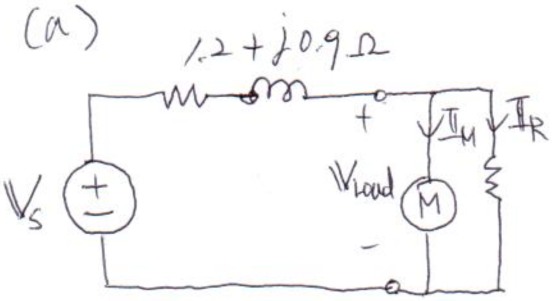
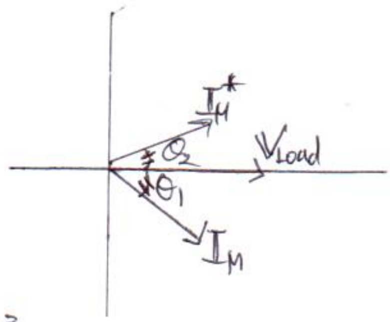
(a)




let $V_{load} = 240\angle 0°$

lagging power factor가 0.6 이므로

오른쪽의 그림에서 $|\theta_1| = |\theta_2|$ , $\sin\theta_1 = -\frac{4}{5}$ $\sin\theta_2 = \frac{4}{5}$ 이다.

$S_M = V_{Load} \cdot I_M^*$ 이고

$S_M = P + jQ = VI\cos\theta + jVI\sin\theta = 720 + j960$

$\therefore I_M^* = \dfrac{S_M}{V_{Load}} = \dfrac{720 + j960}{240} = 3 + j4 \quad \therefore I_M = 3 - j4$

$I_R^* = \dfrac{S_R}{V_{Load}} = \dfrac{560}{240} = \dfrac{7}{3}$

$I_{Tot} = I_M + I_R = 3 - j4 + \frac{7}{3} = \frac{16}{3} - j4$

$V_s = Z \cdot I_{Tot} + V_{Load} = \left(\frac{12}{10} + j\frac{9}{10}\right)\left(\frac{16}{3} - j4\right) + 240 = 250\angle 0°$

(b)

$I_{Tot} = \frac{16}{3} - j4 \cong 6.67\angle -36.87°$

$pf = \cos\theta = \cos(-36.87°) = 0.8$

$\theta = \theta_V - \theta_{I_{Tot}} = 0 - (-33.7°) > 0$ 이므로 lagging 이다.

(d) $\mathbb{Y}_R + \mathbb{Y}_M = \dfrac{\frac{2}{3}}{240} + \dfrac{3-j4}{240} = \dfrac{1}{45} - j\dfrac{1}{60}$

$\mathbb{Y}_{Load} = \mathbb{Y}_R + \mathbb{Y}_M + \mathbb{Y}_C = \dfrac{1}{45} - j\dfrac{1}{60} + jwC$

pf=1 이므로 $\theta = 0°$ 이며 $\mathbb{Y}_{Load}$ 허수부가 0이 되어야 한다.

$\therefore j\left(-\dfrac{1}{60} + wC\right) = 0 \quad \therefore wC = \dfrac{1}{60} \quad C = \dfrac{1}{2\pi f \cdot 60} = \dfrac{1}{2\pi \cdot 60 \cdot 60} \simeq 44\,\mu F$

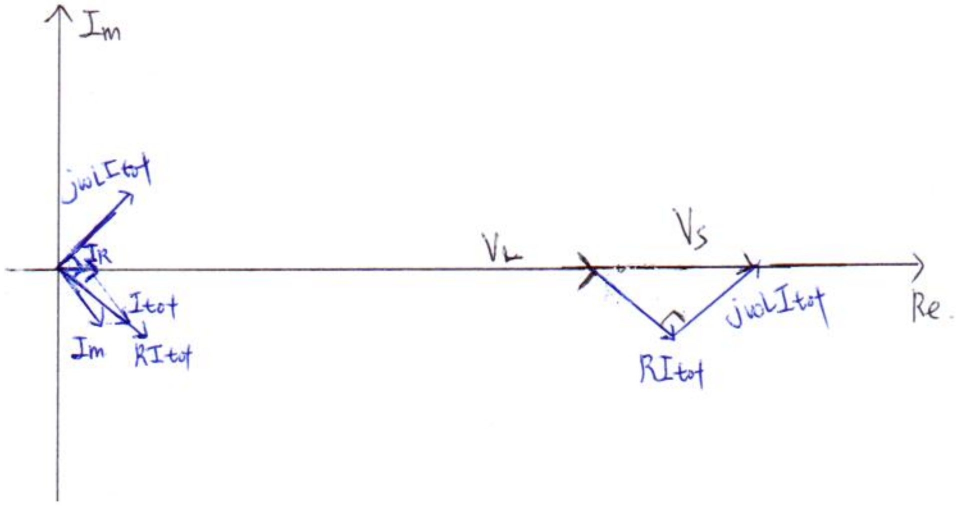
(e) pf=1, $\theta = 0°$ 이므로 $\mathbb{I}_{Tot} = \dfrac{16}{3}$

