

[IT CookBook] 기초 신호 및 시스템

: 개념과 원리가 한눈에 보이는 200여 개의 풍부한 예제

[연습문제 답안 이용 안내]

- 본 연습문제 답안의 저작권은 한빛아카데미(주)에 있습니다.
- 이 자료를 무단으로 전제하거나 배포할 경우 저작권법 136조에 의거하여 최고 5년 이하의 징역 또는 5천만원 이하의 벌금에 처할 수 있고 이를 병과(併科)할 수도 있습니다.

Chapter 05 연속 시간 푸리에 급수

[Quick Review]

- [1] Ans) 변환
- [2] Ans) \times
- [3] Ans) 일대일
- [4] Ans) \bigcirc
- [5] Ans) 주파수
- [6] Ans) \times
- [7] Ans) 기본파
- [8] Ans) \bigcirc
- [9] Ans) \times
- [10] Ans) 선
- [11] Ans) \times
- [12] Ans) 빠르다
- [13] Ans) 없다
- [14] Ans) \times
- [15] Ans) \bigcirc
- [16] Ans) 직류
- [17] Ans) \times

[18] Ans) 3θ

[19] Ans) ○

[20] Ans) ×

[기초 문제]

5.1

Ans)

$$(a) \quad x(t) = \frac{1}{2}e^{j\pi}e^{-j5\pi t} + \frac{1}{2}e^{-j3\pi t} + e^{j\frac{\pi}{2}}e^{-j\pi t} + e^{-j\frac{\pi}{2}}e^{j\pi t} + \frac{1}{2}e^{j3\pi t} + \frac{1}{2}e^{-j\pi}e^{j5\pi t}$$

기본주파수 $\omega_0 = \pi$, 기본파($|X_1| = 1$, $\phi_1 = -\frac{\pi}{2}$), 3고조파($|X_3| = \frac{1}{2}$, $\phi_3 = 0$), 5고조파($|X_5| = \frac{1}{2}$, $\phi_5 = -\pi$),

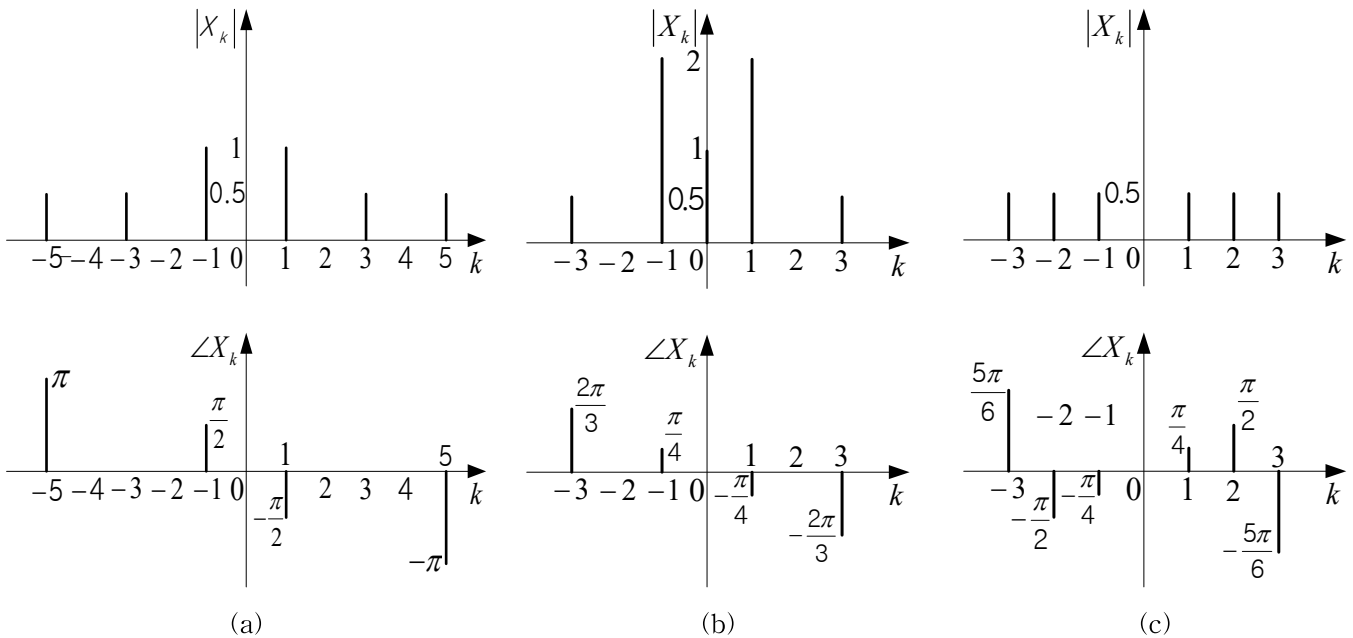
$$(b) \quad x(t) = \frac{1}{2}e^{j\frac{2\pi}{3}}e^{-j3\pi t} + 2e^{j\frac{\pi}{4}}e^{-j\pi t} + 1 + 2e^{-j\frac{\pi}{4}}e^{j\pi t} + \frac{1}{2}e^{-j\frac{2\pi}{3}}e^{j3\pi t}$$

