

Medical Computer System and Analysis (1111)

Homework #1 (Due: 2022.10.17)

Please use Python or Matlab for this homework.

Please include the source codes and comprehensive report (.pdf) in your uploaded ZIP file.*

1. Generate the following signals and their plots in time domain:

(f_s : sampling frequency)

- (a) $1 - \exp(-t / T_1)$, $0 \leq t \leq 6000$, $T_1 = 1000$
- (b) $\exp(-t / T_2)$, $0 \leq t \leq 500$, $T_2 = 60$
- (c) $\cos(200\pi t + 10\pi)$, $0 \leq t \leq 20$ msec , $f_s = 250 \text{ Hz}$
- (d) $\cos(200\pi t + 10\pi)$, $0 \leq t \leq 20$ msec , $f_s = 100 \text{ Hz}$
- (e) $\frac{\sin(200\pi t)}{\pi t}$, $-100 \leq t \leq 100$ msec , $f_s = 400 \text{ Hz}$

2. According to Prob.1, plot the Fourier transformed spectra for the signals of (c), (d) and (e) with respect to proper frequency in Hz.
3. Convolve the time-domain signals in Prob.1(c) with Prob.1(e) by transforming them into frequency domain. Please show the signals before and after doing convolution in frequency domain and transform the convolved signal back to time domain.
4. According to Prob.1.(e), plot the time domain signal with 2 side-lobes and 6 side-lobes. Then transform them into frequency domain. Explain the results in your own words.
5. Use Matlab or Python to plot the following 2-D functions as gray-level images (image size = 512x512 pixel), and also display their FFT results (magnitude) as images with Log scale in intensity.

$$(a) \cos[2\pi(x + 2y)] \quad (b) \frac{\sin(4\pi x)}{\pi x} \frac{\sin(2\pi y)}{\pi y}$$

6. A 2D Gaussian function can be expressed as:

$$f(x, y) = A \exp \left(- \left(\frac{(x - x_0)^2}{2\sigma_x^2} + \frac{(y - y_0)^2}{2\sigma_y^2} \right) \right)$$

where A is the amplitude, x_0, y_0 is the center and σ_x, σ_y are the spreads of the blob.

Please plot its 2D gray-level image of 512x512 pixel with $A = 1$, (x_0, y_0) is the center of image, $\sigma_x = \sigma_y = 10$.