연습문제 해답

(기초회로이론-개정2판)

2019. 3.

- 최윤식 저 -

일반 독자들께

본 교재를 사용해 주셔서 감사 드립니다. 개정2판에는 많은 문제들을 보완했고, 이전 판에서의 오탈자들을 수정하였습니다.

하지만, 그럼에도 불구하고 이번에도 개정2판의 해답집을 만들면서 보니 또 많은 오류가 있었습니다. 제가 발견한 오류들은 정리하여 올려놓습니다만, 공부하시다가 또 다른 오류를 발견하시면 번거로우시겠지만 연락주시면 감사하겠습니다. 지적해주시는 오류들은 다음 번 수정판에 반영하여 수정하도록 하겠습니다.

본 해답은, 풀이 없이 답만 올려놓았습니다. 풀이와 답은 강사님들께만 제공하여 학생들에게 선택적으로 제공하는 것으로 출판사와 방침을 정했지만, 혼자 공부하시는 분들께서 공부에 도움이 되도록 답만이라도 공개해 달라는 요청이 많아 답만은 제공하는 것으로 방침을 바꾸었습니다.

참고하시고 공부하시는 데에 활용해 주시면 감사하겠습니다. 언제라도 교재에 대한 의견이나 요청이 있으시면 저나 한빛아카데미 출판사에 연락주십시오.

감사합니다.

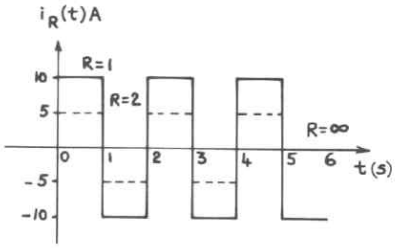
2019. 3. 최윤식 씀

오탈자와 본문 오류 등은 한빛미디어 홈페이지 http://www.hanb.co.kr 에서 확인하실 수 있습니다.

편집자 드림

제2장 전기회로소자 및 계수

2-1



2-2

(a) $E(1)=2$[J] (b) $E(2)=4$[J] (c) $E(3)=8$[J] (d) $E(4)=10$[J] (e) $E(5)=12$[J]

2-3

1) $v=-250[V]$

2) $v=+100[V]$

3) $v=200[V]$

2-4

a) $P=18[W]$

b) $P=-20[W]$

c) $P=-21[W]$

2-5

$E(0,5)=3.75[J]$

2-6

1) 구간 [0,1]에서, $E[0,1]=\frac{1}{30}[J]$

2) 구간 [0,2]에서, $E[0,2]=\frac{4}{30}[J]$

3) 구간 [0,5]에서, $E[0,5]=\frac{11}{30}[J]$

2-7

저항 R_1 에 의하여 소모되는 전력은 $P_1=400[W]$,

저항 R_2 에 의하여 소모되는 전력은 $P_2=500[W]$.

2-8

$R=25\Omega$ 이 되고, 100V 전원에 연결하면, $400[W]$ 을 소모한다.

2-9
v 는 10V. $i=-3A$.

2-10
$0 \le t \le 4s$ 구간에서, 전력 $P=80t[W]$
$4 \le t \le 5s$ 구간에서, 전력 $P=-60t^2+320t[W]$
$5 \le t \le 10s$ 구간에서, 전력 $P=-20t+200$ [W]
전체 에너지는 $1110[J]$

2-11
(a) $150[Wh]$
(b) 15원

2-12
4Ω 저항에 의하여 소비된 전력은 $36\,W$, 8Ω 저항에 의하여 소비된 전력은 $32\,W$, 9Ω 저항에 의한 소비전력은 $81\,W$.

제3장 저항회로

3-1
(a) 1메시, 2노드 (b) 2메시, 4노드 (c) 3메시, 4노드

3-2
(a) $V_{DE}=1$[V]일 때,
V_{AC}= 8[V], V_{AD}= 3[V], 또한 V_{AE}= 4[V], $V_{AF}=0$[V].
(b) $V_{CD}=1[V]$일 때,
$V_{AC}=1[V]$, $V_{AD}=3[V]$, $V_{AE}=-2[V]$, $V_{AF}=-6[V]$
(c) $V_{FE}=4[V]$ 일 때,
$V_{AD}=3[V]$, 나머지는 모름.

3-3
(a) $i_{AC}=23mA$, $i_{BD}=16mA$
(b) $i_{AC}=23mA$. $i_{BD}=62mA$

3-4
$R_{eq}=10\Omega$

3-5

$i_x = \frac{10}{7}[A]$

3-6

$i_s = 6A,\ v = 45[V]$

3-7

$v_1 = 30[V].\ v = 225[V]$

3-8

$R = 3.2\,\Omega$

3-9

$v_0 = \frac{115}{8} i_0$

3-10

$v_x = -20\,V$

3-11

$v_0 = 3.2[V]$

3-12

(a) $R = 6\Omega$

(b) $v = 6\,V$, i = 1A

(c) $i_2 = \frac{4}{5}A$

3-13

2Ω에 흐르는 전류 $I_2 = \frac{51}{5}A$

3-14

(a) $v_{2K\Omega} = 4\,V,\ v_{3K\Omega} = 6\,V,\ v_{7K\Omega} = 14\,V$

(b) $p_{6\,V전원} = -12m\,W,\ p_{2K\Omega} = 8m\,W,\ p_{3K\Omega} = 12m\,W,$

$p_{18\,V전원} = -36m\,W,\ p_{7K\Omega} = 28m\,W$

3-15

(a) $2m$℧ 저항전류, $i = 4mA$, $3m$℧ 저항전류 $i = 6mA$, $7m$℧ 저항전류 $i = 14mA$

(b) $p_{2m℧} = 8m\,W,\ p_{6mA전원} = -12m\,W,\ p_{3m℧} = 12m\,W,\ p_{18mA전원} = 36m\,W,\ p_{7m℧} = 28m\,W$

3-16
3Ω에 흐르는 전류 $2A$, 걸리는 전압 $v=6\,V$, 전력 $p=12\,W$.

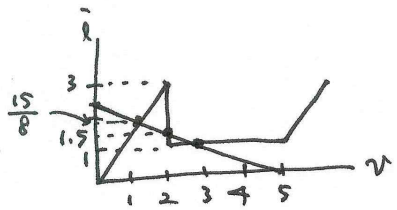
3-17
임의의 전류 전원 값 $i=0.12A$.

3-18
10Ω 소비 전력 $P=4.096\,W$.

3-19
(a) 100Ω 저항 소비 전력 $P=1600\,W$
(b) 300V 전원 $P=-1200\,W$ 을 소비.
(c) $P=-640\,W$ 을 소비한다.

