

Please make a zip file named *HW1_stdno_lastname* and upload in cw. For practical exercises no report is needed, just complete .ipynb files. For theoretical exercises you are allowed to use solutions, but you need to justify each equation in your proof. Feel free to contact if you had any question elgh14@gmail.com.

Theoretical

1. What is stationary signal? What's the properties of its auto-covariance and autocorrelation matrix of a stationary sequence? Proof the symmetric property of these matrices.
2. A stationary signal $X(t)$ has the auto-covariance function

$$\gamma_X(\tau) = 16e^{-5|\tau|} \cos 20\pi\tau + 8 \cos 10\pi\tau$$

- (a) Find the variance of the signal.
 - (b) Find the power spectrum density (PSD) of this signal.
 - (c) Find the autocorrelation function (ACF) of this signal.
 - (d) Find the value of the spectral density at zero frequency.
3. What is separability in signals? Proof the separability property of 2D Fourier Transform.
 4. What is the fourier transform of a comb function? Find the inverse fourier transform of X :

$$X(e^{j\omega}) = \sum_{k=-\infty}^{\infty} (-1)^k \delta\left(3\omega - \frac{k\pi}{2}\right)$$

Practical

5. Fill the file `fourier.ipynb` to Plot fourier transform of images leaf, scene, rocks, and starfish.
6. Fill the file `convolution.ipynb`.
 - Read image Poppy and do wanted operations on its size and channels.
 - When we convolve an image, we will lose information on corners of the image. To avoid this, we can add rows and columns of zeros to up, down, left and right of image. Write a function which pads the image.
 - Write a function to convolve given image and filter. Then convolve image with and without padding using given sobel filters.
 - Convolve image with both sobel filters using opencv library.