IT@CookBook, 처음 만나는 회로이론(2판)

[연습문제 답안 이용 안내]

Chapter 01 연습문제 해답

1.1 -1.602×10^{-13} [C]

1.2 $6e^{-2t}$ [A], $-3(e^{-2}-1)$ [C]

1.3 $G=1$[mS], $R=1$ [kΩ]

1.4 20 [V]

1.5 10 [mV]

1.6 (a) 10 [W] (b) -6 [W]

1.7 전압원 V_A: 50 [W] (소모)
전압원 V_B: 100 [W] (소모)
전압원 V_C: -150 [W] (공급)

1.8 $i=7$ [A]

1.9
(1) 접점 1: $i_6=-i_1=-2$ [A]
(2) 접점 3: $i_2=i_3=3$ [A]
(3) 접점 5: $i_4=-i_5=-4$ [A]
(4) 접점 2: $i_8=-i_1-i_2+i_7=-2-3+1=-4$ [A]
(5) 접점 4: $i_9=-i_3-i_4-i_8=-3-(-4)-(-4)=5$ [A]

1.10

(1) 루프 I: $v_2 = v_1 + v_3 = 1 + 2 = 3$ [V]

(2) 루프 III: $v_5 = -v_3 + v_6 = -2 + 3 = 1$ [V]

(3) 루프 IV: $v_7 = -v_6 + v_9 = -3 + 5 = 2$ [V]

(4) 루프 II: $v_4 = v_5 - v_8 = 1 - 4 = -3$ [V]

1.11 접점: 6개, 분기: 8개

1.12 $i = 1$ [A]

1.13 $v_1 = 2 \times (-3) = -6$ [V], $v_2 = -3 \times (-3) = 9$ [V]

1.14 $v_1 = 15$ [V], $v_2 = 25$ [V]

1.15 $6 + 4 = 10$ [Ω]

1.16 $G_{eq} = 10 \,\|\, 40 = \dfrac{10 \cdot 40}{10 + 40} = 8$ [S]

1.17 $i = 1$ [A]

1.18

(a) $i = \dfrac{2}{10} \dfrac{[\mathrm{A \cdot h}]}{[\mathrm{h}]} = 0.2$ [A]

(b) $P = VI = 9 \times 0.2 = 1.8$ [W]

(c) $W = Pt = 1.8 \times 10 = 0.018$ [kWh]

1.19 $i_1 = \frac{30}{10} = 3\,[\mathrm{A}],\ i_2 = \frac{30}{6} = 5\,[\mathrm{A}],\ i_3 = \frac{30}{5} = 6\,[\mathrm{A}]$

1.20 첫 번째 띠: 갈색, 두 번째 띠: 파랑, 세 번째 띠: 빨강

Chapter 02 연습문제 해답

2.1 $R_2 = 500\,[\Omega]$

2.2 $v_3 = V_S \times \frac{8}{R_{eq}} = 3 \times \frac{8}{24} = 1\,[\mathrm{V}]$

2.3 $v_1 = 12 \times \frac{2}{2+4} = 4\,[\mathrm{V}],\quad v_2 = 12 \times \frac{4}{2+4} = 8\,[\mathrm{V}]$

2.4 $i_1 = 20 \times \frac{4}{6+4} = 8\ \ [\mathrm{mA}]$

$i_2 = 12 \times \frac{5}{20+5} = 2.4\,[\mathrm{mA}]$

$i_3 = 12 \times \frac{20}{20+5} = 9.6\,[\mathrm{mA}]$

2.5 $i_1 = \frac{20}{R_{eq}} = 4\,[\mathrm{A}]$

$i_2 = i_1 \times \frac{R_{eq1}}{R_{eq1}+12} = 4 \times \frac{4}{4+12} = 1\,[\mathrm{A}]$

$i_3 = i_1 \times \frac{12}{R_{eq1}+12} = 4 \times \frac{12}{4+12} = 3\,[\mathrm{A}]$

$i_4 = i_3 \times \frac{5}{20+5} = 0.6\ \ [\mathrm{A}]$

$i_5 = i_3 \times \frac{20}{20+5} = 2.4\ \ [\mathrm{A}]$

2.6 $i_1 = 2v_1 = -\frac{2}{3}\,[\mathrm{A}],\quad i_2 = 3v_2 = -\frac{1}{3}\,[\mathrm{A}]$

