

Problem 5.17: DSP Tricks

Sammy is faced with computing **lots** of discrete Fourier transforms. He will, of course, use the FFT algorithm, but he is behind schedule and needs to get his results as quickly as possible. He gets the idea of computing **two** transforms at one time by computing the transform of $s(n) = s_1(n) + js_2(n)$, where $s_1(n)$ and $s_2(n)$ are two real-valued signals of which he needs to compute the spectra. The issue is whether he can retrieve the individual DFTs from the result or not.

- What will be the DFT $S(k)$ of this complex-valued signal in terms of $S_1(k)$ and $S_2(k)$, the DFTs of the original signals?
- Sammy's friend, an Aggie who knows some signal processing, says that retrieving the wanted DFTs is easy: "Just find the real and imaginary parts of $S(k)$." Show that this approach is too simplistic.
- While his friend's idea is not correct, it does give him an idea. What approach will work? **Hint:** Use the symmetry properties of the DFT.
- How does the number of computations change with this approach? Will Sammy's idea ultimately lead to a faster computation of the required DFTs?