Signal Processing Lab Quiz

MONSOON 2022

For the following tasks, you must submit all work (calculations, code, plots, results in addition to comments). Submit the codes in the 'Codes' folder, results in the 'Results' folder, zip it and submit on Moodle

1 Question - 1

Write a function to down-sample a given sequence by positive integers M and N. In a 3x1 plot, plot the original signal $x[n]$, and the down-sampled sequences $x_M[n]$ and $x_N[n]$. For each of these cases, determine the **DTFT** and in a 3x1 plot, plot the **amplitude spectrum** of the original signal $x[n]$ and of the two down-sampled sequences $x_M[n]$ and $x_N[n]$. Test the working of your function using the sequence

$$x[n] = sin(2\pi fn)$$

Assuming `last = {Roll_Number}%10 + 6`

- frequency, `f = last/10`
- time vector, `n = 0:last/10000:2*last*pi`
- `M = last`
- `N = 100*last`

Use the above mentioned parameters to generate the sequence and test the working of the function as mentioned above. State what you observe and give a possible explanation for the results (**To be written and submitted**)

2 Question - 2

Recover the original sequence by up-sampling (and linearly interpolating) the down-sampled sequence. For this, use the obtained down-sampled sequences $x_M[n]$ and $x_N[n]$, and set the up-sampling rates as M and N respectively *Q1*.

In a 2x2 plot, plot the down-sampled sequences $x_M[n]$ and $x_N[n]$ and the up-sampled sequences $x_M^{up}[n]$ and $x_N^{up}[n]$. For each of these cases, determine the DTFT and in a 2x2 plot, plot the **amplitude spectrum** of the down-sampled sequences $x_M[n]$ and $x_N[n]$ and of the up-sampled sequences $x_M^{up}[n]$ and $x_N^{up}[n]$. State what you observe and give a possible explanation for the results (**To be written and submitted**).

3 Question - 3

Implement a matched filter to detect and locate the position of patterns in a given sequence. Test the working of your filter over the sequence

$$x[n] = \begin{cases} 5\sin(2\pi fn) & \text{if } 0 \leq n < \frac{\pi}{last} \\ 5\cos(2\pi fn) & \text{if } \frac{\pi}{last} \leq n < 2\pi - \frac{\pi}{last} \\ 5\sin(2\pi fn) & \text{if } 2\pi - \frac{\pi}{last} \leq n \leq 2\pi \end{cases}$$

Assuming `last = {Roll_Number}%10 + 6`

- frequency, `f = last`
- time vector, `n = 0:last/1000:2*pi`

Design the matched filter to detect the sequence

$$p[n] = 5\sin(2\pi f_1 n_1)$$

Assuming `last = {Roll_Number}%10 + 6`

- frequency, f_1 = `last`