2.7 $v_A = \frac{12}{5}\,[\mathrm{V}],\ \ v_B = -\frac{4}{5}\,[\mathrm{V}]$

2.8 $I_2 = \frac{3}{2}(-4) = -6\,[\mathrm{A}]$

2.9 $9\,[\mathrm{A}]$

2.10 $I_1 = 5\,[\mathrm{A}],\ I_2 = -1\,[\mathrm{A}]$

2.11 $12\,[\mathrm{V}]$

2.12 $10\,[\mathrm{V}]$

2.13 $-1.2\,[\mathrm{A}]$

2.14 $-6\,[\mathrm{V}]$

2.15 $P_{\max} = \frac{V_{Th}^2}{4R_{Th}} = \frac{4^2}{4\times 3} = \frac{4}{3}\,[\mathrm{W}]$

2.16 $R_{Th} = (20+30)\,\|\,(40+10) = \frac{50\times 50}{50+50} = 25\,[\Omega]$

$V_{Th} = 30\times 3 - 20\times 2 = 50\,[\mathrm{V}]$

2.17 $i_{out} = 0\ [\mathrm{A}],\ R_N = \dfrac{v_{out}}{i_{out}} = \dfrac{1}{0} = \infty$ (개방 회로)

2.18 $R_N = (20+30)\,\|\,(40+10) = \dfrac{50\times 50}{50+50} = 25\ [\Omega]$

$I_N = \dfrac{V_N}{R_N} = \dfrac{50}{25} = 2\ [\mathrm{A}]$

2.19 $R_N = (15+25)\,\|\,10 = \dfrac{40\times 10}{40+10} = 8\ [\Omega],\ I_N = 6\ [\mathrm{A}]$

2.20 $P_L = \dfrac{V_L^2}{R_L} = \dfrac{8^2}{10} = 6.4\ [\mathrm{W}],\ 50\%$

Chapter 03 연습문제 해답

3.1 $i_C(t) = C\dfrac{dv_C(t)}{dt} = (60\times10^{-3})\dfrac{220-120}{6} = 1\,[\mathrm{A}]$

3.2 $W_C = 100\,[\mu\mathrm{J}]$

3.3 $P_C(t) = v_c(t)i_C(t) = e^{-2t}\times(-6\times10^{-6}e^{-2t}) = -6e^{-4t}\,[\mu\mathrm{W}]$

3.4 $v_1 = 10i_1 = 10\,[\mathrm{V}],\ \ v_2 = 40-25i_1 = 15\,[\mathrm{V}]$

3.5 $C_{eq} = \dfrac{1}{\frac{1}{10}+\frac{1}{15}+\frac{1}{20}+\frac{1}{30}} = 4\,[\mathrm{mF}]$

3.6 $C = 10\,[\mu\mathrm{F}]$

3.7 $C_{eq} = 4+6 = 10\,[\mathrm{F}]$

3.8 $C_{eq} = C_{eq1}+C_{eq2} = 5+5 = 10\,[\mathrm{mF}]$

3.9 $C_{eq} = \dfrac{2\times2}{2+2} = 1\,[\mathrm{F}]$

3.10 $v_4 = v_2 - v_3 = 45-30 = 15\,[\mathrm{V}]$

3.11 $v_L(t) = L\dfrac{di_L(t)}{dt} = (6\times10^{-3})\dfrac{(100-50)\times10^{-3}}{2\times10^{-3}} = 150\ [\mathrm{mV}]$

3.12 $W_L = \dfrac{1}{2}Li_L^2 = \dfrac{1}{2}\times2\times10^{-3}\times(10)^2 = 0.1\ [\mathrm{J}]$

3.13 $P_L(t) = v_L(t)i_L(t) = -10\times10^{-3}e^{-t/2}\times(e^{-t/2}) = -10e^{-t}\ [\mathrm{mW}]$

3.14 $i_L = \dfrac{2}{8+2}\times10 = 2\ [\mathrm{A}],\ W_L = \dfrac{1}{2}Li_L^2 = \dfrac{1}{2}\times5\times10^{-3}\times2^2 = 10\ \ [\mathrm{mJ}]$

3.15 $L_{eq} = 0.1\ [\mathrm{H}]$

3.16 $L_{eq} = \dfrac{1}{\frac{1}{12}+\frac{1}{10}+\frac{1}{20}+\frac{1}{60}} = 4\ [\mathrm{mH}]$