3-20
(a) 전류전원에 의하여 공급되는 전력은 $P=3.6\,W$,
(b) 900Ω에 의하여 소비되는 전력은 $P=1.44\,W$

3-21



3개의 포인트, $i=\frac{15}{8},\frac{3}{2},1$ 의 값이 가능.

3-22
$v_x=0.3[V]$, 종속전원에서 발생하는 전력은 $P=7.8[W]$

제4장 저항회로의 해석방법

4-1
$i_x=1A$

4-2
$i_x=0.5A$

4-3

$V_A = 0[V] \quad V_B = -2.5[V] \quad V_C = 2.5[V]$

4-4

$i(t) = \frac{40}{3}[A]$

4-5

$i_A - \frac{11}{3}mA,\ i_B = 4mA,\ i_C = -\frac{1}{3}mA$

4-6

$\mathrm{R} = 7\Omega$

4-7

$i_1 = 1.69[A], i_2 = 1.39[A], i_3 = 1.92[A]$

4-8

$v_1 = 1\,V$, 종속전원을 500Ω으로 바꾸면, $v_1 = 1\,V$

4-9

$v_x = 6[V]$

4-10

$i_x = -0.3A$

4-11

$i_B = -1.333[mA], \quad i_C = -3[mA],\ i_A = 4.333[mA]$

4-12

$v = 10\,V$, $i = 0.02A$, 소비전력은 $P = 0.2\,W$

4-13

R= 1Ω 에 의하여 소비되는 전력 $P = \frac{9}{169}[W]$

4-14

$P = -423\,W$

4-15

$P = 104.3[W]$ 혹은 방향설정에 따라 -104.3[W]

4-16

$P = 95.2\ W$

4-17

$P = 0.75\,W,\ A = 0.015$

4-18

독립방정식의 수는 다음의 7개.

메시 1 : $v_1 - v_2 = v_{R_1} + v_{R_7} + v_{L_1}$

메시 2 : $v_2 = v_{C_3} + v_{R_4} + v_{L_2}$

메시 3 : $-v_3 = v_{R_6} + v_{R_8} - v_{R_7}$

메시 4 : $0 = v_{R_5} - v_{R_8} - v_{L_2}$

메시 5 : $-v_1 + v_3 = v_{C_1} - v_{R_2} - v_{R_1} - v_{R_6}$

메시 6 : $-v_4 = v_{C_2} - v_{R_5}$

메시 7 : $v_4 = v_{R_3} - v_{C_1} - v_{C_2} - v_{R_4}$

4-19

$P = 0.8071[W]$

제5장 회로해석 정리

5-1

$v_a = 7[V]$

5-2

$v_0 = 30\,V$

5-3

4Ω에 흐르는 전류는 2A , 방향은 오른쪽에서 왼쪽으로 흐른다.

5-4

$v = -3[V]$

5-5

테브닌등가회로의 $v_{oc} = -12[V], R_{th} = 16[\Omega]$.

5-6

$R_{th} = 4[K\Omega],\ \ v_{oc} = 24[V]$

5-7

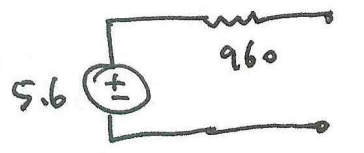
$R_{th} = 5\Omega\ ,\ v_{oc} = 18\,V$

5-8

$v_{oc} = 8\,V,\ \ R_{th} = \frac{4}{3}\Omega$

5-9

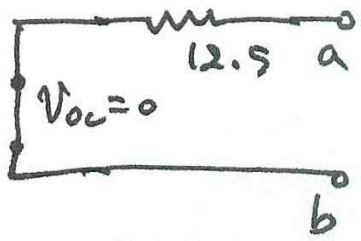
$v_{oc} = 5.6\,V,\ \ R_{th} = 960[\Omega]$



5-10

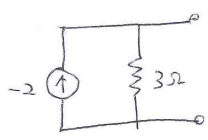
(a) $v_{oc} = v = 15[V].\quad R_{th} = 12.5\Omega$

(b) $R_{th} = 12.5\Omega$

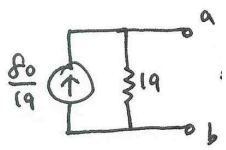


5-11

$I_{sc} = -2\ \ R_t = 3\Omega$ 노턴등가회로는



5-12



5-13

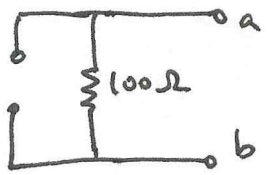
$i_{sc} = 4A,\ R_{th} = \frac{v_{oc}}{i_{sc}} = -9\Omega$

5-14

$P_{\max} = \frac{15}{452} W$

5-15

(a) $I_{sc} = 0,\ R_{th} = 100\Omega.$ 노턴 등가회로는



(b) $R_L = 100\Omega$

(c) 최대 전달 전력 $P_{\max} = 2500[W]$

5-16

(a) $v_x = 2.8[V]$

(b) 5A 전원전력 14W.

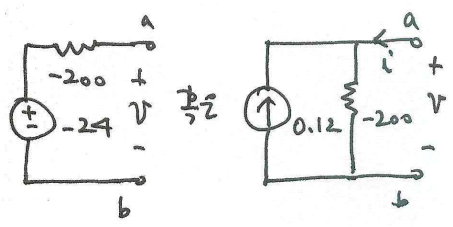
(c) 6V 전원 발생 전력 $p = 21.6\,W$

(d) 전력 $p = -12.32[W]$

5-17

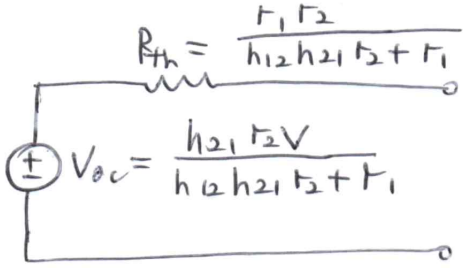
$v_{oc} = -24[V],\ R_{th} = -200[\Omega]$

$i = -\frac{v}{200} = 0.12$



5-18

$R_{th} = \dfrac{r_1 r_2}{r_1 + r_2 h_{21} h_{12}}$. 테브닌등가회로는



제6장 연산증폭기

6-1

$v = 7[V], \quad i = 0.25[mA]$

6-2

$R_1 = 33.3K\Omega$, $R_2 = 66.6K\Omega$, $R_3 = 50K\Omega$

6-3

$v_o = -1[V]$

6-4

$v_a = -10[V]$, $v_b = -6[V]$, $v_c = -6[V]$. $v_d = -6, \quad v_e = -4$, $v_g = -4$, $v_f = \dfrac{-16}{3}$

