Homework 3

Due date: 29/10/2023

On cross correlation and convolution

Consider a signal $s_0(x)$ given by $s_0(x) = \sin(2\pi x)$ for $x \in [-3,3]$ and $s_0(x) = 0$ elsewhere. In addition, there is a high-frequency perturbation $p(x)$ given by $p(x) = \sin(20\pi x)$ for $x \in [-3,3]$ and $p(x) = 0$ elsewhere. The perturbed signal $s(x)$ is given by $s(x) = s_0(x) + p(x)$.

(a) Calculate the cross correlation $\int_{-\infty}^{\infty} s_0(y) s_0(y+x) dy$ of s_0 with itself. Give your result as a function of x.

(b) Calculate the convolution $(s * r)(x) = \int_{-\infty}^{\infty} s(y) r(x-y) dy$ for the perturbed signal s and a response function r given by $r(x) = \frac{1}{\sqrt{2\pi\sigma^2}} e^{-\frac{x^2}{2\sigma^2}}$ with $\sigma = 0.2$. You are encouraged to see the effect of σ on $(s * r)(x)$ by trying other values of σ.

Please perform the integrations in (a) and (b) via numerical computation.

Note that you can use any computer language to carry out the numerical computation.

Please submit both the computer program and the plots.