3.17 첫 번째 띠: 노랑, 두 번째 띠: 검정, 세 번째 띠: 빨강, 네 번째 띠: 금색

3.18 $L_{eq} = \dfrac{50\times50}{50+50} = 25\ [\mathrm{mH}]$

3.19 $L_{eq} = \dfrac{20\times5}{20+5} = 4\ [\mathrm{H}]$

3.20 $L = 40\ [\mathrm{mH}]$

Chapter 04 연습문제 해답

4.1 $i_1 = 1,\ i_2 = -1,\ i_3 = -3$

4.2

$$\mathbf{A} = \begin{bmatrix} 2 & 4 & -1 & -3 \\ 1 & -3 & 7 & -2 \\ -3 & -2 & 6 & 1 \\ -1 & 1 & 4 & -3 \end{bmatrix}, \quad \mathbf{x} = \begin{bmatrix} i_1 \\ i_2 \\ i_3 \\ i_4 \end{bmatrix}, \quad \mathbf{c} = \begin{bmatrix} -2 \\ 4 \\ 1 \\ 7 \end{bmatrix}$$

4.3

$$\begin{bmatrix} 2 & 4 & -1 & -3 \\ 1 & -3 & 7 & -2 \\ -3 & -2 & 6 & 1 \\ -1 & 1 & 4 & -3 \end{bmatrix} \begin{bmatrix} i_1 \\ i_2 \\ i_3 \\ i_4 \end{bmatrix} = \begin{bmatrix} -2 \\ 4 \\ 1 \\ 7 \end{bmatrix}$$

4.4 $\mathbf{A}^{-1} = \frac{1}{2}\begin{bmatrix} 4 & -6 \\ -5 & 8 \end{bmatrix} = \begin{bmatrix} 2 & -3 \\ -5/2 & 4 \end{bmatrix}$

4.5 $\mathbf{A}^{-1} = \frac{1}{3}\begin{bmatrix} 5 & 2 & -1 \\ -2 & 1 & 1 \\ -2 & -2 & 1 \end{bmatrix} = \begin{bmatrix} 1.6667 & 0.6667 & -0.3333 \\ -0.6667 & 0.3333 & 0.3333 \\ -0.6667 & -0.6667 & 0.3333 \end{bmatrix}$

4.6 역행렬을 구할 수 없다.

4.7 $i_1 = \dfrac{\det(\mathbf{A}_1)}{\det(\mathbf{A})} = \dfrac{5}{5} = 1$, $i_2 = \dfrac{\det(\mathbf{A}_2)}{\det(\mathbf{A})} = \dfrac{10}{5} = 2$

4.8 $v_1 = \dfrac{|D_1|}{|D|} = \dfrac{0}{10} = 0$, $v_2 = \dfrac{|D_2|}{|D|} = \dfrac{0}{10} = 0$, $v_3 = \dfrac{|D_3|}{|D|} = \dfrac{10}{10} = 1$

4.9 $v_C(t) = 7 - 5e^{-0.2t}$

4.10 $i_L(t) = -e^{3t}$

4.11 $v_C(t) = (1+2t)e^{-3t}$

4.12 $i_L(t) = 2 - 8e^{-t} + 4e^{-2t}$

4.13 $|z| = \sqrt{(-1)^2 + 1^2} = \sqrt{2}$

4.14 $f(2+j3) = 2(2-j3) + j(2+j3) + 3 = 4 - j4$

4.15 $|2z - 3\bar{z}| = \sqrt{(-5)^2 + 10^2} = 5\sqrt{5}$

4.16 $z = 1^{1/2}\left(\cos\left(-\dfrac{\pi}{2}\right) + i\sin\left(-\dfrac{\pi}{2}\right)\right)^{1/2} = \cos\left(-\dfrac{\pi}{4}\right) + i\sin\left(-\dfrac{\pi}{4}\right)$

4.17 (a) $2\angle 120^\circ$ (b) 64

4.18 $e^z = e^{\ln 2 - i\pi} = e^{\ln 2}\cos(-\pi) + ie^{\ln 2}\sin(-\pi)$

$e^z = 2\cos(\pi) = -2$

4.19 $\left[\frac{1}{2}\left(\cos\frac{\pi}{12} + i\sin\frac{\pi}{12}\right)\right]^4\left[2\left(\cos\frac{\pi}{3} + i\sin\frac{\pi}{3}\right)\right]^5$

$= 2\left[\cos\left(\frac{\pi}{3} + \frac{5\pi}{3}\right) + i\sin\left(\frac{\pi}{3} + \frac{5\pi}{3}\right)\right]$