6-5

$\mathrm{v_x} = 4[\mathrm{V}]$, $i_a = -0.6[mA]$

6-6

(a) $v_{out} = -\dfrac{R_f}{R_1} w - \dfrac{R_f}{R_2} x + \dfrac{(R_2' // R_f')(R_f + (R_1 // R_2))}{(R_1' + (R_2' // R_f'))(R_1 // R_2)} y + \dfrac{(R_1' // R_f')(R_f + (R_1 // R_2))}{(R_{2'} + (R_1' // R_f'))(R_1 // R_2)} z$

(b) $v_{out} = 10[V]$

6-7

$R_f = R_f' = 100K\Omega$ 으로 정하면, $R_1 = 25K\Omega$, $R_2 = 50K\Omega$,

$R_1' = 10K\Omega$, $R_2' = 100K\Omega$

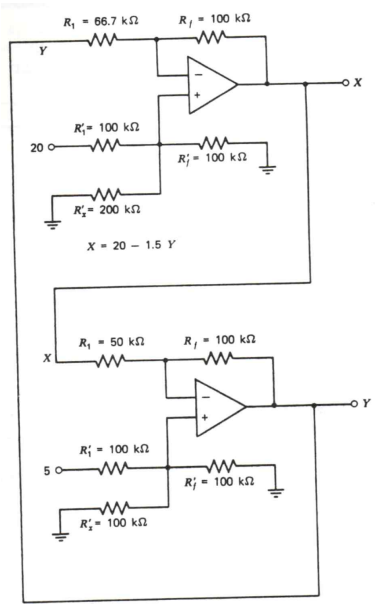
6-8

$$\frac{v_o}{v_s} = \frac{1}{R_3}(R_3 + R_4) + \frac{R_2}{R_3}$$

6-9

$$a = \frac{1}{4}, b = -\frac{3}{4}$$

6-10



제7장 에너지 저장소자

7-1

$$v_L(t) = 10^{-3}\frac{d}{dt}(0.1\sin 10^6 t) = 100\cos 10^6 t$$

7-2

(a) $L = 10[H]$

(b) $C = 160[\mu F]$

7-3

(a) $i(t) = 0.5\cos t + 0.125\sin 2t$

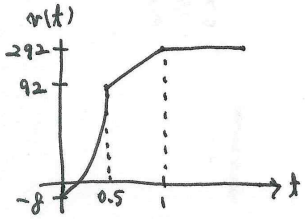
(b) $E = 0.623[J]$

7-4

0<t<0.5 때, $v(t) = 400t^2 - 8$

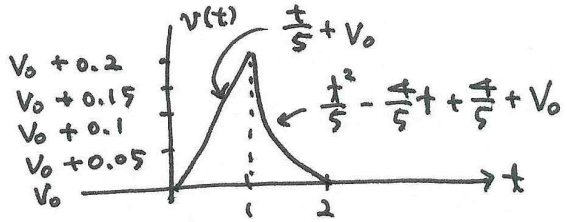
$0.5 \le t < 1$ 때, $v(t) = 400t - 108$

$t \ge 1$ 때, $v(t) = 292$



7-5

$$v(t) = \begin{cases} \frac{t}{5} + v_{0,}, 0 \le t < 1 \\ \frac{t^2}{5} - \frac{4}{5}t + \frac{4}{5} + v_0, 1 \le t < 2 \\ v_0, 2 \le t < \infty \end{cases},$$



7-6

(a) t=0에서, $i = 2\pi \times 10^{-5}[A]$

(b) $t = \frac{1}{4}$ 초에서, $i = 0[A]$

(c) $t = \frac{1}{2}$ 초에서, $i = -2\pi \times 10^{-5}[A]$

7-7

$t = 300\mu s$ 때, $i(300\mu) \approx 0.15[mA]$

7-8

$i_{avg} = 10.42 \times 10^{-3} A$

7-9

(a) $i = 3.274e^{\frac{t}{50}}[A]$

2) $i = 0.149e^{\frac{t}{50}}[A]$

7-10

(a) $V = 0.6[V]$

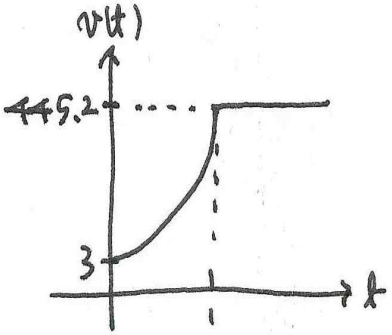
(b) $V = 0.2e^{-10^4 t}$

(c) t=0에서 $|V| = 0.08[V]$

7-11

$0 < t \leq 1$ 때, $v(t) = 3e^{5t}$

t>1 때, $v(t) \approx 445.2$



(a) $P(0.2) = 66.50[W]$

(b) $P(0.8) = 26.8[KW]$

7-12

(a) $E(0) = 2 \times 10^{-9}[J]$

(b) $E(1.571\mu) = 2 \times 10^{-9}[J]$

(c) 전체 에너지는 $E = E_L + E_C = 2 \times 10^{-9}[J]$

7-13

$i_1(0) = 0,\ i_2(0) = 3,\ i_3(0) = -2$

7-14

$0 < t < \frac{1}{2}$ 때, $i_L(t) = 2t - 2,$

$\frac{1}{2} \leqq t < 1$ 때, $i_L(t) = -1$

$1 \leqq t < \frac{3}{2}$ 때, $i_L(t) = 2t - 3$

$\frac{3}{2} \leqq t < 2$ 때, $i_L(t) = 0$, 계속하여 각 구간별로 구하면, 최종 $i_L(t)$의 파형은

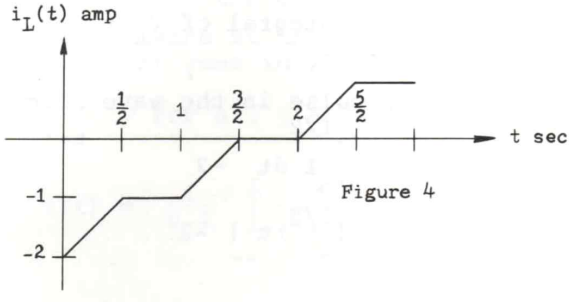


Figure 4

7-15

(a) t<0 일 때, $i_1(0^+) = 4[A]$, $i_2(0^+) = 1[A]$

(b) t>0 때, $i(t) = 5e^{-5t}$

제8장 RL과 RC 회로의 완전응답

8-1

(a) $t = 0^+$에서 $i_L(0^+) = 0$

(b) $t = \infty$ 에서, $i_L(\infty) = 8[A]$,

(c) $t = 4m$초에서, $i_L(4m) = 5.057[A]$

8-2

$p_R = 71.44[W]$, $p_L = 79.76[W]$, $p_S = -151.2[W]$

8-3

1차 미분방정식은 $\frac{di}{dt} = \frac{2}{3}$, $i(t) = \frac{2}{3}t + 2$

8-4

$v(t) = 6 + 2e^{-\frac{4}{3}t}$

8-5

$i(t) = -0.04e^{-30t} + 0.06[A]$

8-6

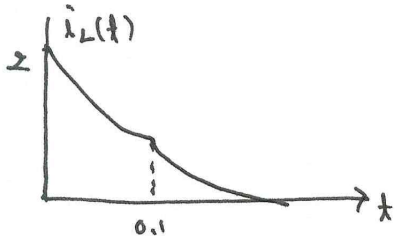
$v_c(t) = -5e^{-2t} + 5\sqrt{2}\cos(2t - 45^\circ)$