기본주파수 $\omega_0 = \pi$, DC($X_0 = 1$), 기본파($|X_1| = 2$, $\phi_1 = -\frac{\pi}{4}$), 3고조파($|X_3| = \frac{1}{2}$, $\phi_3 = -\frac{2\pi}{3}$)

$$(c) \quad x(t) = \frac{1}{2}e^{j\frac{5\pi}{6}}e^{-j6\pi t} + \frac{1}{2}e^{-j\frac{\pi}{2}}e^{-j4\pi t} + \frac{1}{2}e^{-j\frac{\pi}{4}}e^{-j2\pi t} + \frac{1}{2}e^{j\frac{\pi}{4}}e^{j2\pi t} + \frac{1}{2}e^{j\frac{\pi}{2}}e^{j4\pi t} + \frac{1}{2}e^{-j\frac{5\pi}{6}}e^{j6\pi t}$$

기본주파수 $\omega_0 = 2\pi$, 기본파($|X_1| = \frac{1}{2}$, $\phi_1 = \frac{\pi}{4}$), 2고조파($|X_2| = \frac{1}{2}$, $\phi_2 = \frac{\pi}{2}$),

3고조파($|X_3| = \frac{1}{2}$, $\phi_3 = -\frac{5\pi}{6}$)



5.2

Ans) $a_0 = \frac{1}{T} \int_T x(t) dt$

$$a_k = \frac{2}{T} \int_T x(t) \cos k \omega_0 t \, dt$$

$$b_k = \frac{2}{T} \int_T x(t) \sin k \omega_0 t \, dt$$

5.3

Ans)

$$(a) \, x(t) = 3 + 4 \cos\left(\pi t - \frac{\pi}{3}\right) + 2 \cos\left(3\pi t - \frac{\pi}{2}\right)$$

$$(b) \, x(t) = 2 + 2\sqrt{2} \cos\left(2\pi t + \frac{\pi}{4}\right) + 2 \cos\left(4\pi t + \frac{\pi}{2}\right)$$

5.4

Ans)

$$(a) \, x(t) = 1 + 4 \cos\left(\pi t - \frac{\pi}{6}\right) - 2 \cos(2\pi t) + 4 \cos\left(3\pi t - \frac{3\pi}{4}\right)$$

$$(b) \, x(t) = 2 + 4 \cos\left(2\pi t - \frac{\pi}{4}\right) + 2 \cos\left(4\pi t + \frac{\pi}{3}\right) + 2 \sin(6\pi t)$$

