Problem 1

We want to construct a Gaussian mask from the Gaussian filter equation and find its frequency representation. We suggest to use the following equation for the Gaussian filter

\[ h(i, j) = e^{-[(i-m)^2 + (j-m)^2]/2\sigma^2} \]  

In this equation (which is a generalization of the equation we saw in class), the peak is located at pixel \((m, m)\) and not at the origin. \(m\) represents the center element of the mask. Example: \(m = 2\) for a 3 by 3 mask and \(m = 3\) for a 5 by 5 mask. For a given standard deviation, do the following:

1) Construct a 3 by 3 Gaussian mask using equation (1) then normalize it so that the sum of its elements is 1.
2) Use matlab command \texttt{fspecial} to create a Gaussian filter and compare with your mask.
3) Use your program from question 1) or the matlab command \texttt{fspecial} to construct a 300 by 300 Gaussian filter.
4) Plot the frequency response of your Gaussian filter. Use command \texttt{freqz2(h)} to obtain the frequency response.
5) Obtain and display the magnitude of the FFT of the Gaussian filter with the DC component in the center, use \texttt{fft2} and \texttt{fftshift} or equivalent functions. You may need to use log, or other tricks to help display the FFT.

Problem 2

1) Read an image of your choice
2) Add Gaussian noise to the image, we call this noisy image “image2”. Use command \texttt{imnoise} or other equivalent functions.
3) Add salt and pepper noise to the image, we call this noisy image “image3”. Use command \texttt{imnoise} or other equivalent functions.
4) Write code to perform filtering operation in the space domain (using convolution). The size of the mask should not be larger than 25 elements. Do not use built in functions for this question.
5) Write code to perform median filtering operation. Do not use image processing built in functions for this question. You can use other built-in functions such as \texttt{sort}.
6) Use the convolution code to perform Gaussian filtering on image2.
7) Use the convolution code to perform Gaussian filtering on image3.
8) Use your code to perform median filtering on image2.
9) Use your code to perform median filtering on image3.
10) Show and discuss your results.