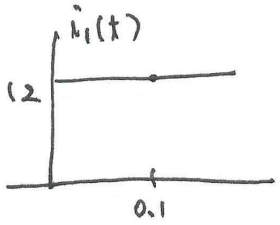
8-7

$v(t) = -0.15e^{-\frac{1}{0.38}t} - 0.25$

8-8

$i_L(t) \approx 1.21e^{-3(t-0.1)}$, $i_1(t) = 12[A]$





8-9

$i_L(t) = 4e^{-0.5t} - 2$

8-10

(a) $i_L(t) = 4 - 4e^{-100t}u(t)[A]$

(b) $i_1(t) = 2 - \frac{8}{3}e^{-100t}u(t)[A]$

8-11

$i = (0.1 + 0.2e^{-2500t})u(t)[mA]$

8-12

$i_L(t) = 0.02(1 - e^{-25000t})u(t)[A]$

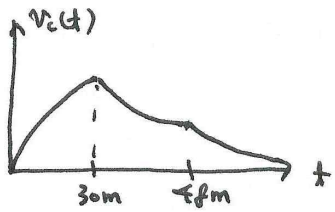
8-13

(a) t < 0 때, $v_c(0) = 0$

$0 \le t < 30m$ 때, $v_c(t) = -10e^{-200t} + 10$

$30m \le t < 48m$ 때, $v_c(t) = 4024.2e^{-200t}$

$t \ge 48m$ 때, $v_c(t) = 33.17e^{-100t}$



(b) $v_c(100m) \approx 0.0015$

8-14

t>0 때의, $i(t) = 0.5e^{-5000t}[A]$, $v(t) = -25e^{-5000t}[V]$

8-15

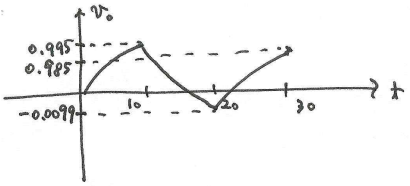
t>0 때, $v_C(t) = 20[V]$

8-16

$0 < t < 10m$ 때, $v_o(t) = -100e^{-t} + 100$

$10m \le t < 20m$ 때, $v_o(t) = 102.01e^{-t} - 100$

$20m \le t < 30m$ 때, $v_o(t) = -102.03e^{-t} + 100, \quad v_o(30m) = 0.985$

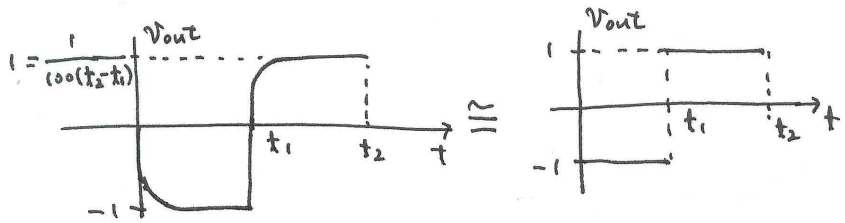


8-17

(a) $\frac{dv_{out}}{dt} + 10^4 v_{out} = -10\frac{dv_{\text{in}}}{dt}$

(b) $0 < t < t_1$ 때, $v_{out} = e^{-10^4 t} - 1$

$t_1 < t < t_2$ 때, $v_{out} = 1 - e^{-10^4(t-10m)}$



제9장 RLC 회로의 완전응답

9-1

$\omega_0 = \frac{1}{\sqrt{2}} \times 10^7 [rad/s]$

9-2

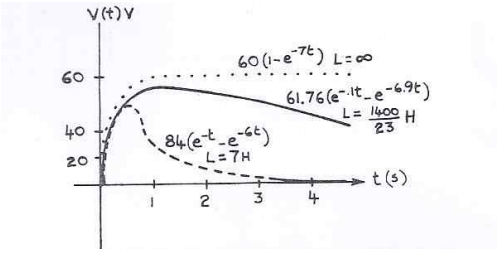
$v_c(t) = \frac{3}{2}(e^{-t} - e^{-3t})[V]$

9-3

$\frac{d^2v}{dt} + 7\frac{dv}{dt} + 6v(t) = 0$

(a) $v(t) = 61.76(e^{-0.1t} - e^{-6.9t})$, $v_{CMax}(.622) = 57.2[V]$

(b) $L = \infty$ 이면, $v(t) = 60(1 - e^{-7t})$



9-4

$i_L(0^+) = i_L(0^-) = 10[mA]$, R의 값에 상관없이 $\frac{di(0^+)}{dt} = 0$

9-5

$$\frac{d^2v}{dt^2} + \frac{1}{L[(1+b)R_2 + R_1]}\frac{dv}{dt} + \frac{1}{LC}v(t) = \frac{(1+b)R_2}{LC[(1+b)R_2 + R_1)]}v_s$$

9-6

$v(t) = 3e^{-3t} - e^{-t}$

9-7

$v(t) = -4e^{-2t}\sin 2t$

9-8

$v_C(t) = 0.25v_0e^{-0.293t} - 0.25v_0e^{-1.707t} - 0.354v_0te^{-1.707t}$

9-9

$v(t) = -0.77e^{43.32t} - 5.23e^{-3.32t} + 16$

9-10

$v(t) = 3e^{-400t}\cos 300t + 4e^{-400t}\sin 300t$

9-11

(a)

$$\begin{bmatrix} \frac{di_1}{dt} \\ \frac{di_2}{dt} \\ \frac{dv_c}{dt} \end{bmatrix} = \begin{bmatrix} -4 & 0 & -2 \\ 0 & -4 & 2 \\ 1 & -1 & 0 \end{bmatrix} \begin{bmatrix} i_1 \\ i_2 \\ v_c \end{bmatrix} + \begin{bmatrix} 20 \\ 0 \\ 0 \end{bmatrix}$$

(b) $i_2(t) = -1.5e^{-4t} - e^{-3t} - e^{-t} + 2.5, \quad v_1(t) = -3e^{-4t} - 2e^{-3t} - 2e^{-t} + 5[V]$

