2014년 국가직 7급 회로이론 A책형 해설

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1. **【정답】** ②

$$Z_{eq}=2+j2+\frac{1}{j2\times\frac{1}{4}}=2+j2+\frac{2}{j}=2+j2-j2=2\,[\Omega]$$

2. **【정답】** ①

$I(s)=\frac{s}{2s+s}\cdot\frac{3}{s^2}=\frac{1}{s^2}$ 이므로 역변환하면 $i(t)=t\,[\mathrm{A}]$

3. **【정답】** ①

교류 전압원의 실효값 $\frac{20}{\sqrt{2}}=10\sqrt{2}\,[\mathrm{V}]$ 이므로

저항 R에 전달되는 평균전력 $P=\frac{10^2}{5}+\frac{(10\sqrt{2})^2}{5}=20+40=60\,[\mathrm{W}]$

4. **【정답】** ③

$$Z(s)=\frac{\frac{2}{s}}{2+\frac{1}{s}}+2s=\frac{2}{2s+1}+2s=\frac{2+2s(2s+1)}{2s+1}=\frac{4s^2+2s+2}{2s+1}$$

극점 $p=-\frac{1}{2}$

$4s^2+2s+2=0,\ 2s^2+s+1=0$

$$s=\frac{-1\pm\sqrt{1^2-4\cdot2\cdot1}}{4}=-\frac{1}{4}\pm j\frac{\sqrt{7}}{4}$$

영점 $z_1,\ z_2=-\frac{1}{4}\pm j\frac{\sqrt{7}}{4}$

5. **【정답】** ②

$$I(s)=\frac{20}{20+30+\frac{1}{10^{-4}s}}\frac{7.5}{s}=\frac{2\times10^{-3}s}{5\times10^{-3}s+1}\frac{7.5}{s}$$

$I(s)=\dfrac{15\times10^{-3}}{5\times10^{-3}s+1}=\dfrac{3}{s+200}$ 이므로 역변환하면 $i(t)=3e^{-200t}\,[\mathrm{mA}]$

6. **【정답】** ②

$$\frac{V_i-0}{\dfrac{1}{0.005\times10^{-6}s}}=\frac{0-V_o}{20\times10^3}$$

$5\times10^{-9}s\,V_i=-5\times10^{-5}V_o,\;\; V_o=-10^{-4}s\,V_i$

역변환하면 $v_i(t)=-10^{-4}\dfrac{dv_i}{dt}$

$0\sim1\,\mu s$에서 $\dfrac{dv_i}{dt}=\dfrac{0.1}{10^{-6}}=10^5\,[\mathrm{V/s}]$ 이므로 $v_i(t)=-10\,[\mathrm{V}]$ 이다.

$1\sim3\,\mu s$에서 $\dfrac{dv_i}{dt}=-\dfrac{0.1}{10^{-6}}=-10^5\,[\mathrm{V/s}]$ 이므로 $v_i(t)=10\,[\mathrm{V}]$ 이다.

따라서 보기 중 가장 적절한 그래프는 ②번이다.

7. **【정답】** ②

2차측 부하저항 $10\,[\Omega]$에 최대전력을 전달해야하므로 1차측의 임피던스는 태브냉 등가저항인 $Z_1=R_{\mathrm{Th}}=1\,[\mathrm{k}\Omega]$ 이다.

$\dfrac{Z_1}{Z_2}=\left(\dfrac{n_1}{n_2}\right)^2$ 에서 $\dfrac{n_1}{n_2}=\sqrt{\dfrac{10^3}{10}}=10,\;\; n_1:n_2=10:1$

$\dfrac{v_1}{n_1}=\dfrac{v_2}{n_2}$ 에서 $v_1=\dfrac{v_i}{2}$ 이므로 부하에서 소비되는 전력

$$P=\frac{v_2^2}{10}=\frac{\left(\dfrac{n_2}{n_1}v_1\right)^2}{10}=\left(\frac{n_2}{n_1}\right)^2\frac{\left(\dfrac{v_i}{2}\right)^2}{10}=\frac{1}{10^2}\frac{v_i^2}{40}=\frac{v_i^2}{4000}$$ 이다.

