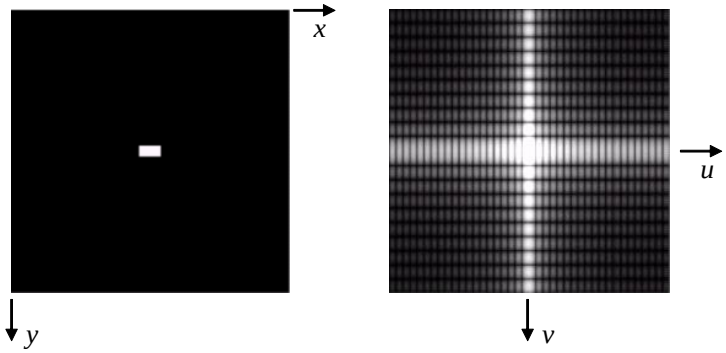
This is the transfer function of a Butterworth low-pass filter: $H(u,v) = \dfrac{1}{1+\left[D(u,v)/D_0\right]^{2n}}$

(a) Plot the approximate curves for n=1 and n=2.
(b) Which one in (a) is more similar to an ideal low-pass filter?
(c) Which one in (a) is more likely to cause ringing along edges in the filtered image?

Explain, qualitatively, the reason that the spacing of peaks along the *u* direction is smaller than the spacing of peaks along the *v* direction in the frequency-domain (Fourier) image?



Name the three types of redundancy mentioned in the class. For each one, briefly describe one coding method designed to reduce it.

Consider an image where pixels can take values of 0, 1, 2, or 3 with probabilities of 0.5, 0.25, 0.125, and 0.125, respectively.
(a) Without symbol coding, how many bits per pixel are required to store the image?
(b) Compute the entropy of the image; give the result in "bits per pixel".
(c) Devise a Huffman coding table for the four values. How many bits per pixel are required to store the image after Huffman coding?

Describe how non-uniform illumination can affect global thresholding, and how adaptive thresholding solves the problem. Just give the basic idea.

List the steps of the watershed algorithm.

Explain the steps of using "inverse filtering" to restore a blurred image.

The purpose is to do block-based transform coding. The following is a 2x2 gray-level image block (left) and four "basis blocks".

24	36
32	48

1/4 x

1	1
1	1

1/2 x

1	1
-1	-1

1/2 x

1	-1
1	-1

1/2 x

1	-1
-1	1

(a) Obtain the four coefficients by projecting the image block to the four basis blocks.
(b) Reconstruct the image block by dropping the last coefficient (i.e., using only the first three basis blocks and their respective coefficients.)
(c) Reconstruct the image block using only the DC coefficient.
(d) For the results of (b) and (c), compute the sum of squared errors with the formula below. Which is closer to the original?

$$e = \sum_{x=0}^{M-1}\sum_{y=0}^{N-1}\left[\hat{f}(x,y) - f(x,y)\right]^2$$ (*M* and *N*: size of the block)