9-12

$i_1(t) = e^{-10^6 t}[9\cos(2\times10^6 t) - 3\sin(2\times10^6 t)]\,[mA]$

9-13

$i(t) = 16e^{-2000t} - 4e^{-8000t} + 24[mA]$

9-14

(a) $v_1(t) = 132e^{-40t} + 1072e^{-160t}[mV]$

(b) $v_2(t) = 400 - 264e^{-40t} - 536e^{-160t}[mV]$

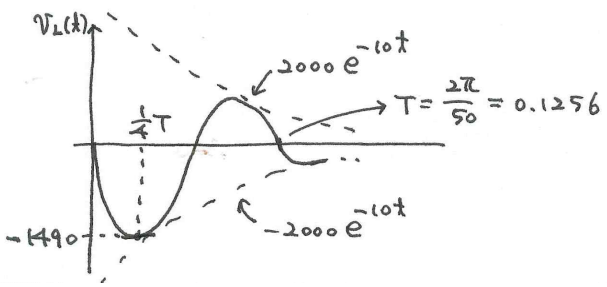
(c) $v_3(t) = -528e^{-40t} - 268e^{-160t} + 400[mV]$

9-15

$v_C(t) = 250e^{-500t} - 125e^{-2000t}[V]$

9-16

(a) $v(t) = -2000e^{-10t}\sin 50t[V]$



(b) 최대값은 1/4 주기값에서 -1490[V].

9-17

$$\frac{d^3v_1(t)}{dt^3} + 2\frac{d^2v_1(t)}{dt^2} + 2\frac{dv_1(t)}{dt} + v_1(t) = \frac{I}{2}$$

(단, I 는 상수이므로, $\frac{d^2I}{dt^2} = 0, \frac{dI}{dt} = 0$ 이다.)

제10장 정현파의 정상상태응답 해석

10-1

$i(t) = 3.236\cos(300t - 14.4^\circ)$

10-2

(a) $A=8,\ \mathrm{b}=-1$

(b) $A=-20,\ a=-5\sqrt{3}$

10-3

(a) $5\angle 30^\circ$

(b) $5\sqrt{2}+j5$

10-4

$R=4.53,\ \mathrm{L}=\dfrac{2.115\times 10^3}{2\times 10^6}=1.0575[\mathrm{mH}]$

10-5

$i(t)\ =\ 0.5+\dfrac{1}{6}\cos(4t+45^\circ)[mA]$

10-6

$v_R=5\cos\omega t+\dfrac{5}{2}+3\sin\omega t=\sqrt{5^2+3^2}\cos(\omega t-Tan^{-1}\dfrac{5}{3})+\dfrac{5}{2}$

정현파의 실효값은 주파수와 상관없이 $v_{eff}=\dfrac{\sqrt{93}}{2}$

10-7

$Y=0.04+0.8j[\mho],\ Z=\dfrac{1}{Y}=\dfrac{1}{0.04+0.8j}$

10-8

$i(t)=\dfrac{1}{\sqrt{2}}\cos 15^\circ e^{-1000t}\approx 0.683e^{-1000t}$

10-9

$i(t)=1\cos(t-90^\circ)$

10-10

$v_c(t)=5.74e^{-10(t-10)}$

10-11

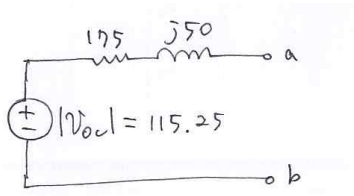
$i(t)=0.06364\cos(20t-2.07^\circ)[A]$

10-12

$i(t)=5e^{-\frac{1}{50}t}$

10-13

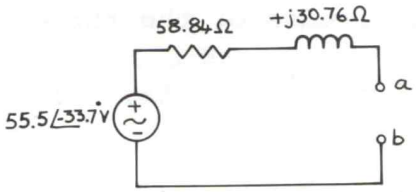
$Z_{th} = 175 + j50$, $V_{oc} = 115.25[V]$



10-14

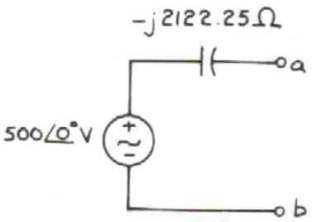
Z_{th}=$53.84 + j30.76$

V_{oc}= V_{th} $= 55.5 \angle -33.7^\circ$



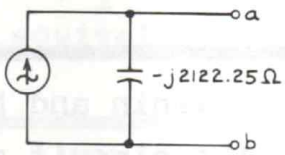
10-15

$Z_{th} = -j2122.25\Omega$. $V_{oc} = 500 \angle 0^\circ$



노턴 등가회로는 다음과 같다.

$$\dot{I} = \frac{500}{-j2122.25}\ A$$



$\dot{I} = 0.236/90^\circ$ A.

10-16

$v_{Css} = \frac{1}{2}\sin t - \frac{1}{2}\cos t$

순간응답 $v_{Ct} = \frac{1}{2}e^{-t}$, 이는 $t = \infty$ 때, 정상상태에서 0으로 수렴함으로, 위의 수식의 정상상태응답이 맞는 것을 알 수 있다.

10-17

$I_1 = -3 + 0.890\cos(250t - 57.7^\circ)$, $V_2 = 75 + 13.3\cos(250t - 57.7^\circ)$

10-18

$v(t) = 2\cos t + 2\sin t - 23e^{-2t} + 26e^{-3t}$

10-19

$i_L(t) = i_{L1}(t) + i_{L2}(t) = \frac{1}{2\sqrt{2}}\sin(t - 45^\circ) + \frac{11}{12}e^{-\frac{2}{3}t} + \frac{1}{3}$

10-20

$v_1(t) = 1,70e^{-5t} + 12.78e^{-2t} - 15e^{-3t}$

제11장 교류 정상상태 전력

11-1

$R = 10\Omega$, C = 0.1F

11-2

(a) $V_1 = 528\angle 15.83^\circ$

(b) 소자는 커패시터 소자, $C = 426\mu F$

11-3

$P = 573.11[W]$

11-4

$C = 0.1\mu F$

11-5

전체 전력소모량은 13.92[W]

11-6

(a) $V_{SS} = 736\angle -3^\circ[V]$

(b) 전송효율= 89.7[%]

11-7

$P_{AV} = 63.7[W]$

11-8

$R = 400\Omega$, 전류 $|I| = 2.18[A]$, $X = \pm 34.4\Omega$ 즉, X 가 인덕터라면, + 값, 커패시터라면 −값

