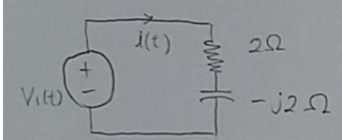
<전기회로>

20112442

김용성

(Chapter 5.)

2. In the network in Figure P5.2, $v_1(t) = 24\cos(377t + 20°)$ V. Find the equations for the current and instantaneous power as a function of time.



$$i(t) = \frac{V_1(t)}{Z} = \frac{24\cos(377t+20°)}{2-j2}$$

$$= \frac{24\angle 20°}{2-j2} = \frac{24\angle 20°}{2.83\angle -45°}$$

$$= 8.485\angle 65°$$

$$p(t) = V_1(t) \cdot i(t).$$

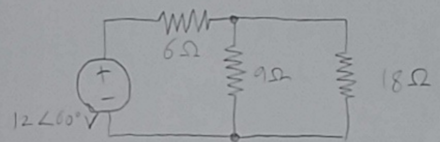
$$= \frac{V_M I_M}{2}\left(\cos(\theta_v - \theta_I) + \cos(2\omega t + \theta_v + \theta_I)\right)$$

$$= \frac{(24)(2.835)}{2}\left(\cos(-45°) + \cos(754t + 85°)\right)$$

$$= 101.8\left(0.707 + \cos(754t + 85°)\right)$$

$$= 71.98 + 101.8\cos(754t + 85°)\ W.$$

4. Determine the total average power absorbed and supplied in the network in Figure P5.4

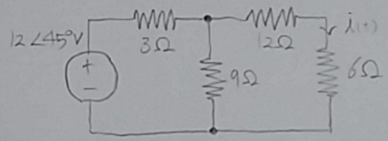


총 저항 R = 12Ω

$$I = \angle 60°$$

$$P = \frac{1}{2} \cdot 1^2 \cdot 12 = 6\ W$$

6. Determine the average power absorbed in the 6Ω resistor in the network in Figure P5.6.



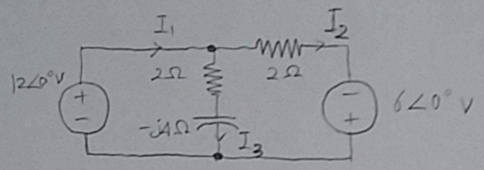
총 저항 R = 9Ω

전체전류 $I = \frac{12\angle 45°}{9}$ A

$$i(t) = \frac{12\angle 45°}{9} \times \frac{9}{27} = \frac{4\angle 45°}{9}\ A$$

$$P = \frac{1}{2} \cdot \left(\frac{4}{9}\right)^2 \cdot 6\Omega = 0.59W$$

9. Find the total average power absorbed and supplied in the Circuit in Figure p5.9.



$$I_2 = \frac{12+6}{2} = 9\angle 0° \text{ A}$$

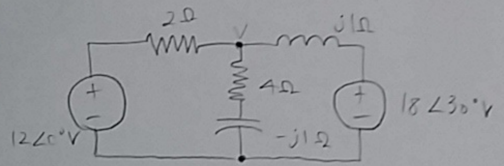
$$I_3 = \frac{12}{2-j4} = \frac{6}{1-j2} = \frac{6(1+j2)}{5} \text{ A}$$

$$I_1 = I_2 + I_3$$

$$P_{supplies} = \frac{12 \times I_1}{2} \cos(\theta_V - \theta_I) \text{ W}$$

$$P_{absorb} = \left(\frac{2 \cdot (I_2)^2}{2} + \frac{2-j4 \cdot (I_3)^2}{2} \right) \text{W}.$$

