Solution to Assignment 1

Problem 1: Sketch the following CT signals as function of the independent variable $t$ over the specified range.

i) $x_1(t) = \cos\left(\frac{3\pi t}{4} + \frac{\pi}{8}\right)$ for $(-1 \leq t \leq 2)$

ii) $x_2(t) = \sin\left(-\frac{3\pi t}{8} + \frac{\pi}{2}\right)$ for $(-1 \leq t \leq 2)$ (added)

iii) $x_3(t) = 5t + 3e^{-t}$ for $(-2 \leq t \leq 2)$

iv) $x_4(t) = \left(\sin\left(\frac{3\pi t}{4} + \frac{\pi}{8}\right)\right)^2$ for $(-1 \leq t \leq 2)$ (added)

v) $x_5(t) = \cos\left(\frac{3\pi t}{4}\right) + \sin\left(\frac{\pi t}{2}\right)$ for $(-2 \leq t \leq 3)$

vi) $x_6(t) = t \exp(-2t)$ for $(-2 \leq t \leq 3)$

vii) $x_7[k] = \cos\left(\frac{3\pi k}{4} + \frac{\pi}{8}\right)$ for $(-5 \leq k \leq 5)$

viii) $x_8[k] = \sin\left(-\frac{3\pi k}{8} + \frac{\pi}{2}\right)$ for $(-10 \leq k \leq 10)$ (added)

ix) $x_9[k] = 5k + 3^k$ for $(-5 \leq k \leq 5)$

x) $x_{10}[k] = \left|\sin\left(\frac{3\pi k}{4} + \frac{\pi}{8}\right)\right|$ for $(-6 \leq k \leq 10)$

xi) $x_{11}[k] = \cos\left(\frac{3\pi k}{4}\right) + \sin\left(\frac{\pi k}{2}\right)$ for $(-10 \leq k \leq 10)$ (added)

xii) $x_{12}[k] = k^4 + 1$ for $(-10 \leq k \leq 10)$

Solution:

The CT signals ((i) to (vi)) can be plotted in MATLAB as follows. The CT signals are plotted in Fig. 1.

```matlab
% clear figure
clf
% signal defined in part (i)
t1 = -1:0.01:2;
x1 = cos(3*pi*t1/4+pi/8);
subplot(3,2,1), plot(t1, x1), grid on
xlabel('t')               % Label of X-axis
ylabel('x_1(t)')          % Label of Y-axis

% signal defined in part (ii)
t2 = -1:0.01:2;
x2 = sin(-3*pi*t2/8+pi/2);
subplot(3,2,2), plot(t2, x2), grid
xlabel('t')                   % Label of X-axis
ylabel('x_2(t)')             % Label of Y-axis

% signal defined in part (iii)
t3 = -2:0.01:2;
x3 = 5*t3 + 3*exp(-t3);
subplot(3,2,3), plot(t3, x3), grid
xlabel('t')               % Label of X-axis
ylabel('x_3(t)')          % Label of Y-axis

% signal defined in part (iv)
t4 = -1:0.01:2;
x4 = sin(3*pi*t4/4+pi/8); x4 =x4.*x4;
subplot(3,2,4), plot(t4, x4), grid
xlabel('t')               % Label of X-axis
ylabel('x_4(t)')          % Label of Y-axis
```
% signal defined in part (v)
t5 = -2:0.01:3;
x5 = cos(3*pi*t5/4) + sin(pi*t5/2);
subplot(3,2,5), plot(t5, x5), grid
xlabel('t') % Label of X-axis
ylabel('x_5(t)') % Label of Y-axis

% signal defined in part (vi)
t6 = -2:0.01:3;
x6 = t6.*exp(-2*t6);
subplot(3,2,6), plot(t6, x6), grid
xlabel('t') % Label of X-axis
ylabel('x_6(t)') % Label of Y-axis

Fig 1: CT signals for Problem 1, parts (i) to (vi).
The DT signals ((vii) to (xii)) can also be plotted using the following MATLAB commands. The plots are shown in Fig. 2.
% clear figure
c1f
% signal defined in part (i)
k1 = -5:5;
x1 = cos(3*pi*k1/4+pi/8);
subplot(3,2,1), stem(k1, x1, 'filled'), grid on
xlabel('k') % Label of X-axis
ylabel('x_1[k]') % Label of Y-axis