11-9

R-C 가지 소모 전력 $P = VI\cos\theta = 707.4[W]$, R-L 가지 소모 전력 $P = 1989[W]$

11-10

$P(t) = 400\cos(6t + 20.60^\circ)$

11-11

$I_1 = 2[A]$, $V_1 = 8 - j6[\mathrm{V}]$, $V_2 = 40 - j30[V]$, $I_2 = 0.4[A]$

11-12

$P_{2\Omega} = 35.8621[mA]$, $P_{source} = 52.41[mW]$

11-13

$Z_T = 6.98 - j10.38$

11-14

$$v = R_1 i_1 + (L_1 + L_2)\frac{di_1}{dt} + M\frac{di_2}{dt} \quad ,$$

$$0 = L_3\frac{d^2 i_2}{dt^2} + M\frac{d^2 i_2}{dt^2} + R_2\frac{di_2}{dt} + \frac{1}{C_1}i_2$$

11-15

(a) $I_1 = 176\angle -25.16^\circ = 159.30 - j74.83$

(b) $\dfrac{V_1}{I_1} = Z_1 = 0.463 + j0.231 = 0.517\angle 26.52^\circ$

11-16

$$Z_{ab} = \frac{3s^4 + 12s^3 + 19s^2 + 15s + 4}{5s^3 + 11s^2 + 4s} \quad \text{단, } s = j\omega$$

11-17

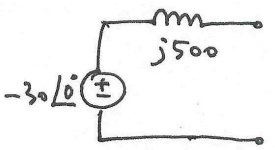
$i_R(t) = 1.79\cos(5000t + 26.6^\circ)[mA]$

11-18

$i_2(t) = 0.435(e^{-0.73t} - e^{-0.27t})u(t)$

11-19

(a) Z_{th}=j500[Ω], $V_{oc} = -30\angle 0^\circ$



(b) $Z_L = Z_{th}^* = -j500$

(c) 부하를 가하기 전 역률은 0

제12장 3상 회로

12-1

$I_{aA} = \frac{V_{an}}{Z} = \frac{390\angle 30^\circ}{319.4\angle -90^\circ} = 1.22\angle 120^\circ$, $I_{bB} = 1,22\angle 0^\circ$, $I_{cC} = 1.22\angle -120^\circ$

12-2

$I_{nn'} = I_{11'} + I_{22'} + I_{33'} = 22.9\angle -18.8^\circ$

12-3

$I_{nn'} = I_{an} + I_{bn} + I_{cn}$, 모두 합하면, 균형 3상의 경우 0 이 된다.

12-4

$I_{nn'} = I_{an} + I_{bn} + I_{cn}$, 모두 합하면, 균형 3상의 경우 0 이 된다.

12-5

(a) $P_{\mathrm{Total}} = 3 \times 1440 = 4.32[\mathrm{KW}]$

(b) $P_{\mathrm{Total}} = 3 \times 1920 = 5.76[\mathrm{KW}]$

(c) $P_{\text{송전선로}} = |I|^2(0.2) = 472.8[W]$, 전 전력은 3배인 1.42[KW].

12-6

$P_A = I_{aA}^* I_{aA} Z_A = 16.88 + j12.71$, $3P_A = 50.64[W]$

12-7

(b) 직렬 연결된 부하의 전체 평균전력은, $P_1 + P_2 = 6 + 5.81 = 11.81KW$

전체 리액턴스전력 $P_{x1} + P_{x2} = 8 - 4.36 = 3.64Kvar$ 가 된다.

(a) 전체 피상전력 $P_A = 12.36[Kva]$

(c) 선전류 $I_L = 32.4[A]$

(d) 역률 $pf = 0.955$(뒤진역률)

12-8

$C = \frac{1}{47 \times 377} = 56.5\mu F$

12-9

$C = \frac{1}{141 \times 377} = 18.8[\mu F]$

12-10

(a) $|i_{Aa}| = 160.5[A]$

(b) $|v_{AB}| = \sqrt{3} \times 751.88 = 1302.3$

(c) 역률= $\cos(\angle v_{An} - \angle I_{An}) = 0.42$ (뒤진역률)

12-11

(a) $v_{cn} = 390 \angle (-90^\circ - 120^\circ) = 390 \angle -210^\circ$

(b) $v_{bc} = v_{bn} - v_{cn} = 675 \angle -60^\circ$

(c) $v_{ac} = v_{an} - v_{cn} = 675 \angle 0^\circ$

12-12

(a) 조명부하에 의한 전력소모 $P_1 = 12.9[KW]$, 전체평균전력소모 $P = 3P_1 = 38.7[KW]$

(b) 모터에 의한 평균전력소모 $P_2 = 15.46[KW]$, 전체평균전력소모 $P = 3P_2 = 46.38[KW]$

12-13

$|I_a| = |I_b| = |I_c| = 13.85[A]$

12-14

$I_{aa'} = I_1 = 3.66 \angle 15^\circ$, $I_{cc'} = -I_2 = 11.96 \angle 66^\circ$, $I_{bb'} = -I_{aa'} + I_{c'c} = 14.54 \angle -125.1^\circ [A]$

12-15

$v_{a'b'} = v_{a'n'} + v_{n'b'} = 1509 \angle 20.6^\circ$, $v_{b'c'} = v_{b'n'} + v_{n'c'} = 1392 \angle -99.0^\circ$,

$v_{c'a'} = v_{c'n'} + v_{n'a'} = 1461 \angle 144.8^\circ$

12-16

(a) $|I_1| = 3.273[A]_{\mathrm{s}}$

(b) $|I_2| = 6.288[A]_{\mathrm{s}}$

(c) $|I_{phase}| = 8[A]_{\mathrm{rms}}$

12-17

$P_P = 2912$, 전체평균전력 $P = 3 \times 2912 = 8736[W]$

12-18
선전류는, $I_{aA} = 9\angle 97.4^\circ\,[A]_{\rm s}$,$I_{bB} = 9\angle -22.6^\circ\,[A]_{\rm s}$, $I_{cC} = 9\angle -142.6^\circ\,[A]_{\rm s}$

12-19
$|I| = 10\sqrt{3}$ [A]

12-20
(a) $I_{P1} = 5.2\angle 0^\circ$, $I_{P2} = 10.4\angle 180^\circ$, $I_{P3} = 13.8\angle 195^\circ$
(b) 선전류 $I_{L1} = 18.5 + j3.57[A]$, $I_{L2} = -15.6 + j0[A]$, $I_{L3} = -2.9 - j3.57[A]$
(c) 선간전압 $V_{AB} = 390\sqrt{3}\angle 60^\circ\,[V]_{\rm s}$, $V_{BC} = 390\sqrt{3}\angle -60^\circ\,[V]_{\rm s}$,
$V_{CA} = 390\sqrt{3}\angle 180^\circ\,[V]_{\rm rms}$

제13장 라플라스 변환 회로해석

13-1
$A(\frac{1}{s} - \frac{1}{s-b})$

13-2
$\mathcal{L}(f(t)) = -\frac{5}{3s^2} + \frac{5}{s} + e^{-\frac{21}{5}s}(\frac{5}{3s^2})$