$\therefore \mathbb{S}_{Load} = \mathbb{V}_{Load}\mathbb{I}_{Tot}^{*} = 240 \times \dfrac{16}{3} = 1280\ W$

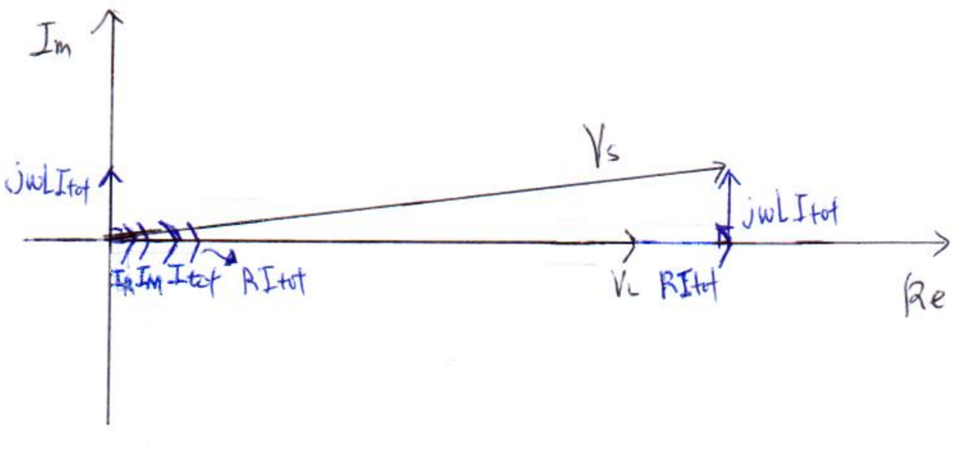
$\therefore \mathbb{V}_s = \mathbb{V}_{Load} + \mathbb{Z} \cdot \mathbb{I}_{Tot} = 240 + (1.2 + j0.9) \cdot \dfrac{16}{3}$

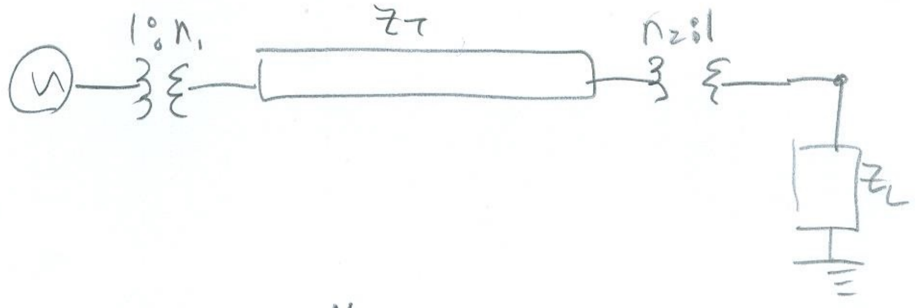
$= 246.4 + j4.8$

(c)

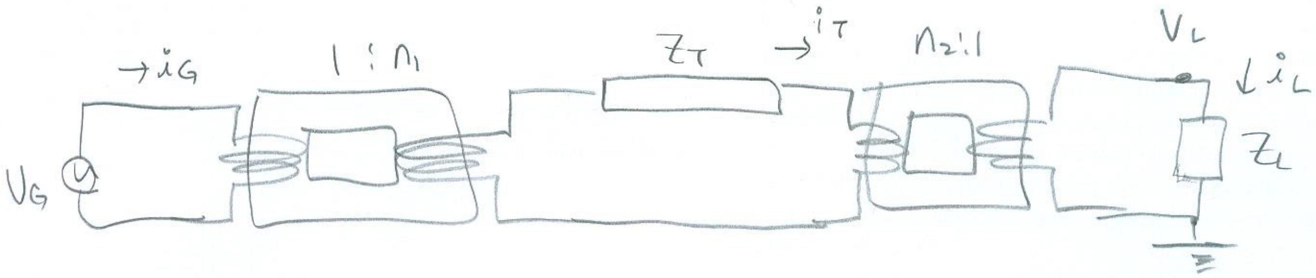

Im
jωLItot
IR
Itot
Im
RItot
VL
Vs
jωLItot
RItot
Re.

