

Chapter 1 Answers

- 1.1. Converting from polar to Cartesian coordinates:
 $z = 1 + j \cos \pi = -1$, $e^{j\pi} = \cos \pi + j \sin \pi = -1$
 $z = 1 + j \cos \frac{\pi}{3} = 1 + j$, $e^{j\frac{\pi}{3}} = \cos \frac{\pi}{3} + j \sin \frac{\pi}{3} = \frac{1}{2} + j\frac{\sqrt{3}}{2}$
 $z = 1 + j \cos \frac{\pi}{4} = 1 + j$, $e^{j\frac{\pi}{4}} = \cos \frac{\pi}{4} + j \sin \frac{\pi}{4} = \frac{\sqrt{2}}{2} + j\frac{\sqrt{2}}{2}$
 $z = 1 + j \cos \frac{\pi}{6} = 1 + j$, $e^{j\frac{\pi}{6}} = \cos \frac{\pi}{6} + j \sin \frac{\pi}{6} = \frac{\sqrt{3}}{2} + j\frac{1}{2}$
- 1.2. Converting from Cartesian to polar coordinates:
 $z = 1 + j$, $r = \sqrt{2}$, $\theta = \frac{\pi}{4}$
 $z = 1 + j\sqrt{3}$, $r = 2$, $\theta = \frac{\pi}{3}$
 $z = 1 + j$, $r = \sqrt{2}$, $\theta = \frac{\pi}{4}$
- 1.3. (a) $x_m = \int_{-\infty}^{\infty} x(t) \delta(t - m) dt = x(m)$.
 (b) $x(t) = e^{j\pi t}$, $|x(t)| = 1$. Therefore, $X_m = \int_{-\infty}^{\infty} |x(t)|^2 dt = \int_{-\infty}^{\infty} 1 dt = \infty$.
 $X_m = \int_{-\infty}^{\infty} e^{j\pi t} \delta(t - m) dt = e^{j\pi m} = 1$.
 (c) $x(t) = \cos(2t)$. Therefore, $X_m = \int_{-\infty}^{\infty} \cos(2t) \delta(t - m) dt = \cos(2m)$.
 $X_m = \int_{-\infty}^{\infty} \frac{1}{2} [e^{j2t} + e^{-j2t}] \delta(t - m) dt = \frac{1}{2} [e^{j2m} + e^{-j2m}] = \cos(2m)$.
 (d) $x(t) = (t^2 - 1) \cos(t)$. Therefore, $X_m = \int_{-\infty}^{\infty} (t^2 - 1) \cos(t) \delta(t - m) dt = (m^2 - 1) \cos(m)$.
 (e) $x(t) = e^{-t^2}$, $|x(t)| = 1$. Therefore, $X_m = \int_{-\infty}^{\infty} e^{-t^2} \delta(t - m) dt = e^{-m^2}$.
 $X_m = \int_{-\infty}^{\infty} \frac{1}{\sqrt{\pi}} e^{-t^2} \delta(t - m) dt = \frac{1}{\sqrt{\pi}} e^{-m^2}$.
 (f) $x(t) = \cos(t)$. Therefore, $X_m = \int_{-\infty}^{\infty} \cos(t) \delta(t - m) dt = \cos(m)$.
 $X_m = \int_{-\infty}^{\infty} \frac{1}{2} [e^{jt} + e^{-jt}] \delta(t - m) dt = \frac{1}{2} [e^{jm} + e^{-jm}] = \cos(m)$.
- 1.4. (a) The signal $x(t)$ is shifted by 3 to the right. The shifted signal will be zero for $t < -3$ and $t > 1$.
 (b) The signal $x(t)$ is shifted by 4 to the left. The shifted signal will be zero for $t < -4$ and $t > 1$.

- 1.5. (a) $\Re\{x(t)\} = -2 + 3e^{j\pi t} \cos(2t + \pi)$
 (b) $\Re\{x(t)\} = \sqrt{2} \cos(\frac{\pi}{4}) \cos(2t) = \sqrt{2} \cos(2t)$
 (c) $\Re\{x(t)\} = e^{-t} \cos(2t + \pi) = -e^{-t} \cos(2t)$
 (d) $\Re\{x(t)\} = e^{-t} \cos(200t + \pi) = -e^{-t} \cos(200t)$
- 1.6. (a) $x(t)$ is a periodic complex exponential.
 $x(t) = e^{j\pi t} - e^{j2\pi t}$
 The fundamental period of $x(t)$ is $\frac{2}{\pi}$.
 (b) $x(t)$ is a complex exponential multiplied by a decaying exponential. Therefore, $x(t)$ is not periodic.
 (c) $x(t)$ is a periodic signal.
 $x(t) = e^{j\pi t} - e^{j2\pi t}$
 $x(t)$ is a complex exponential with a fundamental period of $\frac{2}{\pi}$.
 (d) $x(t)$ is a periodic signal. The fundamental period is given by $T = \frac{2\pi}{\omega} = \frac{2\pi}{\pi} = 2$.
 By choosing $n = 3$, we obtain the fundamental period to be 6.
 (e) $x(t)$ is not periodic. $x(t)$ is a complex exponential with $\omega = 1/\pi$. The reason that $x(t)$ is not periodic is that $\omega(\frac{2\pi}{\omega})$ is not an integer. Therefore, $x(t)$ is not periodic.

