Discrete Cosine Transform

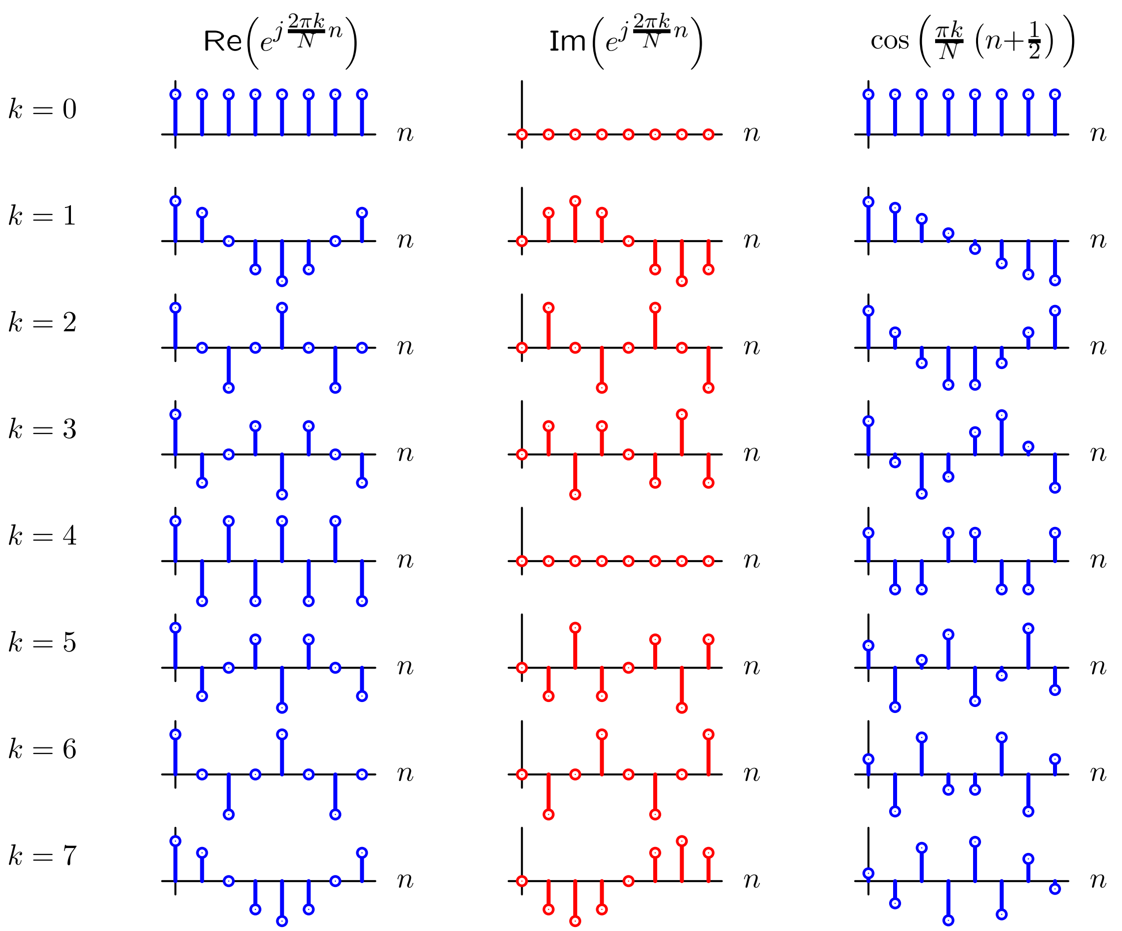
The Discrete Cosine Transform (DCT) is widely used in image coding schemes such as JPEG.

It is defined by the following analysis and synthesis equations.

$$F_C[k] = \frac{1}{N}\sum_{n=0}^{N-1} f[n]\cos\left(\frac{\pi k}{N}\left(n+\frac{1}{2}\right)\right) \qquad \text{(analysis)}$$