% signal defined in part (ii)
k2 = -10:10;
x2 = sin(-3*pi*k2/8+pi/2);
subplot(3,2,2), stem(k2, x2, 'filled'), grid on
xlabel('k') % Label of X-axis
ylabel('x_2[k]') % Label of Y-axis

% signal defined in part (iii)
k3 = -5:5 ;
x3 = 5*k3 + 3*exp(-k3);
subplot(3,2,3), stem(k3, x3, 'filled'), grid on
xlabel('k') % Label of X-axis
ylabel('x_3[k]') % Label of Y-axis

% signal defined in part (iv)
k4 = -6:10 ;
x4 = abs(sin(3*pi*k4/4+pi/8)) ;
subplot(3,2,4), stem(k4, x4, 'filled'), grid on
xlabel('k') % Label of X-axis
ylabel('x_4[k]') % Label of Y-axis
axis([-6 -10 0 1])

% signal defined in part (v)
k5 = -10:10 ;
x5 = cos(3*pi*k5/4) + sin(pi*k5/2) ;
subplot(3,2,5), stem(k5, x5, 'filled'), grid on
xlabel('k') % Label of X-axis
ylabel('x_5[k]') % Label of Y-axis

% signal defined in part (vi)
k6 = -10:10 ;
x6 = 4*k6.*exp(abs(-k6)) ;
subplot(3,2,6), stem(k6, x6, 'filled'), grid
xlabel('k') % Label of X-axis
ylabel('x_6[k]') % Label of Y-axis

Fig 2: DT signals for Problem 1, parts (vii) to (xii)
Problem 2 Determine if the following CT signals are periodic. If yes, calculate the fundamental period $T_o$ for the CT signals.

i) $x_2(t) = |\sin(-5\pi t/8 + \pi/2)|$

ii) $x_3(t) = \sin(6\pi t/7) + 2\cos(3t/5)$

iii) $x_5(t) = \exp(j 3\pi t/8) + \exp(\pi t/86)$

iv) $x[k] = 5 \times (-1)^k$

v) $x_2[k] = \exp(j (7\pi k/4)) + \exp(j (3k/4))$

vi) $x_4[k] = \sin(3\pi k/8) + \cos(63\pi k/64)$

vii) $x_5[k] = \exp(j (7\pi k/4)) + \cos(4\pi k/7 + \pi)$

Solution:

i) Consider $x_2(t) = |\sin(-5\pi t/8 + \pi/2)| = |\cos(5\pi t/8)|$. The signal $x_2(t + T_2)$ is given by $x_2(t + T) = |\cos(5\pi t/8 + 5\pi T_2/8)|$.

Comparing $x_2(t)$ with $x_2(t + T)$, it is clear that the two are equal if $5\pi T_2/8 = \pi$. This implies that $T_2 = 8/5$.

ii) We know that the fundamental periods of the individual terms are given by

$x_3(t) = \sin(6\pi t/7) + 2\cos(3t/5)$

Calculating the ratio of the two periods

$$\frac{T_1}{T_2} = \frac{7/3}{10\pi/3} = \frac{7\pi}{10\pi} \neq \text{rational number}.$$ 

Therefore, $x_3(t)$ is not a periodic signal.

iii) $x_5(t)$ can be split into two terms

$x_5(t) = \exp(j 3\pi t/8) + \exp(\pi t/86)$

Since the second term is not periodic, the overall function $x_5(t)$ is not periodic.

iv) Expressing $(-1) = e^{j\pi}$, $x_1[k]$ is expressed as $x[k] = 5 \times e^{jnk}$.

Computing $x[k + K_1] = 5 \times e^{j(n(k+K_1))}$. For $x_1[k] = x_1[k + K_1]$, clearly $e^{jnk1} = 1 = e^{j2\pi}$, which gives $K_1 = 2$.

v) Looking at the individual terms

$x_2[k] = \exp(j (7\pi k/4)) + \exp(j (3k/4))$

Term I is periodic since $\omega_0/2\pi = 7/8$ is a rational number. Term II is not periodic since $\omega_0/2\pi = 3/8\pi$ is not a rational number. Signal $x_2[k]$ is therefore not periodic.

vi) Looking at the individual terms
\[ x_4[k] = \sin\left(3\pi k/8\right) + \cos\left(63\pi k/64\right) \]

Term I is periodic with a period \( K_{41} \) of 16. Term II is also \( K_{42} \) periodic with a period of 128. Since \( K_{41}/K_{42} = 1/8 \) is a rational number, \( x_4[k] \) is a periodic signal. Using Equation (1.9), the fundamental period of \( x_4[k] \) is given by \( 16n = 128m \). Picking \( n = 8 \) and \( m = 128 \), the overall period of \( x_4[k] \) is given by 128.