5.5

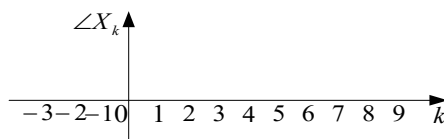
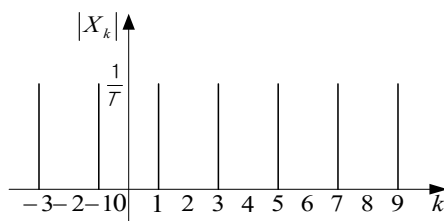
Ans)

$$(a) \, x(t) = \sum_{k=-\infty}^{\infty} X_k e^{jk\omega_0 t} = \sum_{k=-\infty}^{\infty} \frac{1}{2T} (1 - e^{-jk\pi}) e^{jk\omega_0 t}$$

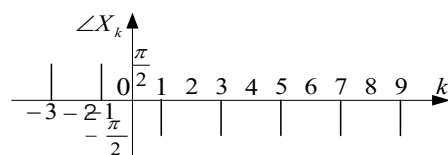
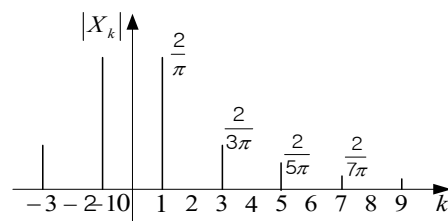
$$X_k = \frac{1}{2T} (1 - e^{-jk\pi})$$

$$(b) \, x(t) = \sum_{k=-\infty}^{\infty} X_k e^{jk\omega_0 t} = \sum_{k=\text{홀수}} -j \frac{2}{k\pi} e^{jk\omega_0 t}$$

$$X_k = \begin{cases} -j \frac{2}{k\pi}, & k = \text{홀수} \\ 0, & k = \text{짝수} \end{cases}$$



(a)



(b)

5.6

Ans)

$$(a) X_k = \begin{cases} j\frac{3}{k\pi}, & k = 1, 3, 5 \dots \\ j\frac{6}{k\pi}, & k = 2, 6, 10 \dots \\ 0, & k = 4, 8, 12, \dots \end{cases}$$

$$X_0 = 0$$

$$(b) X_k = j\frac{1}{2k\pi} \left(-e^{-jk\frac{3}{2}\pi} - e^{-jk\pi} + 2e^{j2k\pi} \right)$$

$$X_0 = \frac{3}{4}$$

$$(c) X_k = j\frac{e^{-jk\pi}}{k\pi} + \frac{e^{-jk\pi}}{k^2\pi^2} - \frac{1}{k^2\pi^2}$$

$$X_0 = \frac{1}{2}$$

5.7

Ans)

$$(a) Y_k = \frac{2}{(1 - 4k^2)\pi}$$

$$(b) X_k = \begin{cases} -j\frac{1}{4}, & k = 1 \\ \frac{1}{(1 - k^2)\pi}, & k = \text{짝수} \\ 0, & k = \text{홀수}, k \neq 1 \end{cases}$$

$$y(t) = \sum_{k=-\infty}^{\infty} Y_k e^{j4\pi kt} = \sum_{k=-\infty}^{\infty} (1 + (-1)^k) X_k e^{j2\pi kt} = \sum_{k=-\infty}^{\infty} \frac{2}{(1 - 4k^2)\pi} e^{j4\pi kt}$$

5.8

Ans)

$$(a) s(t) = \sum_{k=\text{홀수}} \frac{4}{k^2\pi^2} e^{j\frac{k\pi}{2}t}$$

$$S_k = e^{jk\frac{\pi}{2}} X_k = j^k X_k = \begin{cases} \frac{4}{k^2\pi^2}, & k = \text{홀수} \\ 0, & k = \text{짝수} \end{cases}$$

$$(b) y(t) = \sum_{k=\text{홀수}} \frac{4}{k^2\pi^2} e^{j\frac{k\pi}{4}t}$$

$$Y_k = \begin{cases} \frac{4}{k^2\pi^2}, & k = \text{홀수} \\ 0, & k = \text{짝수} \end{cases}$$

