Report - SP Lab 6

Sannidhya Gupta (2021112012)

Question 6.1

b

In the first two subplots we just plot the real and complex parts respectively, and the third plot contains the magnitude of the FT → $\sqrt{real^2 + imag^2}$. Finally, the phase plot can be given by $\phi, where\ \phi = tan^{-1}\frac{imag}{real}$

c

Time scaling

d

And expected FT's indicate peaks at $w = 1$ for $x(t) = e^{jt}$, and peaks at $w = -1\ and\ 1$ for $x(t) = cos(t)$

Observed shapes resemble dying sinusoids

e

We can represent xt by using the piecewise function in MATLAB, given by:

```
xt = piecewise(t<0 & t>=-T,1+t,t>=0 & t<=T,1-t,0);
```

Question 6.4

`b` LPF

When we change the cutoff frequency (w_c) from 2 to 0.5, we can see that initially, the signal which existed at frequency 1, which was allowed through the LPF is now suppressed, and we do not get any output.

`c` HPF

In this case, by using a similar analogy as the previous part, when $w_c = 2$ was blocking all the frequencies present in the input signal (no output was present), now $w_c = 0.5$ allows the signal to pass through as it is and we get the input signal as it is in the output.

`d` Non-ideal filter

According to what is visible, we get the input signal as the output, however it is phase shifted. So the non ideal filter, instead of removing certain frequencies, changes the phase of the signal itself, and also modifies the magnitude a bit.

The complex nature of the filter just reflects in the phase of the output wave, also only the real part of the wave is required and is plotted as the output.

Question 6.5

In order to perform zero order interpolation, `'previous'` parameter was used with `interp1` command, and for linear interpolation, `'linear'` was used.

For the ideal reconstruction filter, we use the `sinc()` function in order to prevent 'division by zero' error.

Visually, none of the interpolations match the original wave, the zeroth order is completely different, linear interpolation is a bit closer as it, unlike the zeroth order, doesn't discrete the output. The sinc reconstruction is the closest to the output out of these three, as it produces sinusoid resembling outputs, however not exact.

About the maximum absolute errors, it is calculated in the program and displayed as output in the terminal

```
MAE for zeroth order
    1.7601

MAE for linear/first order
    1.2076
```

```
MAE for sinc interpoltion
    1.0769
```

Quesiton 6.6

Corresponding `t_samples` vector is:

```
time_grid = -1:Ts:1; % time_grid = t_samples
```

As the sampling interval (Ts) is changed, we observe that:

On decreasing Ts or reducing the size of the sampling interval, we get more and more samples in the sampled signal, and consequently get a more precise and accurate reconstruction of the signal to the original one.

Question 6.8

Nyquist rate is:

```
Nyquist rate = 5
```

We can see that on increasing the size of the sampling interval, we observe aliasing, lose the signal at some points as overlapping occurs, so in this case the reconstruction does not result in an accurate output.