vii) Looking at the individual terms

\[ x_5[k] = \exp\left(j(7\pi k/4)\right) + \cos\left(4\pi k/7 + \pi\right) \]

Term I is periodic with a period \( K_{51} \) of 8. Term II is also \( K_{52} \) periodic with a period of 7. Since \( K_{51}/K_{52} = 8/7 \) is a rational number, \( x_5[k] \) is a periodic signal. Using Equation (1.9), the fundamental period of \( x_5[k] \) is given by \( 8n = 7m \). Picking \( n = 7 \) and \( m = 8 \), the overall period of \( x_5[k] \) is given by 56.

Problem 3: Show that the average power of the DT periodic signal \( x[k] = A \cos(\Omega k) \) is given by \( A^2/2 \).

Solution: By definition,

\[ P_\infty = \frac{1}{N} \sum_{k=0}^{N-1} [A \cos(\Omega k)]^2 = \frac{A^2}{N} \sum_{k=0}^{N-1} \cos^2(\Omega k) , \]

where \( N \) is the fundamental period and is given by \( N = 2\pi/\Omega \). By expressing the squared cosine as a linear term, we get

\[ P_\infty = \frac{A^2}{N} \sum_{k=0}^{N-1} \frac{1 + \cos(2\Omega k)}{2} \]

or,

\[ P_\infty = \frac{A^2}{2N} \sum_{k=0}^{N-1} 1 + \frac{A^2}{2N} \sum_{k=0}^{N-1} \cos(2\Omega k) . \]

Using the Euler’s formula to express the cosine as a sum of two complex exponentials, gives

\[ P_\infty = \frac{A^2}{2N} \times N + \frac{A^2}{4N} \sum_{k=0}^{N-1} e^{j2\Omega k} + \frac{A^2}{4N} \sum_{k=0}^{N-1} e^{-j2\Omega k} . \quad (1) \]

We expand each complex exponential term as GP series to get

\[ \sum_{k=0}^{N-1} e^{j2\Omega k} = \frac{1 - e^{j2\Omega N}}{1 - e^{j2\Omega}} = \frac{1 - e^{j4\pi}}{1 - e^{j2\pi}} = 0 \]

and

\[ \sum_{k=0}^{N-1} e^{-j2\Omega k} = \frac{1 - e^{-j2\Omega N}}{1 - e^{-j2\Omega}} = \frac{1 - e^{-j4\pi}}{1 - e^{-j2\pi}} = 0 . \]

Substituting the values of the exponentials in Eq. (1), we get

\[ P_\infty = \frac{A^2}{2} + 0 + 0 = \frac{A^2}{2} , \]

which proves the result.

Problem 4: Determine if the following CT signals are even, odd, or neither-even-nor-odd. In the later case, evaluate and sketch the even and odd components of the CT signals.
i) \[ x_1(t) = 2\sin(2\pi t)\left[2 + \cos(4\pi t)\right] \]

ii) \[ x_2(t) = t^2 + \cos(3t) \]

iii) \[ x_5(t) = \begin{cases} 
3t & 0 \leq t \leq 2 \\
6 & 2 \leq t \leq 4 \\
3(-t + 6) & 4 \leq t \leq 6 \\
0 & \text{elsewhere} 
\end{cases} \]

iv) \[ x_1[k] = \sin(4k) + \cos(2\pi k/3). \]

v) \[ x_3[k] = \exp\left(j(7\pi k/4)\right) + \cos\left(4\pi k/7 + \pi\right). \]

vi) \[ x_5[k] = \begin{cases} 
(-1)^k & k \geq 0 \\
1 & k < 0 
\end{cases} \]

**Solution:**

i) Since \( x_1(t) = 2\sin(2\pi t)\left[2 + \cos(4\pi t)\right], \)

therefore, the CT function is odd.

ii) Since \( x_2(t) = t^2 + \cos(3t), \)

therefore, the CT function is even.

iv) To see if the DT signal is even or odd, we evaluate

\[ x_1[-k] = \sin(-4k) + \cos(-2\pi k / 3) \]

\[ = -\sin(4k) + \cos(2\pi k / 3) \]

\[ \neq x_1[k] \]

Therefore, the DT signal is neither even nor odd.

