

CSE190 – Image Processing – Midterm

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<http://www-cse.ucsd.edu/~sjb/classes/wi02/cse190>

1:25pm-2:15pm Mon. Feb. 11, 2002.

On this exam you are allowed to use a calculator and one 8.5" by 11" sheet of notes. The total number of points possible is 100. In order to get full credit you must show all your work. Good luck!

1. (25 pts) Consider the system $g(x) = \sum_{k=x-2}^{x+4} f(k)$.
 - (a) Is this system linear? If it is linear, what is the impulse response?
 - (b) Is this system shift invariant?
2. (25 pts) The attached set of plots contains 12 signals and magnitudes of their Fourier transforms. Signals 1-12 are shown in the spatial domain in the top half of the page. Each signal is of length 16. The magnitude of the DFT for each signal is shown in the bottom half of the page, labelled A-L, in random order.

For each of the twelve signals, indicate which DFT magnitude corresponds to it. In each case, provide a brief (one-line) justification.
3. (25 pts) The expression for the 2D isotropic Gaussian is given by $h(x, y) = \frac{1}{2\pi\sigma^2} e^{-(x^2+y^2)/2\sigma^2}$.
 - (a) What type of filter is $h(x, y)$: lowpass, bandpass, or highpass?
 - (b) What is $H(u, v)$, the Fourier transform of $h(x, y)$? If we increase σ , what qualitative effect does it have on $H(u, v)$?
 - (c) What discrete kernel is commonly used to approximate this function? Provide the entries of this kernel for the 5×5 case.
 - (d) Brute-force convolution with the above 5×5 kernel requires 25 multiplications and additions to compute each pixel in the filtered image. Explain how this can be done more efficiently, and quantify the relative improvement.
4. (25 pts) This problem pertains to the theories of color vision discussed in class.
 - (a) Give a brief description of trichromacy theory, using sketches as necessary.
 - (b) Identify at least two of the main problems with trichromacy theory and explain how opponency theory addressed these problems.
 - (c) Give a brief description of dual process theory and how it relates to our current understanding of human perception of color.

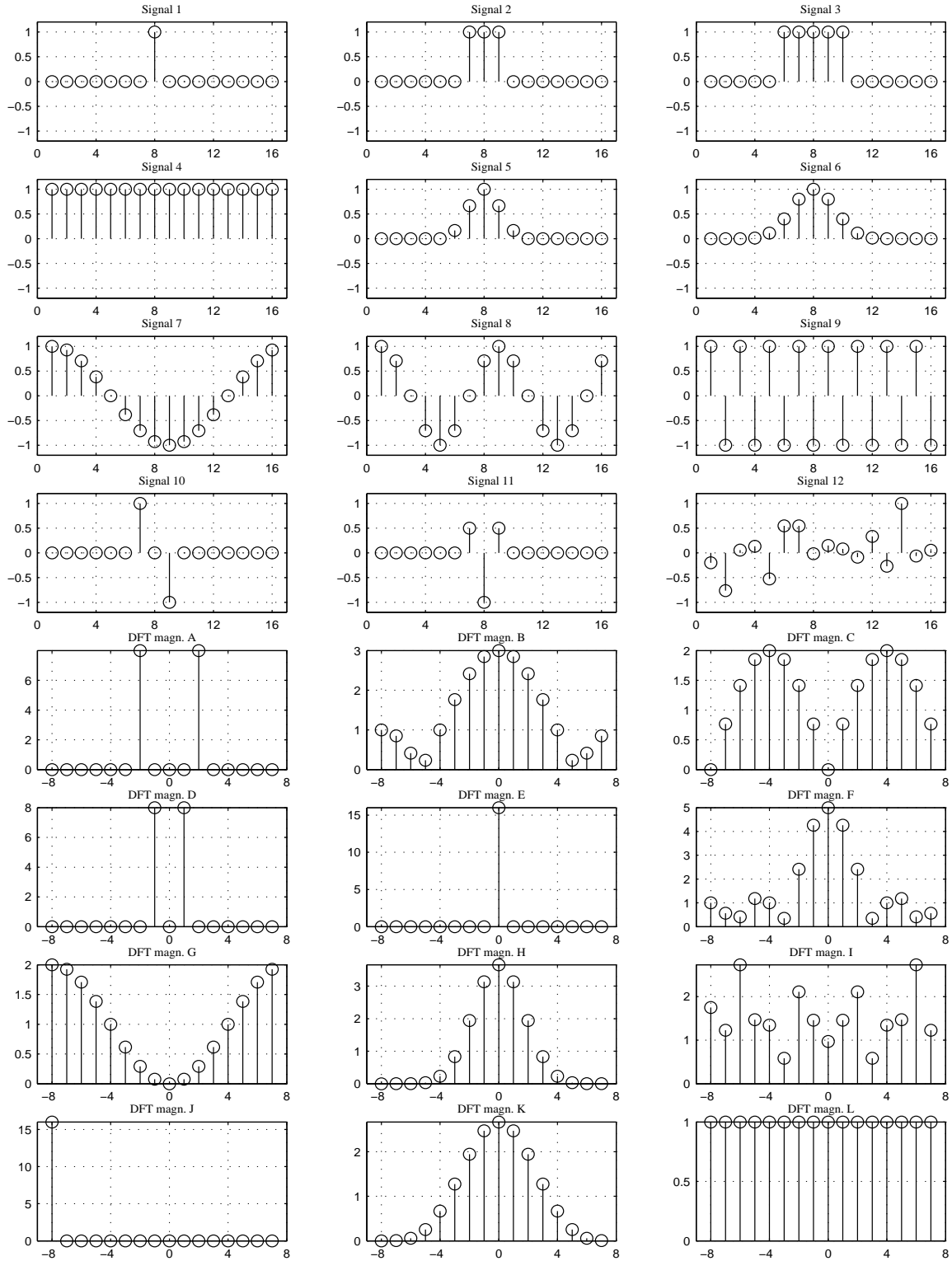


Figure 1: 12 signals and magnitudes of their Fourier transforms.