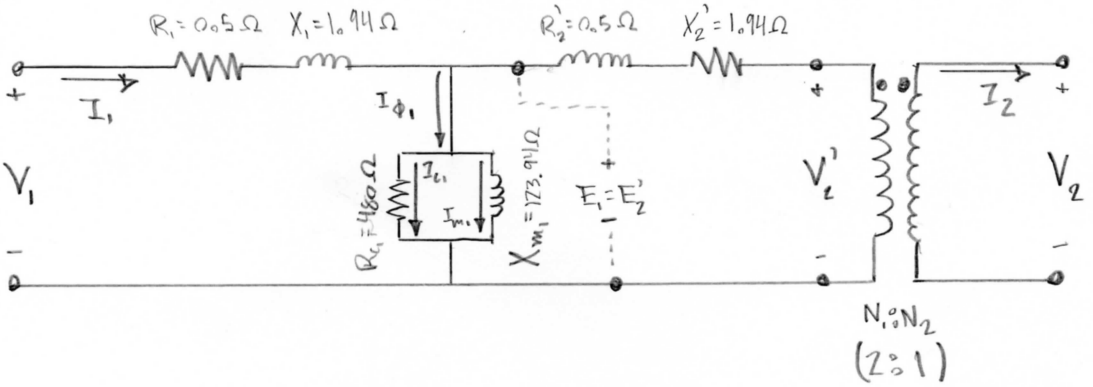
$I_{m_1} = \sqrt{I_1^2 - I_{c1}^2} = \sqrt{1^2 - 0.25^2} = \boxed{0.9682\ A}$ $X_{m_1} = \frac{V_{oc}}{I_{m_1}} = \frac{120}{0.9682} = \boxed{123.94\ \Omega}$

$P_{sc} = I_{sc}^2 R_{eq} \Rightarrow R_{eq} = \frac{P_{sc}}{I_{sc}^2} = \frac{50}{10^2} = \boxed{0.5\ \Omega}$

$Z_{eq} = \frac{V_{sc}}{I_{sc}} = \frac{20}{10} = \boxed{2\ \Omega} \Rightarrow X_{eq} = \sqrt{Z_{eq}^2 - R_{eq}^2} = \sqrt{2^2 - 0.5^2} = \boxed{1.94\ \Omega}$

⇒ All tests were done to the primary side meaning values are with respect to the primary side.

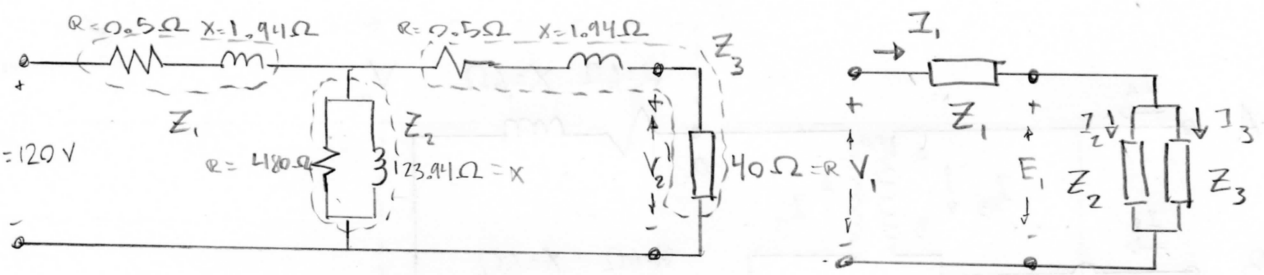
b)



ELEC-344 Assignment #2 Thomas Bement 24099822

Problem 1)

c)



$R_{load} = 10\Omega$

$Z_{load} = \sqrt{R_{load}^2} = 10\Omega \Rightarrow Z_l' = Z_l a^2 = 10(2)^2 = 40\Omega$ $\quad Z = \frac{V}{I} \Rightarrow I = \frac{V}{Z}$ $\Rightarrow V = ZI$

$Z_1 = 0.5 + 1.94j$, $Z_2 = \left(\frac{1}{480} + \frac{1}{123.94j}\right)^{-1} = 30 + 116.19j$