$= 2(\cos 2\pi + i\sin 2\pi) = 2$

4.20 $3^{2-j} = 3^2 \cdot e^{\ln 3^{-j}} = 9e^{-j\ln 3} = 9[\cos(\ln 3) - j\sin(\ln 3)]$

Chapter 05 연습문제 해답

5.1 $\tau = R_{eq}C = 150 \times 2 \times 10^{-3} = 0.3\,[\text{sec}]$

5.2 $R = 5\,[\text{k}\Omega],\ C = 20\,[\mu\text{F}]$

5.3 $v_C(t) = \dfrac{5}{10+5} \times 15 = 5\,[\text{V}]$

5.4 $i(t) = -C\dfrac{dv_C(t)}{dt} = -\dfrac{1}{2}\left(-\dfrac{1}{5}\right)12e^{-t/5} = 1.2e^{-0.2t}\,[\text{A}]$

5.5 $\tau = 5\,[\text{ms}]$

5.6 $R = \dfrac{v_L(t)}{i_L(t)} = \dfrac{200e^{-1000t}}{e^{-1000t}} = 200\,[\Omega],\ L = \dfrac{R}{1000} = \dfrac{200}{1000} = 0.2\,[\text{H}]$

5.7 $i_L(t) = \dfrac{5}{10+5} \times 15 = 5\,[\text{A}]$

5.8 $i(t) = i(0^-)e^{-t/\tau} = 1.54e^{-2t}\,[\text{A}]$

5.9 $i(t) = \dfrac{20}{20+5} \times -i_L(t) = -8e^{-2t}\,[\text{A}]$

5.10 과감쇠 응답 상태

5.11 $i_L(t) = (1+3t)e^{-3t}$ [A]

5.12 $i_L(\infty) = 0$ [A], $v_L(\infty) = 0$ [V]

5.13 $R = 2\sqrt{\dfrac{20\times10^{-3}}{8\times10^{-6}}} = 2\times\dfrac{1}{2}\times100 = 100$ [Ω]

5.14 $v_C(t) = 3e^{-t} - 3e^{-3t}$ [V]

5.15 $i(t) = \left(2\cos 3t + \dfrac{8}{3}\sin 3t\right)e^{-4t}$ [A]

5.16 $i_L(t) = 20e^{-10t} - 5e^{-40t}$ [A]

5.17 $v_C(t) = (8\cos t + 4\sin t)e^{-t/2}$ [V]
$i_C(t) = -2\sin te^{-t/2}$ [A]

5.18 $v_{C_2}(t) = \left(\dfrac{RI_0C_2}{C_1+C_2} + V_0\right)e^{s_1t} - \left(\dfrac{RI_0C_1}{C_1+C_2}\right)e^{s_2t}$ [V]

5.19 $L = \dfrac{1}{C} = \dfrac{1}{100\times10^{-3}} = 10$ [H]

5.20 $i_L(t) = -30\sin\left(\dfrac{10}{3}t\right)$ [A]

Chapter 06 연습문제 해답

6.1 (a) $-3\sin 2t = 3\cos(2t+90^\circ)$

(b) $3\sin(2t-40^\circ) = 3\cos(2t-40^\circ-90^\circ) = 3\cos(2t-130^\circ)$

(c) $-3\sin(2t+40^\circ) = 3\cos(2t+40^\circ+90^\circ) = 3\cos(2t+130^\circ)$

6.2 진폭: $A=2$, 위상: $\phi=-30^\circ$, 각주파수: $\omega=2\pi$

고유 주파수: $f=\dfrac{\omega}{2\pi}=\dfrac{2\pi}{2\pi}=1\,[\text{Hz}]$

주기: $T=\dfrac{1}{f}=\dfrac{1}{1}=1\;[\text{s}]$

6.3 170°, 전류 $i_1(t)$가 전류 $i_2(t)$보다 170° 앞선 전류를 표시한다.

6.4 $V_{\text{rms}}=\sqrt{12}=2\sqrt{3}\,[\text{V}]$

6.5 $I_{\text{rms}}=\sqrt{40}=2\sqrt{10}\,[\text{A}]$

6.6 $f(t)=a_0+\sum_{n=1}^{\infty}(a_n\cos n\omega_0 t+b_n\sin n\omega_0 t)=12-\sum_{n=\text{홀수}}^{\infty}\dfrac{16}{n\pi}\sin(nt)$

6.7 $\mathbf{I}(j\omega)=10\angle 150^\circ$, $\mathbf{V}(j\omega)=40\angle 150^\circ$

6.8 $v(t)=10\cos(3t-120^\circ+180^\circ)=-10\cos(3t+60^\circ)\,[\text{V}]$

6.9 $v(t)=5\cos(10t-36.87^\circ)\,[\text{V}]$

6.10 (a) $i(t) = -2.93 \times \sqrt{2}\cos(20t + 45^\circ) = -4.14\cos(20t + 45^\circ)$
(b) (a)의 결과와 동일하게 된다.