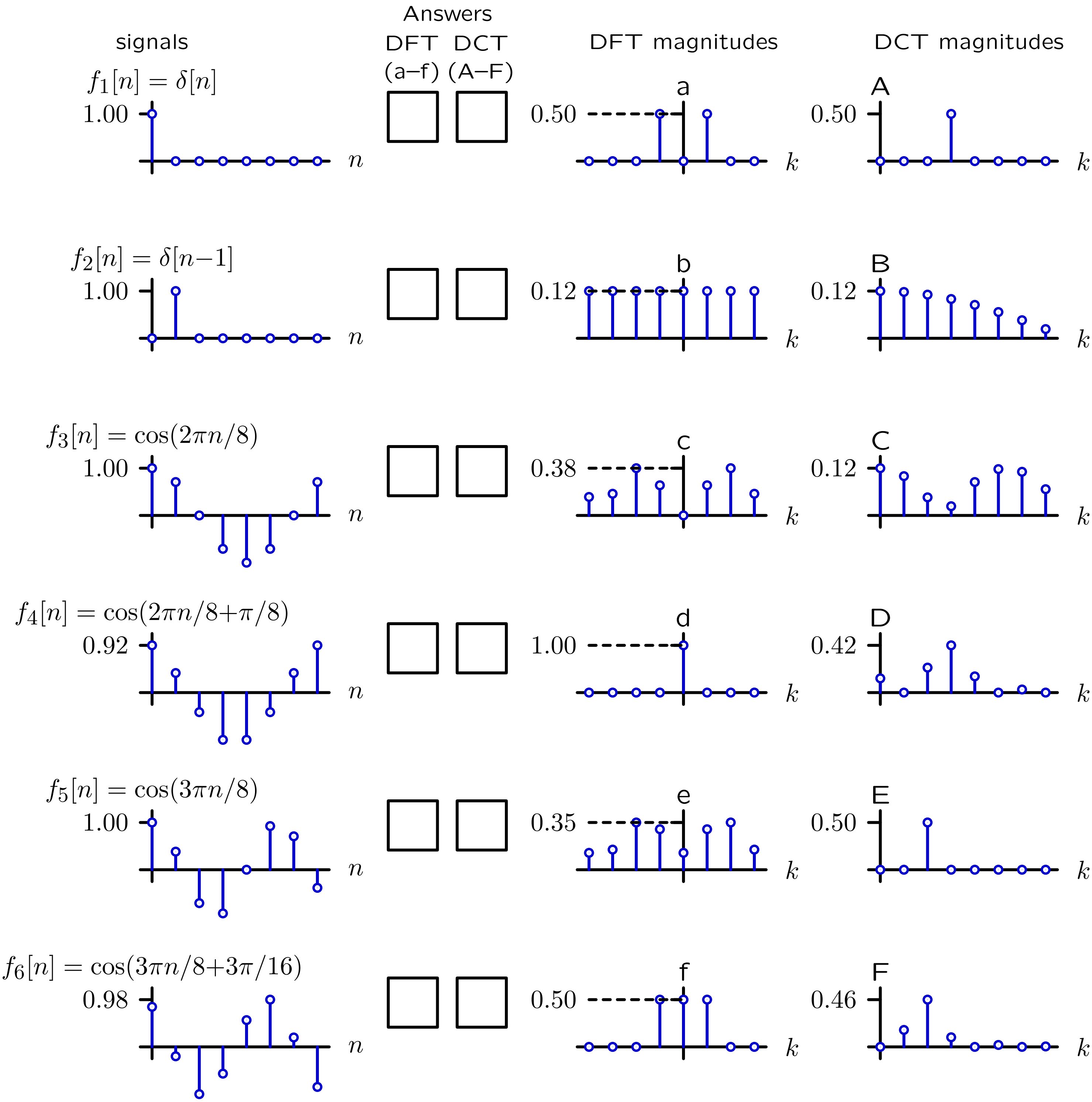
$$f[n] = F_C[0] + 2\sum_{k=1}^{N-1} F_C[k]\cos\left(\frac{\pi k}{N}\left(n+\frac{1}{2}\right)\right) \qquad \text{(synthesis)}$$

Like the DFT, the DCT expands a signal in terms of sinusoidal basis functions. The table below shows the real and imaginary parts of the DFT basis functions (left and center columns) as well as the DCT basis functions (right column) for $N = 8$.



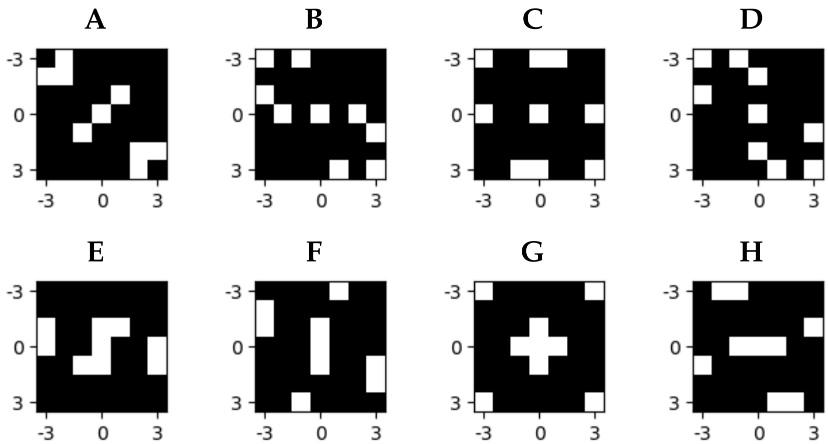
DFT and DCT Magnitudes

For each of the DT signals shown in the left column below, find the associated DFT magnitude from the center column and DCT magnitude from the right column, and enter the appropriate labels in the answer boxes.



Circular Convolution

Two 7×7 images are circularly convolved by computing the 2D iDFT of the product of their 2D DFTs, where both the iDFT and DFTs are of length $N = 7$. The resulting image is one of the eight images shown below.



For each of the following parts, determine which of A-H results.