5.9

Ans)

(a) $V_k = e^{-jk\omega_0} X_k$

(b) $V_k = X_{k-1}$

5.10

Ans) $P = 280$

[응용 문제]

5.11

Ans)

$$(a) \quad x(t) = \frac{1}{2}e^{j\frac{\pi}{6}}e^{-j3t} + e^{j\pi}e^{-j2t} + 2e^{j\frac{3\pi}{4}}e^{-jt} + 1 + 2e^{-j\frac{3\pi}{4}}e^{jt} + e^{-j\pi}e^{j2t} + \frac{1}{2}e^{-j\frac{\pi}{6}}e^{j3t}$$

기본주파수 $\omega_0 = 1$, DC($X_0 = 1$), 기본파($|X_1| = 2$, $\phi_1 = -\frac{3\pi}{4}$), 2고조파($|X_2| = 1$, $\phi_2 = -\pi$),

3고조파($|X_3| = \frac{1}{2}$, $\phi_3 = -\frac{\pi}{6}$)

$$(b) \quad x(t) = \frac{1}{4}e^{j\frac{2\pi}{3}}e^{-j5t} + \frac{1}{2}e^{j\frac{\pi}{2}}e^{-j3t} + e^{j\frac{\pi}{6}}e^{-j2t} + 3 + e^{-j\frac{\pi}{6}}e^{j2t} + \frac{1}{2}e^{-j\frac{\pi}{2}}e^{j3t} + \frac{1}{4}e^{-j\frac{2\pi}{3}}e^{j5t}$$

기본주파수 $\omega_0 = 1$, DC($X_0 = 3$), 2고조파($|X_2| = 1$, $\phi_2 = -\frac{\pi}{6}$), 3고조파($|X_3| = \frac{1}{2}$, $\phi_3 = -\frac{\pi}{2}$),

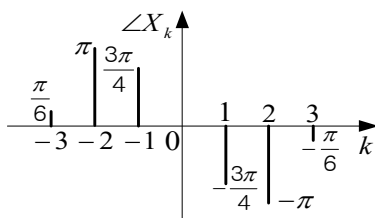
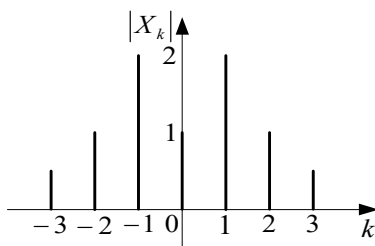
5고조파($|X_5| = \frac{1}{4}$, $\phi_5 = -\frac{2\pi}{3}$)

$$(c) \quad x(t) = \frac{1}{4}e^{j\frac{\pi}{2}}e^{-j8t} + \frac{1}{4}e^{-j\frac{\pi}{2}}e^{-j2t} + \frac{1}{4}e^{j\frac{\pi}{2}}e^{j2t} + \frac{1}{4}e^{-j\frac{\pi}{2}}e^{j8t}$$

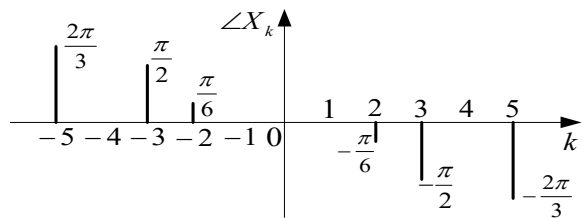
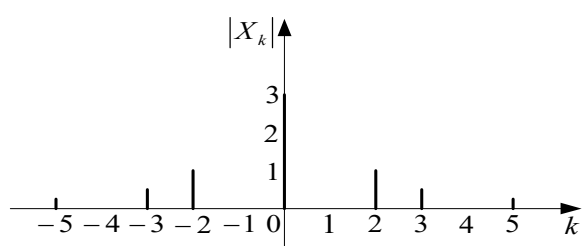
기본주파수 $\omega_0 = 2$, 기본파($|X_1| = \frac{1}{4}$, $\phi_1 = \frac{\pi}{2}$), 4고조파($|X_4| = \frac{1}{4}$, $\phi_4 = -\frac{\pi}{2}$)

$$(d) \quad x(t) = \frac{1}{8}e^{-j3\pi t} + \frac{3}{8}e^{-j\pi t} + \frac{3}{8}e^{j\pi t} + \frac{1}{8}e^{j3\pi t}$$