1.7. $x(t) = \cos(3t) - 1 - \cos(2t) = 2$

Period of first term is $2\pi/3 = \frac{2}{3}$.
 Period of second term is $2\pi/2 = \pi = 2$.
 Therefore, the overall signal is periodic with a period which is the least common multiple of the periods of the first and second terms. This is equal to 6.

1.8. $x(t) = 1 + e^{j\pi t} - e^{j2\pi t}$

Period of the first term in the sum is $2\pi/\omega = 2$ (when $\omega = \pi$).
 Period of the second term in the sum is $2\pi/\omega = 1$ (when $\omega = 2\pi$).
 Therefore, the overall signal $x(t)$ is periodic with a period which is the least common multiple of the periods of the three terms in $x(t)$. This is equal to 6.

1.9. The signal $x(t)$ is as shown in Figure 1.12. $x(t)$ can be obtained by flipping $x(t)$ and then adding the flipped signal to $x(t)$ to the right. Therefore, $x(t) = x(-t) + x(t)$. This means that $M = -1$ and $n = -1$.

- (a) The signal $x(t)$ is flipped. The flipped signal will be zero for $t < -4$ and $t > 2$.
 (b) The signal $x(t)$ is flipped and the flipped signal is shifted by 2 to the right. This new signal will be zero for $t < -2$ and $t > 4$.
 (c) The signal $x(t)$ is flipped and the flipped signal is shifted by 2 to the left. This new signal will be zero for $t < -6$ and $t > 0$.
 1.10. (a) $x(t) = 0$ is obtained by flipping $x(t)$ and shifting the flipped signal by 1 to the right. Therefore, $x(t) = x(-t) + x(t)$ will be zero for $t > -1$.
 (b) From (a), we know that $x(t) = 0$ is not true for $t > -1$. Similarly, $x(t) = 0$ is not true for $t > -1$. Therefore, $x(t) = 0$ will be zero for $t > -1$.
 (c) $x(t)$ is obtained by flipping $x(t)$ by a factor of 4. Therefore, $x(t)$ will be zero for $t < 3$.
 (d) $x(t)$ is obtained by linearly compressing $x(t)$ by a factor of 2. Therefore, $x(t)$ will be zero for $t < 3$.
 1.11. (a) $x(t)$ is not periodic because it is zero for $t < 0$.
 (b) $x(t) = 1$ for all t . Therefore, it is periodic with a fundamental period of 1.
 (c) $x(t)$ is as shown in the Figure 1.14.

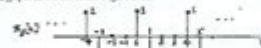


Figure 1.14

- Therefore, it is periodic with a fundamental period of 1.
 1.12. (a) $x(t) = x(t) - \frac{1}{2} [x(t) + x(-t)] = \frac{1}{2} [x(t) - x(-t) - x(-t) + x(t) - x(t) + x(-t)]$
 Therefore, $x(t) = x(t)$ is zero for $t > 0$.
 (b) Since $x(t)$ is an odd signal, $x(t) = x(-t)$ is zero for all values of t .
 (c) $x(t) = x(t) = \frac{1}{2} [x(t) + x(-t)] = \frac{1}{2} [x(t) + x(-t) - x(-t) + x(t) - x(t) + x(-t)]$
 Therefore, $x(t) = x(t)$ is zero when $|t| < 1$ and when $|t| = \infty$.
 (d) $x(t) = x(t) = \frac{1}{2} [x(t) + x(-t)] = \frac{1}{2} [x(t) + x(-t) - x(-t) + x(t) - x(t) + x(-t)]$
 Therefore, $x(t) = x(t)$ is zero only when $|t| = \infty$.



Figure 1.15

- 1.13. $x(t) = \int_{-\infty}^{\infty} x(\tau) \delta(\tau - t) dt = \int_{-\infty}^{\infty} (\tau + 2) \delta(\tau - t) dt = \begin{cases} t, & t < -2 \\ 2, & -2 \leq t \leq 2 \\ 0, & t > 2 \end{cases}$
 Therefore,
 $X_m = \int_{-\infty}^{\infty} x(t) \delta(t - m) dt = 4$

- 1.14. The signal $x(t)$ and the function $g(t)$ are shown in Figure 1.16.

Therefore,
 $g(t) = 5 \sum_{k=0}^{\infty} \delta(t - 2k) - 1 \sum_{k=0}^{\infty} \delta(t - 2k - 1)$

This implies that $A_0 = 5$, $A_1 = 0$, $A_2 = -1$, and $A_3 = 1$.
 1.15. (a) The signal $x(t)$, which is the input to S , is the same as $y(t)$. Therefore,
 $x(t) = y(t) = x(t) + \frac{1}{2} [x(t) - x(-t)]$
 $= x(t) - \frac{1}{2} [x(t) - x(-t)]$
 $= \frac{1}{2} [x(t) + x(-t)] + \frac{1}{2} [x(t) - x(-t)] = x(t)$
 The input-output relationship for S is
 $y(t) = 2[x(t) - x(-t)] + x(t) = 3x(t) - x(-t)$

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