6.11 $v(t) = 5\cos(1000t - 30^\circ)$ [V]

6.12 $v(t) = 10\cos(100t + 60^\circ)$ [V]

6.13 $Z_{eq}(j\omega) = 3 + 1 - j3 = 4 - j3$ [Ω]

6.14 $Z_{eq}(j\omega) = j30 + 10 + 30 - j10 = 40 + j20$ [Ω]

6.15 $Z_{eq} = \dfrac{1}{Y_{eq}} = \dfrac{25(4 - j3)}{(4 + j3)(4 - j3)} = 4 - j3$ [Ω]

6.16 $Y_{eq}(j\omega) = \dfrac{\frac{7}{3}\left(\frac{2}{3} + j\right)(3 - j)}{(3 + j)(3 - j)} = \dfrac{7}{10} + j\dfrac{49}{90}$ [S]

6.17 $i(t) = 0.5\cos(10t + 45^\circ)$ [A]

6.18 $\mathbf{I}_o = \dfrac{-j2}{-j2 + 2}\mathbf{I}_2 = \dfrac{-j}{1 - j} \cdot (-10 - j10) = \dfrac{-10(1 - j)}{1 - j} = -10$ [A]

6.19 $i_1(t) = 0.2\cos(10t + 18.43^\circ)$ [A]

6.20 $C = 25$ [mF]

Chapter 07 연습문제 해답

7.1 $p(t) = 100[\cos(30^\circ) + \cos(100t + 60^\circ)] = 50\sqrt{3} + 100\cos(100t + 60^\circ)$ [W]

7.2 $P = \frac{VI}{2}\cos(\theta_V - \theta_I) = \frac{(10)(5\sqrt{2})}{2}\cos(-15^\circ + 60^\circ) = 25$ [W]

7.3 $P_{L,avg} = \frac{\mathbf{V}_L}{\sqrt{2}}\frac{\mathbf{I}_L}{\sqrt{2}}\cos(121^\circ - 31^\circ) = \frac{10.3}{\sqrt{2}} \times \frac{1.03}{\sqrt{2}}\cos(90^\circ) = 0$ [W]

7.4 $P_{avg} = \frac{1}{2}(20)(10)\cos(45^\circ - 15^\circ) = 50\sqrt{3}$ [W]

7.5 $P_{avg} = \frac{1}{2}|\mathbf{I}_S|^2 \times 5 = \frac{1}{2}(1.2649)^2 \times 5 = 5.2$ [W]

7.6 $P_{avg,\max} = \frac{|\mathbf{V}_{Th}|^2}{8R_{Th}} = \frac{(100)^2}{8(100)} = 12.5$ [W]

7.7 $P_{avg,\max} = \frac{|\mathbf{V}_{Th}|^2}{8R_{Th}} = \frac{(3\sqrt{10})^2}{8(10.3)} = 1.09$ [W]

7.8

(a) $V_{rms} = 5$ [V]

(b) $I_{rms} = \sqrt{(5)^2 + \frac{(3)^2}{2}} = 5.43$ [A]

(c) $V_{rms} = \sqrt{\frac{(7)^2 + (3)^2}{2}} = 5.39$ [V]

7.9 $V_{rms} = \sqrt{4} = 2\,[\mathrm{V}]$

7.10 $pf = \cos(18.43^\circ) = 0.949$

7.11 $pf = \cos(-45^\circ) = 0.707$

7.12 $\mathbf{S} = 180 - j311.77\,[\mathrm{VA}]$

피상 전력: $P_{app} = |\mathbf{S}| = 360\,[\mathrm{VA}]$

평균 전력: $180\,[\mathrm{W}]$

무효 전력: $-311.77\,[\mathrm{VAR}]$

7.13 $\mathbf{S} = 204.79 + j143.39\,[\mathrm{VA}]$

피상 전력: $P_{app} = |\mathbf{S}| = 250\,[\mathrm{VA}]$

평균 전력: $204.79\,[\mathrm{W}]$

무효 전력: $143.39\,[\mathrm{VAR}]$

7.14 $\mathbf{S} = 1058.92 + j332.45\,[\mathrm{VA}]$

피상 전력: $P_{app} = |\mathbf{S}| = 1109.88\,[\mathrm{VA}]$

평균 전력: $1058.92\,[\mathrm{W}]$

무효 전력: $332.45\,[\mathrm{VAR}]$

7.15 $C = \dfrac{Q_C}{\omega \mathbf{V}^2} = \dfrac{390}{(2\pi)(50)(100)^2} = 124.2\,[\mu\mathrm{F}]$