8. **【정답】** ③

$$H(s)=\frac{V_o(s)}{V_i(s)}=\frac{\dfrac{\dfrac{8}{s}}{4+\dfrac{2}{s}}}{2s+\dfrac{\dfrac{8}{s}}{4+\dfrac{2}{s}}}=\frac{\dfrac{8}{s}}{2s\left(4+\dfrac{2}{s}\right)+\dfrac{8}{s}}=\frac{8}{2s(4s+2)+8}=\frac{8}{8s^2+4s+8}$$

$$H(s)=\frac{2}{2s^2+s+2}$$

9. **【정답】** ②

$v_i(t)=u(t-1)+u(t-2)-2u(t-3)$

$$V_i(s)=\frac{1}{s}e^{-s}+\frac{1}{s}e^{-2s}-\frac{2}{s}e^{-3s}=\frac{1}{s}\left(e^{-s}+e^{-2s}-2e^{-3s}\right)$$

$$I(s)=\frac{V_i(s)}{1+s}=\frac{1}{s(s+1)}\left(e^{-s}+e^{-2s}-2e^{-3s}\right)$$

$$I(s)=\left(\frac{1}{s}-\frac{1}{s+1}\right)\left(e^{-s}+e^{-2s}-2e^{-3s}\right)$$

10. **【정답】** ④

먼저 $0\le t<0.25\,[\mathrm{s}]$에서 $\frac{L}{R}=\frac{1+1}{1+1}=1$이므로

$i(t)=10+(0-10)e^{-t}=10\left(1-e^{-t}\right)$이다.

스위치를 b에 연결하면 b의 전위는 $10[\mathrm{V}]$이므로 폐회로에 키르히호프 법칙을 적용하면

$$10-i(t)-\frac{di}{dt}-3i(t)=0,\ \frac{di}{dt}+4i(t)=10$$

$i(0.25)=10\left(1-e^{-0.25}\right),\ i(\infty)=0$이므로 $i(t)=0+10\left(1-e^{-0.25}\right)e^{-4(t-0.25)}$

$i(t)=10e\left(1-e^{-0.25}\right)e^{-4t}=10\left(e-e^{0.75}\right)e^{-4t}$

11. **【정답】** ①

도트가 같은 방향이므로

$v_1=L\frac{di_1}{dt}+M\frac{di_2}{dt},\ v_2=L_2\frac{di_2}{dt}+M\frac{di_i}{dt}$이다.

12. **【정답】** ③

$$Z=10+j\left(2\pi\times50\times\frac{1}{10\pi}\right)=10+j10$$

따라서 역률(power factor) $\frac{10}{10\sqrt{2}}=\frac{1}{\sqrt{2}}=\frac{\sqrt{2}}{2}$

13. 【정답】 ④

$$Z_{11}=\left.\frac{V_1}{I_1}\right|_{I_2=0}=\frac{4I_1}{I_1}=4,\ Z_{12}=\left.\frac{V_1}{I_2}\right|_{I_1=0}=\frac{I_2}{I_2}=1$$

$$Z_{21}=\left.\frac{V_2}{I_1}\right|_{I_2=0}=\frac{I_1}{I_1}=1,\ Z_{22}=\left.\frac{V_2}{I_2}\right|_{I_1=0}=\frac{(s+1)I_2}{I_2}=s+1$$

$$\begin{bmatrix}V_1\\V_2\end{bmatrix}=\begin{bmatrix}4 & 1\\1 & s+1\end{bmatrix}\begin{bmatrix}I_1\\I_2\end{bmatrix}$$

14. 【정답】 ③

$$\frac{V_o(s)}{V_i(s)}=\frac{10}{\frac{1}{sC}+sL+10}=\frac{10Cs}{LCs^2+10Cs+1}=\frac{\frac{10}{L}s}{s^2+\frac{10}{L}s+\frac{1}{LC}}$$

$$\frac{10}{L}=5,\ \frac{1}{LC}=10$$

$$L=2,\ C=\frac{1}{20}=0.05$$

15. 【정답】 ③

입력의 라플라스 변환 : $\frac{1}{s}$

출력의 라플라스 변환 : $10\frac{s}{s^2+2^2}=\frac{10s}{s^2+4}$

$$H(s)=\frac{\frac{10s}{s^2+4}}{\frac{1}{s}}=\frac{10s^2}{s^2+4}$$

16. 【정답】 ①

$$R_n=R_{\mathrm{Th}}=4\parallel(7+5)=\frac{4\times12}{4+12}=3\,[\Omega]$$

$$2=\frac{7I_{sc}-10}{5}+I_{sc},\ 12I_{sc}=20,\ I_{sc}=\frac{20}{12}=\frac{5}{3}\,[\mathrm{A}]$$

