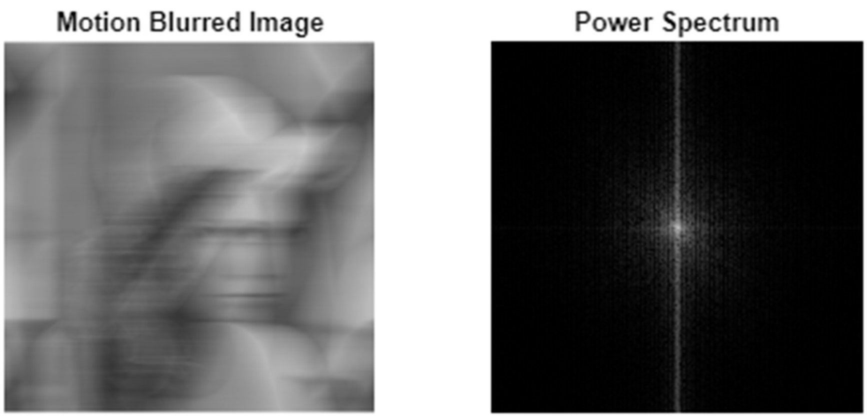
Question 1

```
function h = CreateHorizontalMotionBlurredKernel(d)
% h = CreateHorizontalMotionBlurredKernel(d)
% for example, if d=1, h=[1/3, 1/3, 1/3]; if d=3,
h=[1/7,1/7,1/7,1/7,1/7,1/7,1/7]
    % implematation here

    % Calculate the size of the kernel
    kernelSize = 2 * d + 1;


    % Create the kernel using an averaging filter
    h = ones(1, kernelSize) / kernelSize;
end
```

Question 2

```
function g = MotionBlurInFrequencyDomain(f, h)
% g = MotionBlurInFrequencyDomain(f, h)
% 'f' is the original image, 'h' is the kernel of motion blur
% All inputs and output are in the spatial domain but your process is
in the frequency domain
    % Take the 2D Fourier Transforms of the image and kernel
    F = fftshift(fft2(f));
    H = fftshift(fft2(h, size(f, 1), size(f, 2)));
    % Perform element-wise multiplication in the frequency domain
    G = F .* H;
    % Take the inverse Fourier Transform to get the degraded image
    g = ifft2(ifftshift(G));
    % Ensure the output is real (due to potential numerical errors)
    g = real(g);
end
```

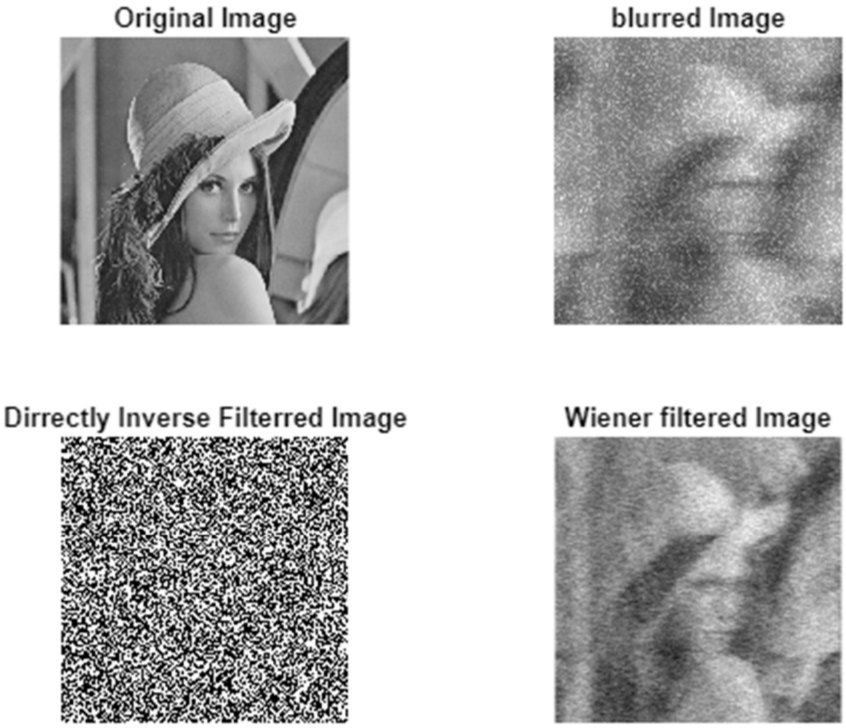


Question 3

```
function f_hat = InverseFilterInFrequencyDomain(g, h, epsilon)
% f_hat = InverseFilterInFrequencyDomain(g, h, epsilon)
% 'g' is degraded image, 'h' is kernel of motion blur
% All inputs and output is in spatial domain but your process has to be in frequency domain
    % Take the 2D Fourier Transforms of the degraded image and kernel
    G = fftshift(fft2(g));
    H = fftshift(fft2(h, size(g, 1), size(g, 2)));
    % Compute the regularization term
    R = ones(size(H));
    R(abs(H) > epsilon) = 1 ./ H(abs(H) > epsilon);
    % Compute the inverse filter in the frequency domain with regularization
    F_hat = R .* G;
    % Take the inverse Fourier Transform to get the estimated image
    f_hat = ifft2(ifftshift(F_hat));
    % Ensure the output is real (due to potential numerical errors)
    f_hat = real(f_hat);
end
```

Question 4

```
function snr = ComputeSpectrumSNR(f, n)
% abs(N(u,v)).^2 / abs(N(u,v)).^2


    % please copy from PDF file
    F = fftshift(fft2(f));
    N = fftshift(fft2(n));
    S_n = sum((abs(N).^2), 'all');
    S_f = sum((abs(F).^2), 'all');
    snr = S_f./S_n;


end


function f_hat = MyWienerFilter(g, h, K, epsilon)
% f_hat = MyWiennerFilter(g, f, h, n, epsilon)
% 'g' is degraded image, 'f' is original image, 'h' is kernel of motion
% blur, 'n' is noise, epsilon is for R(u,v)
% All inputs and output is in spatial domain but your process has to be
in frequency domain

    % Take the 2D Fourier Transforms of the degraded image and kernel
    G = fftshift(fft2(g));
    H = fftshift(fft2(h, size(g, 1), size(g, 2)));


    % Calculate the Wiener filter in the frequency domain
    R = ones(size(H));
    R(abs(H) > epsilon) = 1 ./ H(abs(H) > epsilon);


    F_hat = R .* abs(H).^2 ./ (abs(H).^2 + K) .* G;
    % Take the inverse Fourier Transform to get the estimated image
    f_hat = ifft2(ifftshift(F_hat));
    % Ensure the output is real (due to potential numerical errors)
    f_hat = real(f_hat);
end
```


Original Image
blurred Image
Dirrectly Inverse Filterred Image
Wiener filtered Image

Compare with different K

```
K = [1000, 0.0001, 0]; % pick 3 values of K yourself


figure();
subplot(2,2,1); imshow(f); title('Original Image');
for i = 1:3
    f_hat = MyWienerFilter(g, h, K(i), 0.001);
    mse = sum((f - f_hat).^2, 'all') / numel(f);
    subplot(2,2,i+1); imshow(f_hat);
    title({['Wiener filtered Image with K=' num2str(K(i)) ];['MSE=' 
num2str(mse)]}) % implematation here for K and MSE

end
```

If K goes too small, the effect will be the same as inverse filtering and amplify the noise.
If K goes too large, the value of the resulting intensity approach to zero since the denominator goes infinity large relative to the numerator.