7.16 $C = \dfrac{2Q_C}{\omega \mathbf{V}_S^2} = \dfrac{(2)(400)}{(2\pi)(60)(100)^2} = 212.3\,[\mu\mathrm{F}]$

7.17

abc 위상 순서

$$\mathbf{V}_{an} = \frac{100\sqrt{3}}{\sqrt{3}\angle 30^\circ} = 100\angle -30^\circ$$

$$\mathbf{V}_{bn} = 100\angle(-30^\circ - 120^\circ) = 100\angle -150^\circ$$

$$\mathbf{V}_{cn} = 100\angle 90^\circ$$

acb 위상 순서

$$\mathbf{V}_{an} = \frac{100\sqrt{3}}{\sqrt{3}\angle -30^\circ} = 100\angle 30^\circ$$

$$\mathbf{V}_{cn} = 100\angle(30^\circ - 120^\circ) = 100\angle -90^\circ$$

$$\mathbf{V}_{bn} = 100\angle 150^\circ$$

7.18

$$\mathbf{I}_a = \frac{\mathbf{V}_{an}}{\mathbf{Z}_Y} = \frac{300\angle 0^\circ}{10\angle -36.87^\circ} = 30\angle 36.87^\circ\,[\mathrm{A}]$$

$$\mathbf{I}_b = \mathbf{I}_a\angle -120^\circ = 30\angle(36.87^\circ - 120^\circ) = 30\angle -83.13^\circ\,[\mathrm{A}]$$

$$\mathbf{I}_c = \mathbf{I}_b\angle -120^\circ = 30\angle(-83.13^\circ - 120^\circ) = 30\angle 156.87^\circ\,[\mathrm{A}]$$

$$\mathbf{V}_{ab} = \sqrt{(450)^2 + (150\sqrt{3})^2}\angle \tan^{-1}\left(\frac{\sqrt{3}}{3}\right) = 474\angle 30^\circ\,[\mathrm{V}]$$

$$\mathbf{V}_{bc} = 474\angle(30^\circ - 120^\circ) = 474\angle -90^\circ\,[\mathrm{V}]$$

$$\mathbf{V}_{ca} = 474\angle(-90^\circ - 120^\circ) = 474\angle +150^\circ\,[\mathrm{V}]$$

7.19 $\mathbf{I}_b = 16.48\angle -104.05^\circ\,[\mathrm{A}]$, $\mathbf{I}_L = |\mathbf{I}_b| = 16.48\,[\mathrm{A}]$

7.20 $\mathbf{I}_n = 2.49\angle -48.9^\circ\,[\mathrm{A}]$

Chapter 08 연습문제 해답

8.1 $\mathbf{I}_S(j\omega) = 10\angle 0^\circ\ [\mathrm{A}],\quad R = 10\ [\Omega],$

$j\omega L = j2\times 1 = j2\ [\Omega],\quad \dfrac{1}{j\omega C} = \dfrac{1}{j2\times 0.2} = -j2.5\ [\Omega]$

8.2 $\dfrac{\mathbf{V}_O(j\omega)}{\mathbf{V}_S(j\omega)} = 0.5 - j0.5$

8.3 $\dfrac{\mathbf{V}_O(j\omega)}{\mathbf{V}_S(j\omega)} = 1.5 - j0.5$

$\dfrac{\mathbf{V}_O(j\omega)}{\mathbf{V}_S(j\omega)} = \sqrt{(1.5)^2 + (-0.5)^2}\ \tan^{-1}\left(\dfrac{-0.5}{1.5}\right) = 1.581\angle -18.43^\circ$

8.4 $\dfrac{\mathbf{V}_O(j\omega)}{\mathbf{V}_S(j\omega)} = \dfrac{(2.2 - j0.4)(13 + j)}{(13 - j)(13 + j)} = \dfrac{29 - j3}{170}$