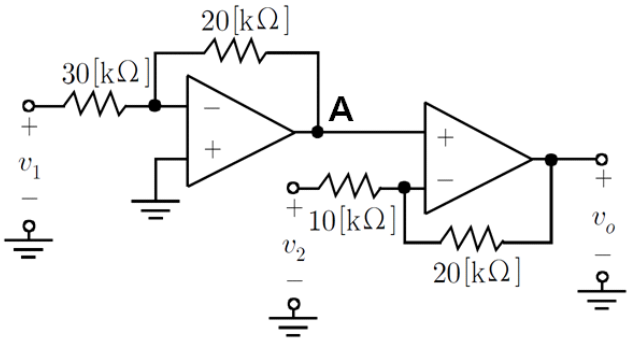
17. 【정답】 ④

$V = \frac{2}{\sqrt{2}} \angle \frac{\pi}{6} = \sqrt{2} \angle \frac{\pi}{6}$ 이다.

$$I = \frac{\sqrt{2} \angle \frac{\pi}{6}}{2 + j2} = \frac{\sqrt{2} \angle \frac{\pi}{6}}{2\sqrt{2} \angle \frac{\pi}{4}} = \frac{1}{2} \angle \left(\frac{\pi}{6} - \frac{\pi}{4} \right) = \frac{1}{2} \angle -\frac{\pi}{12}$$

따라서 $i(t) = \frac{\sqrt{2}}{2} \sin\left(2t - \frac{\pi}{12}\right) = \frac{1}{\sqrt{2}} \sin\left(2t - \frac{\pi}{12}\right)$

18. 【정답】 ③

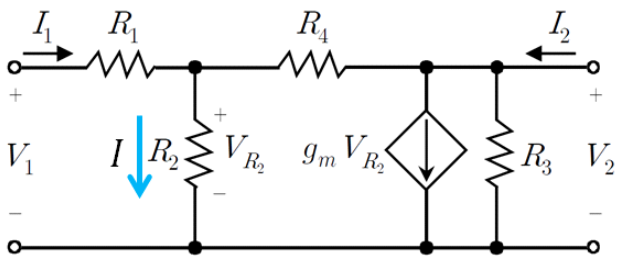


$$\frac{v_1 - 0}{30} = \frac{0 - v_A}{20}, \quad v_A = -\frac{2}{3} v_1$$

$$\frac{v_A - v_2}{10} = \frac{v_o - v_A}{20}, \quad v_o = 2(v_A - v_2) + v_A$$

$$v_o = 2\left(-\frac{2}{3} v_1 - v_2\right) - \frac{2}{3} v_1 = -2v_1 - 2v_2$$

19. 【정답】 ④



$V_{R_2} = IR_2$이고, 저항 R_3에 흐르는 전류를 I_3라 하면

$$I_2 = I_3 + I + g_m V_{R_2} = I_3 + I + g_m R_2 I = I_3 + (g_m R_2 + 1) I$$

$I_3 = \frac{V_2}{R_3}$이고 $V_2 = I(R_2 + R_4)$이므로

$$h_{22}=\left.\frac{I_2}{V_2}\right|_{I_1=0}=\frac{I_3+(g_mR_2+1)I}{V_2}=\frac{1}{R_3}+\frac{(g_mR_2+1)I}{i(R_2+R_4)}=\frac{1}{R_3}+\frac{g_mR_2+1}{R_2+R_4}$$

20. 【정답】 ②

$$Z(j\omega)=2+\frac{j2\left(1+\frac{1}{j}\right)}{j2+1+\frac{1}{j}}=2+\frac{j2(1-j)}{1+j}=2+j(1-j)^2=4$$

$$P=\frac{\left(\frac{4}{\sqrt{2}}\right)^2}{4}=2\,[\mathrm{W}]$$