The even and odd components of \( x_1[k] \) are given by

Even component: \( x_{1\text{ even}}[k] = \frac{1}{2}\left[x_1[k] + x_1[-k]\right] = \cos(2\pi k / 3). \)

Odd component: \( x_{1\text{ odd}}[k] = \frac{1}{2}\left[x_1[k] - x_1[-k]\right] = \sin(4k). \)

v) To see if the DT signal is even or odd, we evaluate

\[ x_3[-k] = \exp(-j7\pi k / 4) + \cos(-4\pi k / 7 + \pi) \]

\[ = \exp(-j7\pi k / 4) + \cos(4\pi k / 7 + \pi) \]

\[ \neq x_3[k] \]

Therefore, the DT signal is neither even nor odd.

The even and odd components of \( x_3[k] \) are given by

Even component: \( x_{3\text{ even}}[k] = \frac{1}{2}\left[x_3[k] + x_3[-k]\right] = \cos(7\pi k / 4) + \cos(4\pi k / 7 + \pi). \)
Odd component: 
\[ x_{3\, \text{odd}}[k] = \frac{1}{2} [x[k] - x[-k]] = j \sin(7\pi k / 4). \]

vi) To see if the DT signal is even or odd, we evaluate

\[ x_5[-k] = \begin{cases} 
(1)^k & -k \geq 0 \\
0 & -k < 0 \\
\end{cases} \]

Therefore, the DT signal is neither even nor odd.

The even and odd components of \( x_5[k] \) are given by

Even component:

\[ x_{5\, \text{even}}[k] = \frac{1}{2} \begin{cases} 
(-1)^k & k < 0 \\
2 & k > 0 \\
\end{cases} \]

Odd component:

\[ x_{5\, \text{odd}}[k] = \frac{1}{2} \begin{cases} 
(-1)^k & k < 0 \\
0 & k > 0 \\
\end{cases} \]

Problem 5: Determine if the following CT signals are energy or power signals or neither. Calculate the energy and power of the signals in each case.

i) \( x_1(t) = \cos(\pi t) \sin(3\pi t) \)

ii) \( x_2(t) = \begin{cases} 
\cos(3\pi t) & -3 \leq t \leq 3 \\
0 & \text{elsewhere} \\
\end{cases} \)

iii) \( x_3(t) = \begin{cases} 
t & 0 \leq t \leq 2 \\
4 - t & 2 \leq t \leq 4 \\
0 & \text{elsewhere} \\
\end{cases} \)

iv) \( x_4[k] = \cos(\pi k / 4) \sin(3\pi k / 8) \) (Changed)

v) \( x_5[k] = (-1)^k \) (Changed)

vi) \( x_6[k] = \begin{cases} 
2^k & 0 \leq k \leq 10 \\
1 & 11 \leq k \leq 15 \) (Changed)

Solution:

i) The CT signal

\[ x_1(t) = \cos(\pi t) \sin(3\pi t) = \frac{1}{2} \sin(4\pi t) + \frac{1}{2} \sin(2\pi t) \]

is periodic with the fundamental period \( T = 1 \). Since periodic signals are always power signals, \( x_1(t) \) is a power signal.

Total energy \( E_{x_1} \) in \( x_1(t) \) is infinite. Based on Problem 1.6, the average power in a sinusoidal signal \( x(t) = A \sin(\omega_0 t + \theta) \) is given by \( A^2 / 2 \). The average power in \( x_1(t) \) is, therefore, given by \( 1/8 + 1/8 = 1/4 \).
ii) The CT signal

\[ x_2(t) = \begin{cases} \cos(3\pi t) & -3 \leq t \leq 3 \\ 0 & \text{elsewhere} \end{cases} \]

is a finite duration signal. Since finite duration signals are always energy signals, \( x_2(t) \) is an energy signal. Average power \( P_{x_2} \) in \( x_2(t) \) is zero. The total energy in \( x_2(t) \) is given by

\[ E_{x_2} = \frac{3}{2} \int_{-3}^{3} \cos^2(3\pi t) dt = \frac{3}{2} \left[ \frac{1}{2} t + \frac{1}{6\pi} \sin(6\pi t) \right]_{-3}^{3} = 3. \]

iii) The CT signal

\[ x_5(t) = \begin{cases} t & 0 \leq t \leq 2 \\ 4 - t & 2 \leq t \leq 4 \\ 0 & \text{elsewhere} \end{cases} \]

is a finite duration signal. Since finite duration signals are always energy signals, \( x_5(t) \) is an energy signal. Average power \( P_{x_5} \) in \( x_5(t) \) is zero. The total energy in \( x_5(t) \) is given by

\[ E_{x_5} = \int_{0}^{2} t^2 dt + \int_{2}^{4} (4-t)^2 dt = \left[ \frac{t^3}{3} \right]_{0}^{2} - \left[ \frac{(4-t)^3}{3} \right]_{2}^{4} = \frac{8}{3} - \frac{8}{3} = \frac{16}{3}. \]