10. Show that the conservation of power holds for the network shown in Figure p5.10.



$$\frac{V-12}{2} + \frac{V}{4-j1} + \frac{V-18\angle 30°}{j1} = 0$$

$V = 18.11\angle 5.9°$ V

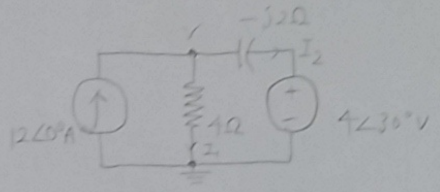
$I_1 = 3.14\angle 12.22°$ A

$I_2 = 4.39\angle 19.84°$ A

$I_3 = 7.54\angle -161.2°$ A

$$P = P_{12\angle 0} + P_{18\angle 30°} + P_{2\Omega} + P_{4\Omega} \text{ W}$$

13. Determine the average power absorbed and supplied by each element in the network in Figure P5.13.



$$-12 + \frac{V}{4} + \frac{V - 4\angle 30°}{-j2} = 0$$

$V = 19.92\angle -54.49°$ V

$I_1 = 4.98\angle -54.49°$ A

$I_2 = 9.97\angle 23.99°$ A

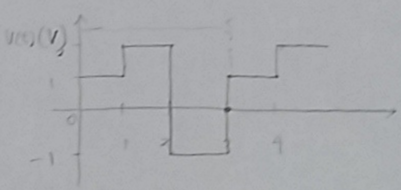
$P_{12\angle 0°} = -69.42$ W

$P_{4\Omega} = 49.6$ W

$P_{4\angle 30°} = 19.83$ W

$$P = P_{12\angle 0°} + P_{4\Omega} + P_{4\angle 30°} \text{ W}$$

14 Determine the rms value of the waveform in Figure P5.14



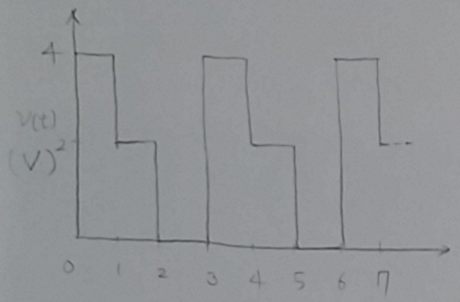
$$V_{rms} = \left[\frac{1}{3} \left(\int_0^1 (1)^2 dt + \int_1^2 (2)^2 dt + \int_2^3 (-1)^2 dt \right) \right]^{\frac{1}{2}}$$

$$= \frac{1}{3} \left([t]_0^1 + [4t]_1^2 + [t]_2^3 \right)^{\frac{1}{2}}$$

$$= \frac{1}{3} \left(1 + (8-4) + (3-2) \right)^{\frac{1}{2}} = \left(\frac{1}{3} \cdot 6 \right)^{\frac{1}{2}}$$

$= (2)^{\frac{1}{2}} \doteq 1.414\ V$

15. Calculate the rms value of the wave form shown in Figure P5.15

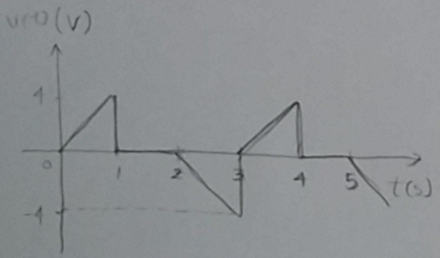


$V_{rms} = \left[\frac{1}{3}\left(\int_0^1 (4)^2 dt + \int_1^2 (2)^2 dt + \int_2^3 (0)^2 dt\right)\right]^{\frac{1}{2}}$

$= \frac{1}{3}\left([16t]_0^1 + [4t]_1^2\right)^{\frac{1}{2}}$

$= \frac{1}{3}(16 + 8 - 4)^{\frac{1}{2}} = \sqrt{\frac{20}{3}}\ V$

17. Compute the rms value of the Voltage waveform shown in figure P5.17.



$V_{rms} = \left[\frac{1}{3}\left(\int_0^1 (4t)^2 dt + \int_2^3 (-4t+8)^2 dt\right)\right]^{\frac{1}{2}}$

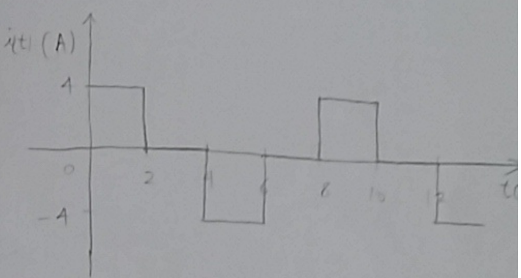
$= \frac{1}{3}\left(\left[\frac{16}{3}t^3\right]_0^1 + \left[\frac{16}{3}t^3 - 32t^2 + 64t\right]_2^3\right)^{\frac{1}{2}}$

