(1) 8.21

(a) \( \hat{y}_1(k) = \text{circular convolution of } \hat{x}_1(n) \) and \( \hat{x}_2(n) \)

\[
\hat{y}_1(n) = \sum_{m=0}^{6} \hat{x}_2(m) \hat{x}_1(n-m) = \sum_{m=0}^{6} \delta(m-2) \hat{x}_1(n-m) = \hat{x}_1(n-2)
\]

(b) \( \hat{y}_5(n) = \sum_{m=0}^{5} \hat{x}_2(m) \hat{x}_1(n-m) = \sum_{m=0}^{5} (\delta(m) + \delta(m-4)) \hat{x}_1(n-m) = \hat{x}_1(n) + \hat{x}_1(n-4) \)

(2) 8.23

(a) \( N \geq P \)

Append \( N-P \) zeros and compute an \( N \)-point DFT.

The DFT is computed at \( \omega_k = \frac{2\pi k}{N} \).

(b) \( N < P \)

Let \( r = \left\lfloor \frac{P}{N} \right\rfloor \), i.e. \( r \) is the smallest integer such that \( N \cdot r \geq P \).

Append \( N \cdot r - P \) zeros at the end of the sequence.

Then, take an \( N \cdot r \)-point DFT.

The DFT is computed at \( \omega_k = \frac{2\pi k}{N} \), \( 0 \leq k \leq rN-1 \).

From these points, select the ones for which

\[ k = rk, \quad 0 \leq k \leq N-1 \]

\[
\omega_k = \frac{2\pi k}{N} = \frac{2\pi k_1}{N}, \quad 0 \leq k_1 < N-1
\]
3. 8.25

\[ y(n) \] has a circular delay of 3 points

\[ \begin{array}{cccc}
0 & 1 & 2 & 3 \\
\uparrow & \uparrow & \uparrow & \uparrow \\
-1 & 0 & 1 & 2 \\
\end{array} \]

\[ \xrightarrow{\quad} \]

4. 8.27.

(a) \[ x_1(n) \ast x_2(n) \]

(b) \[ x_1(n) \bigcirc x_2(n) \]

(c) \( x_1(n) \bigcirc x_2(n) \) same as in (a)

\[ \xrightarrow{\quad} \]

5. 8.32

\[ X(k) = \sum_{n=0}^{7} x(n) W_8^{kn} \quad 0 \leq k \leq 7 \]

16-pt DFT \[ Y(k) = \sum_{n=0}^{15} y(n) W_{16}^{kn} \quad 0 \leq k \leq 15 \]

\Rightarrow \[ Y(k) = \sum_{n=0}^{7} x(n) W_{16}^{2kn} = \sum_{n=0}^{7} x(n) W_8^{kn} \quad 0 \leq k \leq 15 \]

So, \( Y(k) \) has the same shape as \( X(k) \), but it contains two periods \( \Rightarrow \)

Correct choice is C