8.5 $\mathbf{H}_I(j\omega) = \dfrac{\mathbf{I}_O(j\omega)}{\mathbf{I}_S(j\omega)} = \dfrac{(1 + j)(4.5 - j5)}{(4.5 + j5)(4.5 - j5)} = \dfrac{9.5 - j0.5}{45.25}$

8.6 $L = \dfrac{R}{\mathrm{BW}} = \dfrac{10}{20} = 0.5\ [\mathrm{H}],\quad C = \dfrac{1}{100\times L} = \dfrac{1}{100\times 0.5} = 20\ [\mathrm{mF}]$

8.7 $C = \dfrac{1}{R\times \mathrm{BW}} = \dfrac{1}{10\times 20} = 5\ [\mathrm{mF}],\quad L = \dfrac{1}{100\times C} = \dfrac{1}{100\times 5\times 10^{-3}} = 2\ [\mathrm{H}]$

8.8 $Q = \dfrac{\omega_r}{\text{BW}} = \dfrac{5000}{125} = 40$

8.9 $Q = \omega_r RC = (2200)(20)(4\times10^{-6}) = 0.18$

8.10 $\omega_r = \dfrac{1}{\sqrt{LC}} = \dfrac{1}{\sqrt{(20\times10^{-3})(50\times10^{-6})}} = 1000\ [\text{rad/s}]$

$$\text{BW} = \frac{1}{RC} = \frac{1}{(10\times10^{3})(50\times10^{-6})} = 2\ [\text{rad/s}]$$

$$Q = \frac{\omega_r}{\text{BW}} = \frac{1000}{2} = 500$$

8.11 $|\mathbf{H}(j2)| = \dfrac{2}{4(\sqrt{1^2+2^2})^2} = 0.1$

8.12 저역통과 필터.

8.13 $f_0 = \dfrac{\omega_0}{2\pi} = \dfrac{2\times10^6}{2\pi} = \dfrac{10^6}{\pi}\ [\text{Hz}]$

$$\text{BW} = \frac{R}{L} = \frac{200}{10\times10^{-3}} = 2\times10^4$$

$$Q = \frac{\omega_0}{\text{BW}} = \frac{2\times10^6}{2\times10^4} = 100$$

8.14 대역통과 필터, $\omega_0 = \dfrac{1}{(1)(1)} = 1\ [\text{rad/s}]$

8.15 고역통과 필터, $f_c = \dfrac{R}{2\pi L} = \dfrac{300}{2\pi(0.2)} = 238.6\ [\text{Hz}]$

8.16 $\omega_c = 0.2\,[\text{rad/s}]$

8.17 (a) $H = 10^{0.2} = 1.5849$ (b) $H = 10^{-0.2} = 0.6310$

8.18 영점: -20, 극점: -5, (삼중근) -2

8.19 $H_{dB} = 20\log_{10} 2 + 20\log_{10}\left|1+\frac{j\omega}{20}\right| - 20\log_{10}\left|1+\frac{j\omega}{2}\right| - 20\log_{10}\left|1+\frac{j\omega}{5}\right|$

$$\phi = \tan^{-1}\left(\frac{\omega}{20}\right) - \tan^{-1}\left(\frac{\omega}{2}\right) - \tan^{-1}\left(\frac{\omega}{5}\right)$$

8.20 $$\mathbf{H}(j\omega) = \frac{10\left[\frac{1}{10}(10 + j\omega)\right]}{\left[\frac{1}{100}(100 + j\omega)\right]\left[\frac{1}{1000}(1000 + j\omega)\right]} = \frac{10^5(10 + j\omega)}{(100 + j\omega)(1000 + j\omega)}$$

Chapter 09 연습문제 해답

9.1 $$F(s) = -\frac{e^{-st}}{s}\Big|_0^2 + \frac{1}{s}\int_0^2 e^{-st}dt + \frac{2e^{-st}}{s}\Big|_2^4 = \frac{1}{s^2}(1 - e^{-2s} + s - 3se^{-2s} + 2se^{-4s})$$