$= \frac{1}{3}\left(\frac{16}{3} + (144 - 288 + 192) - \left(\frac{128}{3} - 128 + 128\right)\right)^{\frac{1}{2}}$

$= \frac{1}{3}\left(\frac{16}{3} + 48 - \frac{128}{3}\right)^{\frac{1}{2}}$

$= \sqrt{\frac{32}{9}} = \frac{4\sqrt{2}}{3}\ V.$

18. The current waveform in f
P5.18 exists in a 10Ω resistor
Determine the average power
delivered to the resistor.



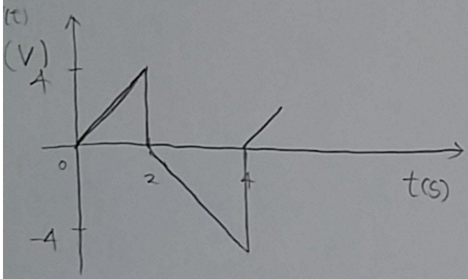
$i_{rms} = \left[\frac{1}{8}\left(\int_0^2 (4)^2 dt + \int_4^6 (-4)^2 dt\right)^{\frac{1}{2}}\right]$

$= \frac{1}{8}\left([16t]_0^2 + [16t]_4^6\right)^{\frac{1}{2}}$

$= \frac{1}{8}(32 + 96 - 64)^{\frac{1}{2}} = \sqrt{8}\ A$

$P_{10\Omega} = (\sqrt{8})^2 \cdot 10 = 80W$

21. The voltage across a 4Ω resistor is given by the waveform shown in Figure P5.21. Find the average power absorbed by the resistor.



$$V_{rms} = \left[\frac{1}{4}\left(\int_0^2 (2t)^2 dt + \int_2^4 (-2t+4)^2 dt\right)\right]^{\frac{1}{2}}$$

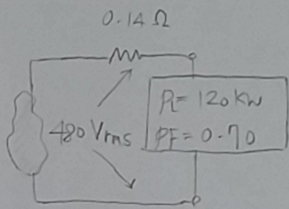
$$= \frac{1}{4}\left(\left[\frac{4}{3}t^3\right]_0^2 + \left[\frac{4}{3}t^3 - 8t^2 + 16t\right]_2^4\right)^{\frac{1}{2}}$$

$$= \frac{1}{4}\left(\frac{32}{3} + \left(\frac{256}{3} - 128 + 64\right) - \left(\frac{32}{3} - 32 + 32\right)\right)^{\frac{1}{2}}$$

$$= \frac{1}{4}\left(\frac{128}{3}\right)^{\frac{1}{2}} = \sqrt{\frac{32}{3}}\ V$$

$$P_{4\Omega} = \frac{\left(\sqrt{\frac{32}{3}}\right)^2}{4} = \frac{8}{3}\ W$$

22. The power consumed by an industrial load is 120kW at 0.70PF lagging from a 480V rms line. If the transmission line resistance between the generator and the load is 0.14Ω, find the power that must be supplied by the power company.



$$I_{rms} = \frac{P_L}{(PF)\cdot(V_{rms})} = \frac{120000}{(0.7)(480)}$$

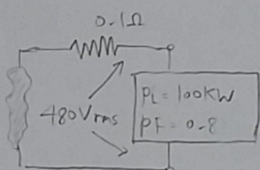
$$= 357.14\ A_{rms}$$

$$P_{supplied} = P_L + (0.14)(357.14)^2$$

$$= 120000 + 17857$$

$$= 137.857\ kW.$$

23. 100 kW, 0.8 PF lagging. The line voltage is 480 Vrms. 0.1Ω, find the transmission line losses.

