Hint for the problem about Wiener filter

Signal model :

$$s(x,y) = \widehat{s}(x,y) + n(x,y), \tag{1}$$

where $s(x,y)$ is observed signal with noise.
Filterated spectrum by Wiener filter:

$$\begin{aligned} \widetilde{\mathcal{S}}(k_x,k_y) &= \Phi(k_x,k_y)\mathcal{S}(k_x,k_y), & (2) \\ \Phi(k_x,k_y) &= \frac{|\mathcal{S}(k_x,k_y)|^2 - |\mathcal{N}'(k_x,k_y)|^2}{|\mathcal{S}(k_x,k_y)|^2}, \quad (\Phi \geq 0). & (3) \end{aligned}$$

Since the noise is a white noise in this problem, the noise spectrum is flat. From this nature, we can estimate $|\mathcal{N}'|^2$ from $|\mathcal{S}(k_x,k_y)|$ in the spectral domain where the signal is not sigificant.

Procedure

1. Compute Fourier transform, $\mathcal{S}(k_x,k_y)$, of the original image, $s(x,y)$.
2. Determine the domain where the signal is not significant (noise dominant domain) by seeing $|\mathcal{S}(k_x,k_y)|$.
3. Determine the noise level from noise dominant domain. It can be considered as a constant.
4. Compute Wiener Filter $\Phi(k_x,k_y)$.

   Since $\Phi \geq 0$, if the numerator of Φ has a negative value, it should be truncated to 0. For the priodic noise, Φ at the frequency of the periodic noise can be also truncated to 0.

5. Compute filterated spectrum $\widetilde{\mathcal{S}}(k_x,k_y)$.
6. Compute filterated image $\widetilde{s}(x,y)$ by applying inverse Fourier transform.