13-3
$f(t) = (3 - 4e^{-t} + e^{-2t})u(t)$

13-4
(a) $f(t) = [e^{-t} - e^{-t}\cos(st) + e^{-t}\sin(2t)]u(t)$
(b) $f(t) = [2te^{-t} - e^{-t} + e^{2t}]u(t)$

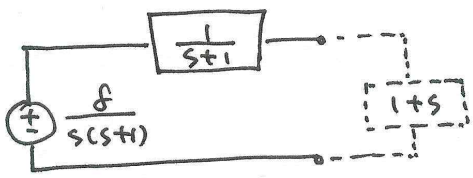
13-5
$F(s) = \frac{3(1 - e^{-2s})}{s}$

13-6
$i(t) = (1 - e^{-t})u(t)$

13-7

(a) $V_{oc}(s) = \dfrac{8}{s(s+1)}$

$Z_{th} = Z_{ab}(s) = \dfrac{1}{s+1}$



(b) $v_{ab}(t) = 4 - 4e^{-t}\cos t + 4e^{-t}\sin t = 4 + 4\sqrt{2}\,e^{-t}\cos(t - 135^\circ)$

13-8

$v(t) = 1.365e^{-6.571t} + 0.636e^{-0.715t}\cos 0.314t - 1.85e^{-0.715t}\sin 0.314t$

$= 1.365e^{-6.571t} + 1.956e^{-0.715t}\cos(0.314t - 23.7^\circ)$

13-9

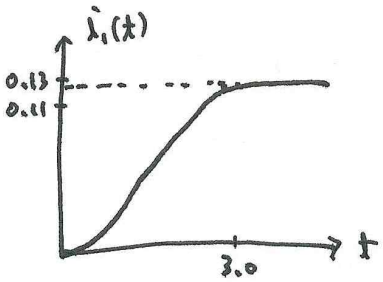
$\mathcal{L}^{-1}(V_c(s)) = v_c(t) = 10000e^{-5t}u(t)$

13-10

$I_x(t) = (\dfrac{5}{12}t - \dfrac{25}{18} + \dfrac{95}{36}e^{-\frac{3}{4}t})u(t)$

13-11

$I_1(t) = \dfrac{1}{8} - \dfrac{1}{8}e^{-4t} - \dfrac{1}{2}te^{-2t}$



13-12

$V_c(s) = \dfrac{3s + 18 + 3V_x(s)}{s^2 + 6s + 8}$

13-13

$$f(t)=\sum_{n\ odd}^{\infty}\frac{8V}{n^2\pi^2}\cos n\omega t=\frac{8V}{\pi^2}[\cos\omega t+\frac{1}{9}\cos 3\omega t+\frac{1}{25}\cos 5\omega t+....$$

13-14

$$f(t)=\frac{\pi^2}{3}+\sum_{n=1}^{\infty}[(-1)^n\frac{4}{n^2}\cos(nt)]$$

13-15

처음 4항으로 근사한 프리에급수는

$$f(t)=\frac{8\sqrt{2}}{\pi^2}[\sin(\frac{\pi t}{4})+\frac{1}{9}(\frac{3\pi t}{4})-\frac{1}{25}\sin(\frac{5\pi t}{4})-\frac{1}{49}\sin(\frac{7\pi t}{4})],\ f(2)=0.9965$$

13-16

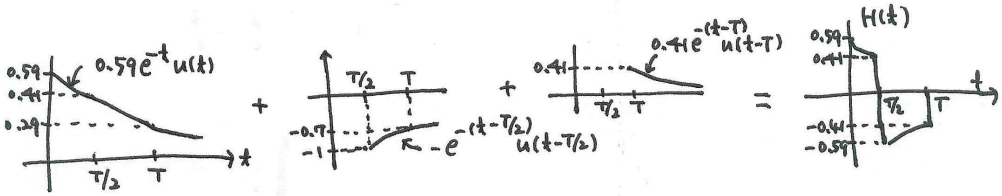
(a) $\mathcal{L}^{-1}(H(s))=h(t)=\frac{1}{3}[e^{-\frac{5}{12}t}\cos\frac{\sqrt{23}}{12}t+e^{-\frac{5}{12}t}\sin\frac{\sqrt{23}}{12}t]$

$$=\frac{\sqrt{2}}{3}e^{-0.417t}\sin(0.4t+45^\circ)$$

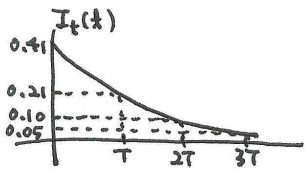
(b) $H(s)=\frac{2s+1}{6s^2+5s+2}$

13-17

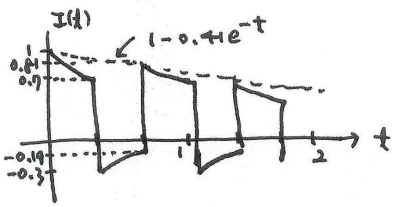
$H(t)=0.59e^{-t}u(t)-e^{-(t-0.35)}u(t-0.35)+0.41e^{-(t-0.69)}u(t-0.69)$



$I_t(t)=0.41e^{-t}$



I(t)= $I_t(t)+I_p(t)$



제14장 2-포트 회로망

14-1

$$y_{21}=\frac{I_2}{V_1}|_{V_2=0}=-\frac{1}{14}, y_{12}=\frac{I_1}{V_2}|_{V_1=0}=-\frac{1}{14},\ y_{22}=\frac{I_2}{V_2}|_{V_1=0}=\frac{5}{14}\mho,$$

$$y_{11}=\frac{I_1}{V_1}|_{V_2=0}=\frac{3}{14},\quad Y=\begin{bmatrix}\frac{3}{14} & -\frac{1}{14}\\ -\frac{1}{14} & \frac{5}{14}\end{bmatrix}$$

14-2

$$y_{11}=\frac{I_1}{V_1}=\frac{1}{R_1}+\frac{1+k}{R_2},\ y_{21}=\frac{-I_{R_2}}{V_1}=-\frac{1+k}{R_2},$$

$$y_{12}=\frac{I_1}{V_2}|_{V_1=0}=-\frac{1}{R_2},\ y_{22}=\frac{I_2}{V_2}=\frac{1}{R_2}+\frac{1}{R_3}$$

14-3

$$h_{12}=\frac{V_1}{V_2}|_{I_1=0}=\frac{Z_3}{Z_2+Z_3},\ h_{22}=\frac{I_2}{V_2}|_{I_1=0}=\frac{1}{Z_2+Z_3}$$

$$h_{11}=\frac{V_1}{I_1}=Z_1+\frac{Z_2Z_3}{Z_2+Z_3}\ ,\ h_{21}=\frac{I_2}{I_1}|_{V_2=0}=-\frac{Z_2}{Z_2+Z_3}$$