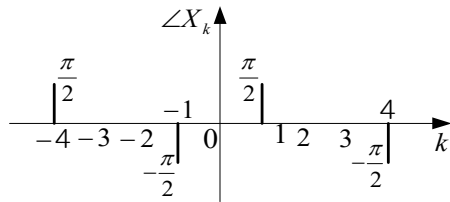
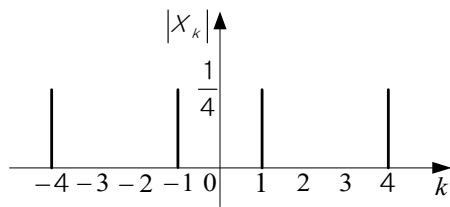
기본주파수 $\omega_0 = \pi$, 기본파($|X_1| = \frac{3}{8}$, $\phi_1 = 0$), 3고조파($|X_3| = \frac{1}{8}$, $\phi_3 = 0$)



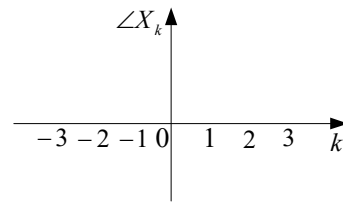
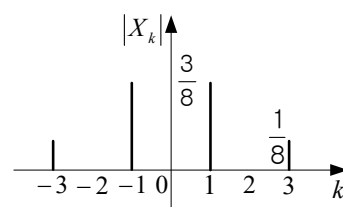
(a)



(b)



(c)



(d)

5.12

Ans)

$$(a) \quad V_k = j k \omega_0 X_k$$

$$(b) \quad V_k = \frac{1}{2} (X_{k+1} + X_{k-1})$$

5.13

Ans)

$$(a) \quad x(t) = \sum_{k=-\infty}^{\infty} X_k e^{j k \omega_0 t} = \sum_{k=-\infty}^{\infty} X_k e^{j k \frac{\pi}{3} t}$$

$$X_k = -j \frac{1}{k\pi} - \frac{3}{k^2 \pi^2} e^{-j k \frac{\pi}{3}} (e^{-j k \frac{\pi}{3}} - 1)$$

$$(b) \quad x(t) = \sum_{k=-\infty}^{\infty} X_k e^{j k \omega_0 t} = \sum_{k \neq 0, k=-\infty}^{\infty} j \frac{1}{k\pi} e^{j k \pi t}$$

$$X_k = j \frac{1}{\pi k}, \quad X_0 = 0$$

5.14

$$\text{Ans) } x(t) = \sum_{k=-\infty}^{\infty} X_k e^{j k \omega_0 t} = \sum_{k=-\infty}^{\infty} X_k e^{j k \frac{\pi}{2} t}$$

$$X_k = \begin{cases} j \frac{1}{4} = \frac{1}{4} e^{j \frac{\pi}{2}}, & k = -2 \\ -j \frac{1}{4} = \frac{1}{4} e^{-j \frac{\pi}{2}}, & k = 2 \\ 0, & k = \text{짝수} (\neq \pm 2) \\ \frac{2}{(4 - k^2)\pi}, & k = \text{홀수} \end{cases}$$

5.15

Ans)

$$(a) \ x(t) = \sum_{k=-\infty}^{\infty} X_k e^{jk\omega_0 t} = \sum_{k=-\infty}^{\infty} X_k e^{jk2\pi t}$$

$$X_k = \begin{cases} -j\frac{10}{k\pi}, & k = \text{홀수} \\ 0, & k = \text{짝수} \end{cases}$$

$$(b) \ P = 25$$