

Homework 3 (Due: May 14th)

(1) Determine the Fourier transform of the following functions.

(a) $g(x) = \exp(-\pi x^2/2)(x^3+x)$

(b) $g(x) = \sin(\pi x/6)$ for $0 < x < 6$, $g(x) = 0$ otherwise

(c) $g(x) = -x$ for $-1 < x < 1$, $g(x) = x-2$ for $1 < x < 2$,
 $g(x) = 2+x$ for $-2 < x < -1$, $g(x) = 0$ otherwise.

(d) $g(x) = \delta(\sin(x))$ (40 scores)

(2) Determine the 2D Fourier transform of

$$g(x, y) = 1 \quad \text{for } (x-1)^2 + \frac{y^2}{4} < 1, \quad g(x, y) = 0 \quad \text{otherwise.}$$

(10 scores)

(3) Determine the 30-point DFT of $g[n]$ where

$$g[n] = 1 \quad \text{when } n \text{ is a multiple of 3 or 5,} \quad g[n] = 0 \quad \text{otherwise.}$$

(10 scores)

(4) Determine the following convolutions.

(a) $\sin(5\pi x)\cos(3\pi x) * \text{sinc}(5x) * \text{sinc}(10x)$

(b) $\delta'(x) * \delta(2x) * \delta(x-3) * \exp(-x^2)$ (20 scores)

(5) Using a Matlab or Python code to determine the continuous Fourier transform of the following functions by the DFT.

(a) $g(x) = \exp(-|x|^{0.5}) - \exp(-2)$, for $-4 < x < 4$,

$g(x) = 0$ otherwise, $\Delta_x = 0.05$.

(b) $g(x) = \sin(\pi x^2/9)$ for $0 < x < 3$, $g(x) = 0$ otherwise, $\Delta_x = 0.1$.

The results should be plotted. The codes should be handed out by NTUCool. (20 scores)