(iv) The DT signal can be expressed as

\[ x_1[k] = \cos(\pi k / 4) \sin(3\pi k / 4) = \frac{1}{2} \sin(5\pi k / 4) + \frac{1}{2} \sin(\pi k / 8), \]

indicating that \( x_1[k] \) is periodic with an overall period of \( N_0 = 16 \). Since periodic signals are always power signals, \( x_1[k] \) is a power signal.

Total energy \( E_{x_1} \) in \( x_1(t) \) is infinite. Based on Problem 1.6, the average power in a sinusoidal signal \( x[k] = A \sin(\omega_0 k + \theta) \) is given by \( A^2 / 2 \). The average power in \( x_1(t) \) is, therefore, given by \( 1/4 + 1/4 = 1/2 \).

(v) The DT signal \( x_3[k] = (-1)^k \) is periodic with a period of \( N_0 = 2 \). Since periodic signals are always power signals, \( x_3[k] \) is a power signal.

Total energy \( E_{x_3} \) in \( x_1(t) \) is infinite. The average power in \( x_1(t) \) is, therefore, given by \( \frac{1}{2} (1 + 1) = 1 \).

(vi) The DT signal

\[ x_5[k] = \begin{cases} 2^k & 0 \leq k \leq 10 \\ 1 & 11 \leq k \leq 15 \\ 0 & \text{elsewhere} \end{cases} \]

is a finite duration signal with length 16. Since finite duration signals are energy signals, \( x_5[k] \) is an energy signal. Average power \( P_{x_5} \) in \( x_5[k] \) is zero. The total energy in \( x_5[k] \) is given by

\[ E_{x_5} = \sum_{k=0}^{10} 2^k + \sum_{k=11}^{15} 1 = \frac{(2^{11} - 1)}{2 - 1} + 5 = 2052. \]
Problem 6: Sketch the following CT signals.

i) \( x_1(t) = u(t) + 2u(t-3) - 2u(t-6) - u(t-9) \)

ii) \( x_4(t) = u(\sin(\pi t)) \)

iii) \( x_5(t) = \text{rect}(t/6) + \text{rect}(t/4) + \text{rect}(t/2) \)

iv) \( x_2[k] = \sum_{m=0}^{\infty} \delta[k-m] \)

v) \( x_5[k] = ku[k] \)

vi) \( x_6[k] = k[u[k+4] - u[k-4]] \)

Solution:
The waveforms for the above signals are shown in Fig. 3. These plots should be sketched by hand.
Problem 7: Consider the following signal

\[ x(t) = \begin{cases} 
  t + 2 & -2 \leq t \leq -1 \\
  1 & -1 \leq t \leq 1 \\
  -t + 2 & 1 \leq t \leq 2 \\
  0 & \text{elsewhere}
\end{cases} \]

Sketch \( x(t-3) \), \( x(2t-3) \), \( x(-2t-3) \), and \( x(-3t/4-3) \). Determine the analytical expressions for each of the four functions.

Solution: The waveforms for signals \( x(t-3) \), \( x(2t-3) \), \( x(-2t-3) \), and \( x(-3t/4-3) \) are shown in Fig. 4.
Problem 8: Consider the CT function \( f(t) \).

i) Sketch the CT function \( g(t) = f(9 - 3t) \).

ii) Calculate the energy and power of the signal \( f(t) \). Is it a power signal or energy signal?

iii) Represent the function \( f(t) \) as a summation of an even and an odd signal. Sketch the even and odd parts.

Solution:

(i) To obtain the waveform for \( g(t) \) from \( f(t) \), one possible order of transformations is:

\[
 f(t) \xrightarrow{\text{reflect about } y\text{-axis}} f(-t) \xrightarrow{\text{shift to the left by } 9} f(-(t - 9)) = f(9 - t) \xrightarrow{\text{scale by a factor of } 3} f(9 - 3t).
\]

The final waveform for \( g(t) = f(9 - 3t) \) is sketched in Fig. 5.