$Z_3 = 40 + 0.5 + 1.94j = 40.5 + 1.94j$

$Z_{eq} = Z_1 + \left(\frac{1}{Z_2} + \frac{1}{Z_3}\right)^{-1} = 33.92 + 13.51j$

$$I_1 = \frac{V_1}{Z_{eq}} = \frac{120}{33.92 + 13.51j} = 3.05 - 1.22j = \boxed{3.29\angle -21.71^\circ}$$

$$E_1 = V_1 - Z_1 I_1 = 120 - (0.5 + 1.94j)(3.05 - 1.22j) = 116.11 - 5.32j = \boxed{116.24\angle -2.62^\circ}$$

$$I_3 = \frac{E_1}{Z_3} = \frac{116.11 - 5.32j}{40.5 + 1.94j} = 2.85 - 0.27j = \boxed{2.87\angle -5.36^\circ}$$

$$V_2' = Z_l' I_3 = 40(2.85 - 0.27j) = 114.17 - 10.72j = \boxed{114.67\angle -5.36^\circ}$$

$$V_2 = \frac{V_2'}{a} = \frac{114.17 - 10.72j}{2} = 57.08 - 5.36j = \boxed{57.33\angle -5.36^\circ}$$

$P_1 = |V_1||I_1|\cos(\phi_1) = 120(3.29)\cos(21.71) = \boxed{366.79\ w}$

$Q_1 = |V_1||I_1|\sin(\phi_1) = 120(3.29)\sin(21.71) = \boxed{146.04\ w}$

$P_2 = |V_2'||I_3|\cos(\phi_2) = 114.67(2.87)\cos(0) = \boxed{329.10\ w}$

$Q_2 = |V_2'||I_3|\sin(\phi_2) = 114.67(2.87)\sin(0^\circ) = \boxed{0\ w}$

$\Rightarrow \eta = \frac{329.10}{366.79} = 0.89$

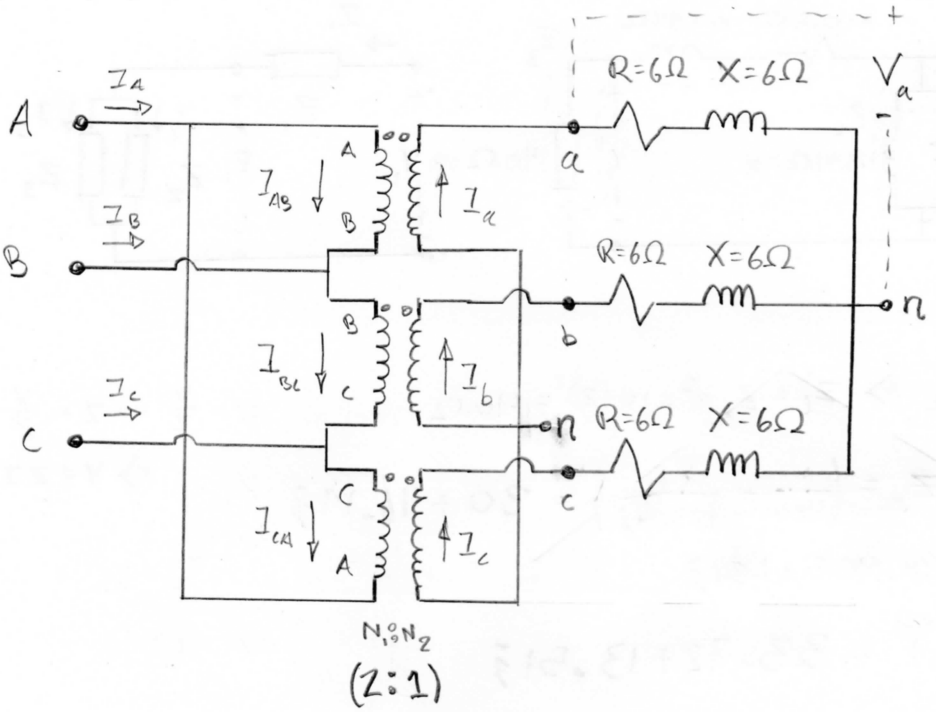
$\eta = 89.72\%$

→ The output power is lower as there are losses within the transformer from hysteresis, eddy currents & flux through the air.

ELEC-344 Assignment #2 Thomas Bement Z4099822

Problem 2)

a)



b) $V_{AB} = 208\ V$ $\quad \frac{N_1}{N_2} = \frac{200}{100} = 2 = a$ $\quad V_a = I_a Z_{eq}$

$V_a = \frac{V_{AB}}{a} = \frac{208}{2} = 104\ V$ $\quad I_a = \frac{V_a}{Z_{eq}} = \frac{104}{8.49\angle 45^\circ} = \boxed{12.26\angle -45^\circ}$

$Z_{eq} = 6 + 6j = \boxed{8.49\angle 45^\circ}$ $\quad V_L = \sqrt{3}\, V_a\ ,\ I_L = I_a$