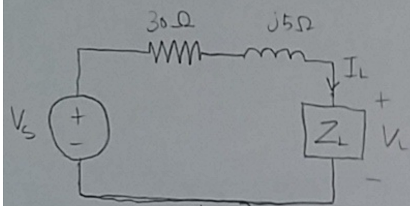


$$I_{rms} = \frac{P_L}{(PF)(V_{rms})} = \frac{100000}{(0.8)(480)} = 260.42\ A$$

$$P_{losses} = (0.1)(260.42)^2$$

$$= 6.782\ kW.$$

28. Calculate the voltage V_s that must be supplied to obtain 2kW, $240\angle 0°$ V rms, and a power factor of 0.8 leading at the load Z_L in the network in Figure P5.28.

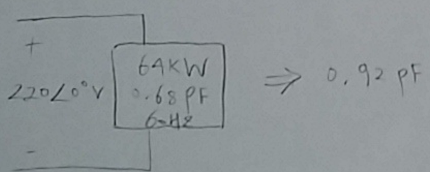


$$I_{rms} = \frac{P_L}{(PF)\cdot V_{rms}} = \frac{2000}{(0.8)\cdot 240} \cdot \cos^{-1}(0.8)$$

$$= 10.42\angle 36.87° \, A_{rms}$$

$$V_S = (30+j5)\, 10.42\angle 36.87°$$
$$+ 240\angle 0°$$
$$= 512.8\angle 26.54° \text{ V}.$$

32. A small plant has a bank of induction motors that consume 64kW at a PF of 0.68 lagging. The 60 Hz line voltage across the motors is $220\angle 0°$ Vrms. The local power company has told the plant to raise the PF to 0.92 lagging. What value of capacitance is required?



$Q_{old} = P_{old} \tan\theta_{old} = (64)(10^3)(\tan(\cos$

$= 69008.2$ var

$S_{old} = 64000 + j69008.2$

$S_{new} = 64000 + j64000 \times \tan(\cos^{-1} 0.92$

$= 64000 + j27260$

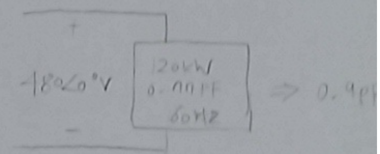
$S_{cap} = S_{new} - S_{old}$

$= -j41748$

$$C = \frac{S_{cap}}{(-j\omega)(V^2)_{rms}} = \frac{\cancel{-}j41748}{(\cancel{-j}377)(220)^2}$$

$= 2289.9\,\mu F$

35



$\theta_{old} = \cos^{-1} 0.77$

$Q_{old} = P_{old} \cdot \tan\theta_{old} = (120)(10^3)(\tan(\cos^{-1}$

$= 99440$ var

$S_{old} = 120000 + j99440$

$S_{new} = 120000 + j120000 \cdot \tan(\cos^{-1} 0.9)$

$= 120000 + j58120$

$S_{cap} = -j41320$

$$C = \frac{41320}{(377)(480)^2} = 510.2\,\mu F$$

42. An abc-sequence balanced three-phase wye-connected source supplies power to a balanced wye-connected load. The line impedance per phase is $1 + j0\,\Omega$ and the load impedance per phase is $20 + j20\,\Omega$. If the source line voltage $\underline{V_{ab}}$ is $100\angle 0°$ Vrms, find the line currents.

$$V_{an} = \frac{100\angle -30°}{\sqrt{3}}\ \text{Vrms}$$

$$V_{bn} = \frac{100\angle -150°}{\sqrt{3}}\ \text{Vrms}$$

$$V_{cn} = 100\angle 90°\ \text{Vrms}$$

$$I_{aA} = \frac{100\angle -30°}{\sqrt{3}(20 + j20)}\ \text{Arms}$$

$$I_{bB} = \frac{100\angle -150°}{\sqrt{3}(20 + j20)}\ \text{Arms}$$

$$I_{cC} = \frac{100\angle 90°}{\sqrt{3}(20 + j20)}\ \text{Arms}$$

46. three phase wye-delta system, $V_{an} = 120\angle 10°$ Vrms, load impedance per phase in the Δ is $24 + j18\,\Omega$.

