# Homework III

Due: Oct. 18. (Sun) 23:59 PM

## I. REMARK

- Reading materials: book (Foundations of Signal Processing, Ch 4 and Ch 5 )
- Read not whole contents but the part only last class covered.
- Use MATLAB and justify your answer.
- Be healthy!!

## II. PROBLEM SET

1) Let finite discrete-time signal $y_1$ be

$$y_1[n] = \cos(2\pi f_o t)|_{t=nT}, n = 0, 1, \ldots, 99$$

where $T$=0.01 sec is the sampling interval and $1/T$ =$f_s$= 100 Hz is the sampling frequency. $f_o$=5 Hz is the frequency of the sinusoidal signal. Plot $y_1$ over $t$ such that the unit for the horizontal axis is sec. Use the option "-." or "-o" for displaying both line and marker. Let $Y_1$ be the DFT of $y_1$. Plot the magnitude $|Y_1|$ over angular frequency (rad/s). Also, plot $|Y_1|$ over frequency (Hz). Use 'fft' and 'fftshift'. The ranges of the frequencies must be

- angular frequency: $-\pi$ to $\pi$
- frequency: $-f_s/2$ to $f_s/2$

2) Let finite discrete-time signal $y_2$ be

$$y_2[n] = \begin{cases} \cos(2\pi f_o t)|_{t=nT}, & n = 0, 1, \ldots, 50 \\ \cos(2\pi f_1 t)|_{t=nT}, & n = 51, 52, \ldots, 99 \end{cases}$$

where $T$=0.01 sec, $f_o$=5 Hz, and $f_1$=25 Hz. Plot the signal and DFTs like problem 1).

3) The signal $y_2$ is given in problem 1). Downsampling by 3 is conducted as

$$y_3[n] = y_2[3n], n = 0, 1, \ldots, 33$$

Plot the signal and DFTs like problem 1). Explain the spectrum changes between $y_2$ and $y_3$.

4) The signal $y_3$ is given in problem 3). Upsampling by 3 is conducted as

$$y_4[n] = \begin{cases} y_3[n/3], & \text{if } n = 0, 3, 6 \ldots, 99 \\ 0, & \text{else} \end{cases}$$

Plot the signal and DFTs like problem 1). Explain the spectrum changes between $y_3$ and $y_4$.

5) The signal $y_5$ is given as

$$y_5[n] = \exp(2\pi j f_o t)|_{t=nT}, n = 0, 1, \ldots, 99$$

Plot the signal and DFTs like problem 1). Explain the spectrum difference between $y_1$ and $y_5$. Why is signal $|Y_1|$ symmetry, but signal $|Y_5|$ not symmetry?

6) The signal $y_6$ is given as

$$y_6[n] = (y_1 * y_5)[n], n = 0, 1, \ldots, 99$$

where $y_1$ and $y_5$ are given in Problems 1) and 5), respectively. $*$ denotes the circular convolution (N=100). Plot the signal and DFTs like problem 1). Explain the spectrum difference between $y_6$ and $y_1$. What is the reason of the change?