9.2 $$\mathcal{L}[\cosh at] = \frac{1}{2}\mathcal{L}[e^{at} + e^{-at}] = \frac{1}{2}\left[\int_0^\infty e^{at}e^{-st}dt + \int_0^\infty e^{-at}e^{-st}dt\right]$$

$$= \frac{1}{2}\left[-\frac{e^{-(s-a)t}}{s-a}\Big|_0^\infty - \frac{e^{-(s+a)}}{s+a}\Big|_0^\infty\right] = \frac{1}{2}\left[\frac{1}{s-a} + \frac{1}{s+a}\right] = \frac{s}{s^2 - a^2}$$

$$\mathcal{L}[\sinh bt] = \frac{1}{2}\mathcal{L}[e^{bt} - e^{-bt}] = \frac{1}{2}\left[\int_0^\infty e^{bt}e^{-st}dt - \int_0^\infty e^{-bt}e^{-st}dt\right]$$

$$= \frac{1}{2}\left[-\frac{e^{-(s-b)t}}{s-b}\Big|_0^\infty + \frac{e^{-(s+b)}}{s+b}\Big|_0^\infty\right] = \frac{1}{2}\left[\frac{1}{s-b} - \frac{1}{s+b}\right] = \frac{b}{s^2 - b^2}$$

9.3 $$f(t) = 2u(t) - 2\delta(t) - 5e^{-3t}$$

9.4 $$f(t) = 2e^{-3t} - 2e^{-t} + 4te^{-t}$$

9.5 $$\mathcal{L}[\cos(t-1)u(t-1)] = \frac{se^{-s}}{s^2 + 1^2}$$

9.6 $$f(t) = 2\delta(t) + e^{-2t}u(t)$$

9.7 $f(t) = f_a(t) + f_b(t) + f_c(t) = 4u(t) - 2u(t-1) + 2u(t-3) - 4u(t-4)$

9.8 $\mathbf{Z}_{in}(s) = s \,||\left(2 + \frac{1}{s}\right) = \frac{s\left(2 + \frac{1}{s}\right)}{s + 2 + \frac{1}{s}} = \frac{s(2s+1)}{s^2 + 2s + 1} == \frac{s(2s+1)}{(s+1)^2}$

9.9 $\mathbf{Z}_{in}(s) = \frac{1}{s} \,||\, \frac{2s^2 + 5s + 2}{3 + 2s} = \frac{\frac{1}{s}(2s^2 + 5s + 2)}{\frac{1}{s} + 3 + 2s} = \frac{2s^2 + 5s + 2}{2s^2 + 3s + 1} = \frac{(2s+1)(s+2)}{(2s+1)(s+1)} = \frac{s+2}{s+1}$

9.10 $i(t) = 2e^{-t}u(t)$

9.11 $\mathbf{I}(s) = \frac{12/s}{\mathbf{Z}(s)} = \frac{4}{2s+1}$

9.12 $\mathbf{V}_1(s) = \frac{6(s+3)}{(s+2)^2}$

9.13 $\mathbf{I}_1 = \frac{|D_1|}{|D|} = \frac{4(s+1)}{s(s^2 + 5s + 2)}$, $\mathbf{I}_2 = \frac{|D_2|}{|D|} = \frac{4}{s^2 + 5s + 2}$

9.14 $\mathbf{I}_1 = \frac{|D_1|}{|D|} = \frac{4(s+2)}{2s^2 + 5s + 1}$, $\mathbf{I}_2 = \frac{|D_2|}{|D|} = \frac{4}{2s^2 + 5s + 1}$

9.15 $v_o(t) = 2e^{-2t} - 10e^{-6t}$

9.16 $$\mathbf{H}(s)=\frac{\mathbf{V}_o(s)}{\mathbf{V}_S(s)}=\frac{10s(s+1)}{2s^2+12s+5}\cdot\frac{s}{2(s+1)}=\frac{5s^2}{2s^2+12s+5}$$

9.17 $$\mathbf{H}(s)=\frac{\mathbf{V}_o(s)}{\mathbf{V}_S(s)}=\frac{2s^3}{3s^3+4s^2+2s+1}$$

9.18 $$\mathbf{H}(s)=\frac{\mathbf{I}_o(s)}{\mathbf{I}_S(s)}=\frac{\mathbf{V}_o(s)}{\mathbf{I}_S(s)}=\frac{2s^3}{2s^3+3s^2+s+1}$$

9.19 $$\mathbf{H}(s)=\frac{\mathbf{V}_o(s)}{\mathbf{I}_S(s)}=\frac{2s^3}{2s^3+3s^2+s+1}$$

9.20 $$\mathbf{H}(s)=\frac{\mathbf{I}_o(s)}{\mathbf{V}_S(s)}=\frac{\mathbf{V}_o(s)}{\mathbf{V}_S(s)}=\frac{2s^3}{3s^3+4s^2+2s+1}$$