(f)


Im
jωLItot
Vs
jωLItot
IR Im Itot RItot
VL RItot
Re




$\Downarrow$




(a) $i_L = \dfrac{V_L}{Z_L} = \dfrac{10}{4+3j}$

$$i_T = \frac{n_1 V_G - n_2 V_L}{Z_T} = \frac{10V_G - 10n_2}{40+30j}$$

$$\|$$

$$i_T = \frac{1}{n_2} i_L = \frac{1}{n_2} \times \frac{10}{4+3j}$$

$$\frac{1}{n_2} \times \frac{10}{4+3j} = \frac{10V_G - 10n_2}{40+30j} \rightarrow \boxed{V_G = n_2 + \frac{10}{n_2}} \text{ [V]}$$

(b)

$$I_G = \frac{n_1}{n_2} \times \frac{10}{4+3j} = \boxed{\frac{100}{(4+3j)} \times \frac{1}{n_2}} \text{ [A]}$$

(c) $n_2 = 10$

$V_G = 10 + \frac{10}{10} = 11$, $i_G = \dfrac{10}{4+3j}$

$$S = \frac{1}{2} V_G I_G^* = \frac{1}{2}\left(10 + \frac{10}{10}\right) \times \frac{10}{4+3j}$$

$$= \frac{11}{5}(4+3j)$$

$$|S| = \frac{11}{5} \times 5 = \boxed{11\ (VA)}$$

$$P = Re(S) = \boxed{\frac{44}{5}\ (W)}$$

$$Q = Im(S) = \boxed{\frac{33}{5}\ (VAR)}$$

(d)

$$P_T = Re\left(\frac{1}{2}|i_T|^2 Z_T\right)$$

$$= Re\left(\frac{1}{2}\left|\frac{10}{4+3j} \times \frac{1}{n_2}\right|^2 \times (40+30j)\right)$$

$$= \frac{80}{n_2^2}$$

$$P_L = Re\left(\frac{1}{2}|i_L|^2 Z_L\right)$$

$$= Re\left(\frac{1}{2}\left|\frac{10}{4+3j}\right|^2 \times (4+3j)\right)$$

$$= 8$$

$$\frac{P_T}{P_T + P_L} \leq 0.05.$$

$$\frac{\frac{80}{n_2^2}}{\frac{80}{n_2^2} + 8} \leq \frac{1}{20} \rightarrow n_2^2 \geq 190$$

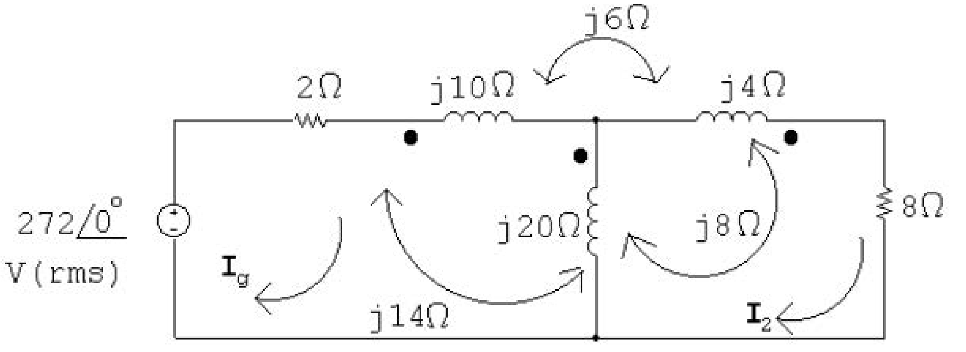
최소 자연수 $n_2$ : $\boxed{14}$

(e)

$$P_T = \frac{80}{n_2^2} = \frac{80}{14^2} = \frac{80}{196} = \boxed{\frac{20}{49}\ (W)}$$

$$P_L = \boxed{8\ (W)}$$

[a]




$$272\underline{/0^\circ} = 2\mathbf{I}_g + j10\mathbf{I}_g + j14(\mathbf{I}_g - \mathbf{I}_2) - j6\mathbf{I}_2$$
$$+j14\mathbf{I}_g - j8\mathbf{I}_2 + j20(\mathbf{I}_g - \mathbf{I}_2)$$
$$0 = j20(\mathbf{I}_2 - \mathbf{I}_g) - j14\mathbf{I}_g + j8\mathbf{I}_2 + j4\mathbf{I}_2$$
$$+j8(\mathbf{I}_2 - \mathbf{I}_g) - j6\mathbf{I}_g + 8\mathbf{I}_2$$