Figure 5: Waveform for Problem 8(i).
(ii) Since $f(t)$ is a finite duration signal, it is an energy signal. The average power in $f(t)$ is 0, while its total energy is given by

$$E_f = \int_{-3}^{3} (-t-3)^2 dt + \int_{0}^{3} (5t/3 - 3)^2 dt = (-t-3)^3 \bigg|_{-3}^{0} + (5t/3 - 3)^3 \bigg|_{0}^{3} = 9 + 7 = 16.$$ 

(iii) We solve part (iii) for Problem 8 graphically.

![Waveforms for Problem 8(iii).](image)

Figure 6: Waveforms for Problem 8(iii).

Problem 9: Consider the two DT signals
\[ x_1[k] = |k|u[k + 4] - u[k - 4] \]
\[ x_2[k] = \text{sgn}[k](u[k - 5] - u[k + 5]) \]

Sketch the following signals expressed as a function of \( x_1[k] \) and \( x_2[k] \).

i) \( x_1[3 - k] \)

ii) \( x_2[6 - 2k] \) (changed)

iii) \( x_1[2k] + x_2[3k] \)

iv) \( x_1[k + 5]x_2[7 - k] \)

v) \( x_1[2k]x_2[-k] \)

The waveforms for the above signals are plotted in Fig. 7.
Fig. 7: Waveforms for Problem 9.

Problem 10: Evaluate the following integrals

i) \[ \int_{-\infty}^{\infty} (t-1) \delta(t-5) dt \]

ii) \[ \int_{-\infty}^{\infty} (2t/3-5) \delta(3t/4-5/6) dt \]

iii) \[ \int_{-\infty}^{\infty} \exp(t-1)\sin(\pi(t+5)/4)\delta(1-t) dt \]

iv) \[ \int_{-\infty}^{\infty} [\sin(3\pi t/4) + \exp(-2t+1)]\delta(-t-5) dt \]

v) \[ \int_{-\infty}^{\infty} [u(t-6)-u(t-10)]\sin(3\pi t/4)\delta(t-5) dt \]

Solution:

(i) \[ \int_{-\infty}^{\infty} (t-1) \delta(t-5) dt = (t-1) \big|_{t=5} = 4 \]

(ii) Integration (ii) simplifies to
\[ \int_{-\infty}^{\infty} (2t/3 - 5) \delta(3t/4 - 5/6) dt \\
= \int_{-\infty}^{\infty} (2t/3 - 5) \delta(3/4(t - 10/9)) dt \\
= \frac{4}{3} \int_{-\infty}^{\infty} (2t/3 - 5) \delta(t - 10/9) dt \\
= \frac{4}{3} (2t/3 - 5) \bigg|_{t=10/9} \\
= -\frac{460}{81}. \\
\]

(iii) Integration (iii) simplifies to

\[ \int_{-\infty}^{\infty} e^{t-1} \sin\left(\frac{\pi(t+5)}{4}\right) \delta(1-t) dt \\
= \int_{-\infty}^{\infty} e^{t-1} \sin\left(\frac{\pi(t+5)}{4}\right) \delta((-1)(-1)) dt \\
= \int_{-\infty}^{\infty} e^{t-1} \sin\left(\frac{\pi(t+5)}{4}\right) \delta(t-1) dt \\
= e^{t-1} \sin\left(\frac{\pi(t+5)}{4}\right) \bigg|_{t=1} \\
= -1. \\
\]

(iv) Integration (iv) simplifies to

\[ \int_{-\infty}^{\infty} \left[\sin\left(\frac{3\pi}{4}\right) e^{-2t+1}\right] \delta(-t-5) dt \\
= \int_{-\infty}^{\infty} \left[\sin\left(\frac{3\pi}{4}\right) e^{-2t+1}\right] \delta((-1)(-1) + 1) dt \\
= \int_{-\infty}^{\infty} \left[\sin\left(\frac{3\pi}{4}\right) e^{-2t+1}\right] \delta(t+1) dt \\
= \left[\sin\left(\frac{3\pi}{4}\right) e^{-2t+1}\right]_{t=-1} \\
= -\frac{1}{\sqrt{2}} e^3. \\
\]

(v) Integration (v) simplifies to

\[ \int_{-\infty}^{\infty} [u(t-6) - u(t-10)] \sin\left(\frac{3\pi}{4}\right) \delta(t-5) dt \\
= [u(t-6) - u(t-10)] \sin\left(\frac{3\pi}{4}\right) \bigg|_{t=5} \\
= 0. \\
\]