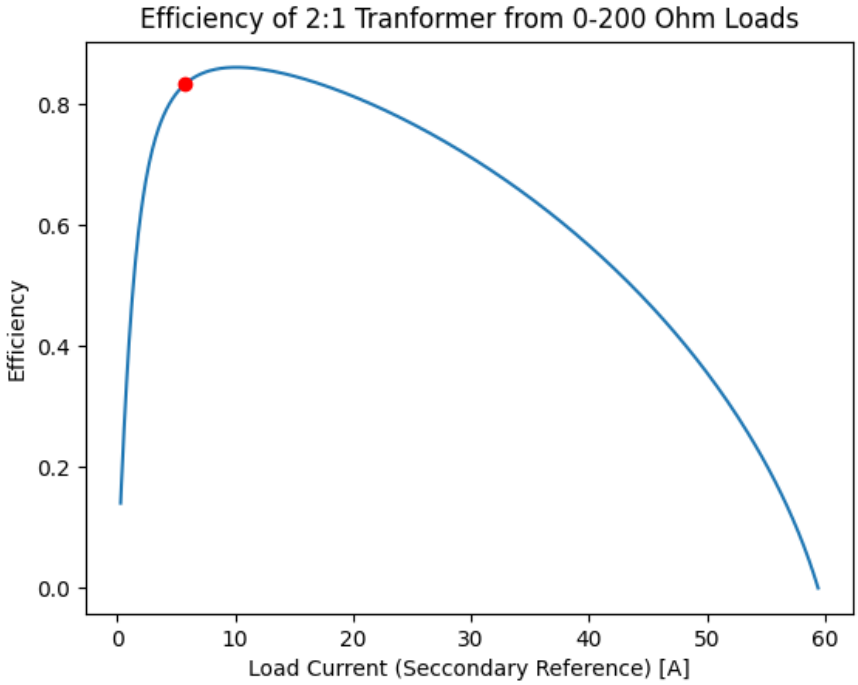
$P_{3\phi,a} = \sqrt{3}|V_L||I_L|\cos(\phi) = \sqrt{3}(\sqrt{3}V_a)I_a\cos(\phi) = 3(104)(12.26)\cos(45) = \boxed{2702.5\ W}$

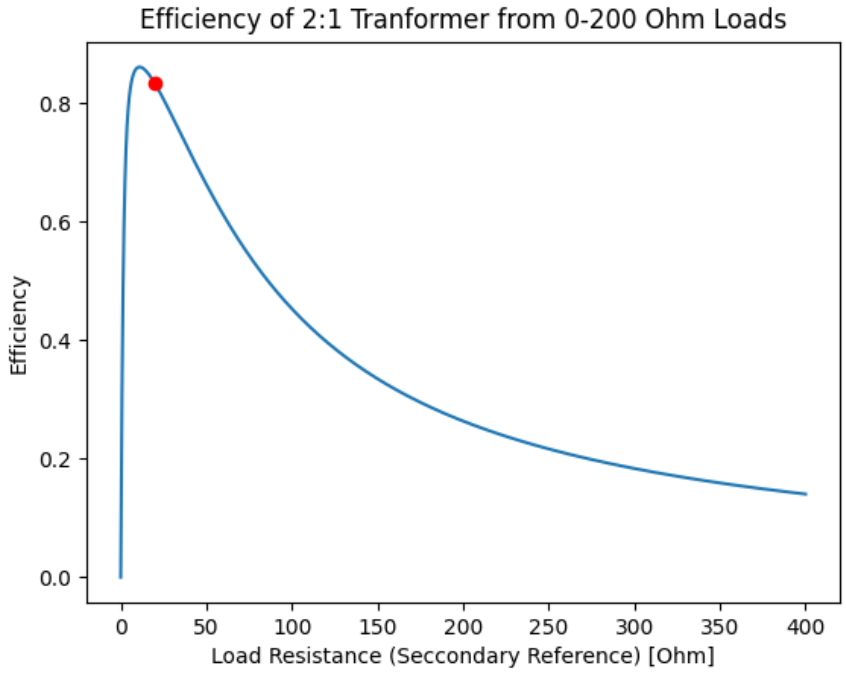
$Q_{3\phi,a} = \sqrt{3}|V_L|I_L|\sin(\phi) = \sqrt{3}(\sqrt{3}V_a)I_a\sin(\phi) = 3(104)(12.26)\sin(45) = \boxed{2702.5\ W}$

c) $I_{AB} = \frac{I_a}{a} = \frac{12.26\angle -45^\circ}{2\angle 0} = \boxed{6.13\angle -45}$

$I_A = S\, I_{AB}$ where $S = \sqrt{3}\angle -30$

$I_A = (\sqrt{3}\angle -30)(6.13\angle -45) = \boxed{10.61\angle -75^\circ}$





Plots for Problem 1 part D. Upper plot shows efficiency versus load current while the plot below shows efficiency versus load resistance. Both plots have problem marked on them with a red point showing where the previous analysis in part C would lie on the curve. Numerical values were compared with work in part C showing good agreement between hand and computational calculations.