14-4

$$z_{11}=\frac{y_{22}}{|Y|}=\frac{y_{22}}{y_{11}y_{22}-y_{12}y_{21}}=4.44\Omega,\ z_{12}=z_{21}=\frac{-y_{12}}{|Y|}=2.22\Omega,\ z_{22}=\frac{y_{11}}{|Y|}=11.11\Omega$$

14-5

$$z_{11}=\frac{s+1}{s(s+2)}+\frac{s}{2}=z_{22}\ ,\ z_{12}=\frac{s+1}{s(s+2)}+\frac{s}{2}-\frac{1}{s+1}=z_{21}$$

14-6

$$y_{11}=\frac{s^2+2s}{s+1},\ y_{12}=-\frac{s}{s+1}=y_{21},\ y_{22}=\frac{3s^3+3s+1}{s(s+1)}$$

$Z=Y^{-1}$ 이므로, $z_{11}=\frac{y_{22}}{|Y|}=\frac{3s^2+3s+1}{s(3s^2+5s+2)}$, $z_{12}=z_{21}=\frac{-y_{12}}{|Y|}=\frac{s}{3s^2+5s+2}$,

$$z_{22}=\frac{y_{11}}{|Y|}=\frac{s^2+2s}{3s^2+5s+2}$$

14-7

$$h_{12}=\frac{V_1}{V_2}|_{I_1=0}=\frac{r_b}{r_b+r_c}\approx 1.6\times 10^{-3},\quad h_{22}=\frac{I_2}{V_2}|_{I_1=0}=\frac{1}{r_b+r_c}\approx 2\times 10^{-6}\mho.$$

$$h_{21} = \frac{I_2}{I_1}|_{V_2=0} = -[\frac{\alpha r_c + r_b}{r_b + r_c}] \approx -0.981$$

14-8

$$h_{11}(s) = \frac{2s^2+1}{s(s^2+1)},\ h_{12}(s) = \frac{s^2}{s^2+1},\quad h_{21}(s) = \frac{-s^2}{s^2+1},\quad h_{22}(s) = \frac{s}{s^2+1}$$

14-9

$$h_{11} = \frac{Z_1 Z_2}{Z_1+Z_2},\quad h_{22} = \frac{Z_1+(Z_2+Z_3)}{(Z_1+Z_2)Z_3}\ ,\ h_{12} = \frac{Z_1}{Z_1+Z_2},\ h_{21} = -\frac{Z_1}{Z_1+Z_2}$$

14-10

(a) $Z_{11} = Z_{22} = 1 + \frac{1}{s} = \frac{s+1}{s}$, $y_{11} = y_{22} = \frac{s+1}{s+1+1} = \frac{s+1}{s+2}$

$Z_{12} = Z_{21} = \frac{1}{s},\ y_{12} = -\frac{1}{s+2} = y_{21}$

(b) $Z_{11} = Z_{22} = \frac{s+1}{s},\ y_{11} = y_{22} = \frac{s+1}{s+2}$, $Z_{12} = -\frac{1}{s}$, $y_{12} = y_{21} = \frac{1}{s+2}$

14-11

$$A = \frac{V_2}{V_1} = \frac{Z_a Z_3 + Z_a Z_1 + \Delta Z}{Z_a Z_3 + \Delta Z} \quad \text{단, } \Delta Z = Z_1 Z_2 + Z_2 Z_3 + Z_1 Z_3$$

$$C = \frac{Z_1 + Z_a + Z_2}{Z_a Z_3 + \Delta Z},\ B = \frac{Z_a \Delta Z}{Z_a Z_3 + \Delta Z},\ D = \frac{Z_a(Z_2+Z_3) + \Delta Z}{Z_a Z_3 + \Delta Z}$$

14-12

$$y_{11} = \frac{Z_2+Z_3}{\Delta Z}, y_{22} = \frac{Z_1+Z_2}{\Delta Z},\ y_{12} = y_{21} = -\frac{Z_2}{\Delta Z}$$

14-13

$h_{11} = 2\mho.\ h_{21} = -0.8,\quad h_{12} = 0.8,\ h_{22} = 0.28\mho$

14-14

$y_{11} = G_1 + G_3,\ \mathrm{y}_{12} = \mathrm{y}_{21} = -\mathrm{G}_3,\ \mathrm{y}_{22} = \mathrm{G}_2 + \mathrm{G}_3$

$$Y = Y_1 + Y_2 = \begin{bmatrix} Cs + \frac{1}{Ls} + G_1 + G_3 & -(Cs+G_3) \\ -(Cs+G_3) & Cs + \frac{1}{Ls} + G_2 + G_3 \end{bmatrix}$$

14-15

$$Z = Z_1 + Z_2 = \begin{bmatrix} 2(sL + \frac{1}{Cs}) & sL + \frac{1}{Cs} \\ sL + \frac{1}{Cs} & 2(sL + \frac{1}{Cs}) \end{bmatrix}$$

14-16

$$z_{11} = \frac{1}{sC} + R + sL_1 \ , \quad z_{22} = R + s(L + L_2), \ z_{12} = sM = z_{21}$$

14-17

$$\frac{V_L}{V_1} = 90000$$

14-18

$$Z = \begin{bmatrix} R_1 + R_3 + s(L_1 + L_3 + 2M_1) & R_3 + s(L_3 - M_2 + M_1) \\ R_3 + s(L_3 - M_2 + M_1) & R_2 + R_3 + s(L_2 + L_3) \end{bmatrix}$$

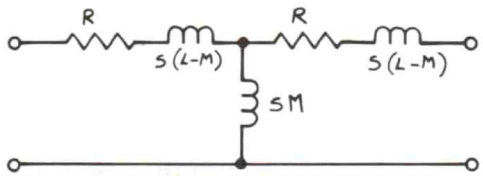
14-19

$$z_{12} = \frac{V_1}{I_2}|_{I_1 = 0} = \frac{Z_1 Z_2}{Z_a + Z_1 + Z_2} + Z_3, \ z_{22} = Z_2 - \frac{Z_2^2}{Z_a + Z_1 + Z_2} + Z_3,$$

$$z_{11} = Z_1 + Z_3 - \frac{Z_1^2}{Z_a + Z_2 + Z_1}, \ z_{21} = \frac{V_2}{I_1} = \frac{Z_1 Z_2}{Z_a + Z_2 + Z_1} + Z_3 = z_{12}$$

14-20

$$Z_1 = R + s(L - M), \ Z_2 = sM, \ Z_3 = R + s(L - M)$$



$$Z_5 = \frac{2RL}{M} + \frac{1}{s}\frac{R^2}{M} + s(\frac{L^2}{M} - M)$$

$$Z_4 = R + s(L + M) = Z_6$$

등가 Π형 회로는