$$I_{aA} = \frac{120\angle 10°}{8 + j6}\ \text{Arms}$$

$$I_{bB} = \frac{120\angle -110°}{8 + j6}\ \text{Arms}$$

$$I_{cC} = \frac{120\angle 130°}{8 + j6}\ \text{Arms}$$

48. three-phase wye-del system, the source has an phase sequence. The load impedance is $12 + j8\,\Omega$

$V_{AB} = 260\angle 45°$ Vrms.

$$V_{an} = \frac{260\angle 15°}{\sqrt{3}}\ \text{Vrms}$$

$$V_{bn} = \frac{260\angle -105°}{\sqrt{3}}\ \text{Vrms}$$

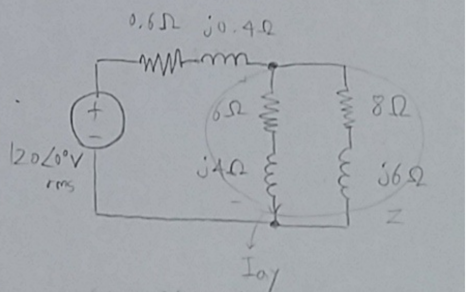
$$V_{cn} = \frac{260\angle 135°}{\sqrt{3}}\ \text{Vrms}$$

$$I_{aA} = \frac{260\angle 15°}{\sqrt{3}(4 + j2.67)}\ \text{Arms}$$

$$I_{bB} = \frac{260\angle -105°}{\sqrt{3}(4 + j2.67)}\ \text{Arms}$$

$$I_{cC} = \frac{260\angle 135°}{\sqrt{3}(4 + j2.67)}\ \text{Arms}$$

54. Find I_{ay} in the circu shown in Figure P5.54



$$Z = \frac{(6+j4)(8+j6)}{(6+j4)+(8+j6)} = \frac{24 + j68}{14 + j10}$$

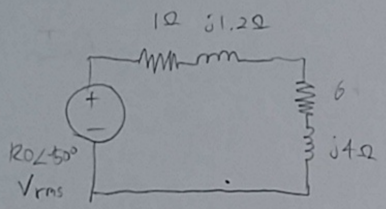
$$I_{ay} = \frac{V_a}{6+j4} = \frac{120\angle 0° \cdot \frac{Z}{Z + 0.6 + j0.4}}{6 + j4}$$

56. A balanced three-phase delta-delta system has the following parameters: $V_{ab} = 207.84\angle -20°$ V rms, $Z_{Line} = 1 + j1.2\ \Omega$, and $Z_{Load} = 18 + j12\ \Omega$. Find the line currents.

$$V_{an} = \frac{207.84\angle -50°}{\sqrt{3}} = 120\angle -50° \text{ V rms}$$

$$V_{bn} = 120\angle -170° \text{ Vrms}$$

$$V_{cn} = 120\angle -290° \text{ V rms}$$



$$I_{aA} = \frac{120\angle -50°}{(7 + j5.2)\Omega} \text{ A rms}$$

$$I_{bB} = \frac{120\angle -170°}{7 + j5.2} \text{ A rms}$$

$$I_{cC} = \frac{120\angle -290°}{7 + j5.2} \text{ A rms}$$

58. A 480V rms line feeds two balanced three-phase loads. If the two loads are rated as follows:

Load 1: 5kVA at 0.8 PF lagging
Load 2: 10kVA at 0.9 PF lagging

determine the magnitude of the line current from the 480V rms source.

$$S_1 = \frac{5k}{0.8}\angle \cos^{-1} 0.8 \text{ V}$$

$$= 4k + j3k \text{ VA}$$

$$S_2 = \frac{10k}{0.9}\angle \cos^{-1} 0.9 \text{ VA}$$

$$= 9k + j4.358k \text{ VA}$$

$$S_T = S_1 + S_2 = 13k + j7.3$$

$$I_L = \frac{S_T}{V_L \cdot \sqrt{3}} = \frac{13k + j7.358}{480 \cdot \sqrt{3}}$$