Exercise 14-2

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Exercise Calculate the discrete Fourier transform of the following sequence.

$$\boldsymbol{f} = \begin{pmatrix} 0 \\ 1 \\ 4 \\ 9 \end{pmatrix}$$

Solution

$$\begin{pmatrix} \omega^0 & \omega^0 & \omega^0 & \omega^0 \\ \omega^0 & \omega^{-1} & \omega^{-2} & \omega^{-3} \\ \omega^0 & \omega^{-2} & \omega^{-4} & \omega^{-6} \\ \omega^0 & \omega^{-3} & \omega^{-6} & \omega^{-9} \end{pmatrix} \boldsymbol{f} = \begin{pmatrix} 1 & 1 & 1 & 1 \\ 1 & -i & -1 & i \\ 1 & -1 & 1 & -1 \\ 1 & i & -1 & -i \end{pmatrix} \begin{pmatrix} 0 \\ 1 \\ 4 \\ 9 \end{pmatrix}$$

$$= \begin{pmatrix} 14 \\ -4+8i \\ -6 \\ -4-8i \end{pmatrix}$$