Step-1

Suppose, we know the values of c_0+c_2, c_0-c_2, c_1+c_3, and c_1-c_3. In order to obtain Fc, we need not calculate c_0, c_1, c_2, and c_3.

We know the following properties of the imaginary number $i=\sqrt{-1}$.

$$\begin{aligned}
i^1 &= i \\
i^2 &= -1 \\
i^3 &= -i \\
i^4 &= 1
\end{aligned}$$

We also know that if $0 \le k \le 4$, then $i^{4n+k} = i^k$

Step-2

Therefore, we have the following:

$$\begin{aligned}
i^6 &= i^2 \\
&= -1 \\
i^9 &= i^1 \\
&= i
\end{aligned}$$

Step-3

Consider the following:

$$\begin{aligned}
Fc &= \begin{bmatrix} c_0+c_1+c_2+c_3 \\ c_0+ic_1+i^2c_2+i^3c_3 \\ c_0+i^2c_1+i^4c_2+i^6c_3 \\ c_0+i^3c_1+i^6c_2+i^9c_3 \end{bmatrix} \\
&= \begin{bmatrix} c_0+c_1+c_2+c_3 \\ c_0+ic_1-1c_2-ic_3 \\ c_0-1c_1+c_2-1c_3 \\ c_0-ic_1-c_2+ic_3 \end{bmatrix} \\
&= \boxed{\begin{bmatrix} (c_0+c_2)+(c_1+c_3) \\ (c_0-c_2)+i(c_1-c_3) \\ (c_0+c_2)-(c_1+c_3) \\ (c_0-c_2)-i(c_1-c_3) \end{bmatrix}}
\end{aligned}$$

Step-4

Thus, suppose we have the following relations:

$$c_0 + c_2 = p$$
$$c_0 - c_2 = q$$
$$c_1 + c_3 = r$$
$$c_1 - c_3 = s$$

Then, $\boxed{Fc = \begin{bmatrix} p+r \\ q+is \\ p-r \\ q-is \end{bmatrix}}$.