

# Mathematics of Image Processing

## Worksheet #5 - More on filtering

Name: \_\_\_\_\_

Box #: \_\_\_\_\_

**Circular convolution** Either download the scripts `circonv.m` and `circconv2.m` or use the Matlab commands `conv` and `conv2` for this worksheet.

2. Let  $X$  be a signal with high and low frequencies. Let  $\delta_r$  be the function defined by  $\delta_r(r) = 1$ ,  $\delta_r(n) = 0$  otherwise. Plot  $X$  and  $\delta_r * X$  and describe the effect of convolution of  $\delta_r$  on  $X$ .

1. Now do the same with an image  $X$  and some  $\delta_{r,s}$  which is a mask whose only non zero entry is 1 at  $r, s$ .

3. Pick some mask  $f$  and zero extend it to an  $N$  point signal (make  $N$  small, say 8) Compute the circulant matrix  $H_f$  described on the last work sheet and find its eigenvalues. Compare this to the values of  $\widehat{f}$ .

4. Again let  $X$  be a signal with 2 low and 2 high frequencies. Let  $N$  be large say 128 or larger. Experiment with various low pass filter masks of 2, 3 and 4 nonzero values. Apply the various filters to the signal to see which one best filters out the high frequencies and preserves the low frequencies. You may wish to look at  $|\widehat{f}|$ .

2. Perform the same experiments for a high pass filter.

3. What condition should a low pass filter satisfy to preserve the DC coefficient of a signal? What condition should high pass filter satisfy to eliminate the DC coefficient?