Solving,

$$I_g = 20 - j4\,\mathrm{A(rms)}; \qquad \mathbf{I}_2 = 24\underline{/0^\circ}\,\mathrm{A(rms)}$$

$$P_{8\Omega} = (24)^2(8) = 4608\,\mathrm{W}$$

[b] $P_g(\text{developed}) = (272)(20) = 5440\,\mathrm{W}$

[c] $Z_{\mathrm{ab}} = \dfrac{\mathbf{V}_g}{\mathbf{I}_g} - 2 = \dfrac{272}{20 - j4} - 2 = 11.08 + j2.62 = 11.38\underline{/13.28^\circ}\,\Omega$

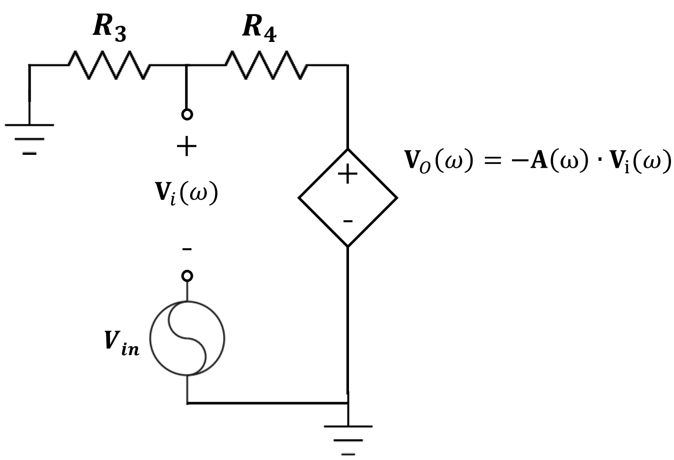
[d] $P_{2\Omega} = |I_g|^2(2) = 832\,\mathrm{W}$

$$\sum P_{\mathrm{diss}} = 832 + 4608 = 5440\,\mathrm{W} = \sum P_{\mathrm{dev}}$$

[4]

(a) $L_2$, $L_1$과 $L_2$에 흐르는 전류의 위상차는 180°여야 한다.

(b) $A(\omega) = \frac{A_O}{1+\frac{j\omega}{\omega_1}}$ 에서 $A_O = 10^5$, $\omega_1 = 10$ rad/s 이다. 이때 Fig. 4-2 (b)의 회로는 아래와 같이 근사할 수 있다.




KCL @ inverting input

$$\frac{V_i + V_{in}}{R_3} + \frac{V_i + V_{in} + A(\omega)V_i(\omega)}{R_4} = 0$$

And output $V_O = -A(\omega) \cdot V_i(\omega)$ gives

$$\frac{V_O}{V_{in}} = \frac{A(\omega)}{1 + \frac{A(\omega)}{k}} \quad where \ \ k = \frac{R_3 + R_4}{R_3}$$

$R_3$, $R_4$, $A(\omega)$를 대입하여 정리하면

$$\frac{V_O}{V_{in}} = \frac{\frac{A_O}{1+\frac{A_O}{k}}}{1 + \frac{j\omega}{\left(1+\frac{A_O}{k}\right)\omega_1}} = \frac{9.999}{1 + \frac{\mathrm{j}\omega}{100.0 * 10^3}} \approx \frac{10}{1 + j\omega/10^5}$$

그러므로 비반전증폭기의 이득($A_O'$)은 10이고 이득-대역폭 곱은 $10^6$으로 일정하므로, 구하고자 하는 회로의 대역폭은 $10^5 rad/s$ 이다.

(c) 회로 B

$$Z(\omega) = \frac{1}{\frac{1}{R} + \frac{1}{j\omega L} + j\omega C} = \frac{R}{1 + \frac{R}{j\omega L} + j\omega RC} = \frac{R}{1 + jR\sqrt{\frac{C}{L}}\left(\frac{\omega}{1/\sqrt{LC}} - \frac{1/\sqrt{LC}}{\omega}\right)}$$

(d) 회로 (b)

Transfer function을 정리하면 $\mathbf{H}(\omega) = -0.01\frac{j\omega}{1+\frac{j\omega}{1000}}$ 이다.

이때 pole p와 low freq. gain k를 $p = \frac{1}{CR_1}, k = R_2 C$ 로 구할 수 있으므로

$R_1 = 1 \ k\Omega, \mathrm{C} = 1 \ \mu\mathrm{F}, R_2 = 10 \ k\Omega$