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| **Cours : Traitement du signal**  **TP n°2 : Spectral Analysis** | |  | Houssem Gazzah  CIPA4 Nantes |
|  | | | |
|  | *Nom …… …………..*  *Prenom …………………..………..* | | |

**FFT**

The **fft** MATLAB command enables you to obtain the spectrum of a signal

The simplest manner to call ftt is to write: **X=fft(x)**

Input x and output X are vectors with the same length, say N

**x** represents N **samples of a signal** x(t), at **0,Ts,…,(N-1)Ts** seconds

**X** represents N **samples of the spectrum** X(f), at **0,fi,…,(N-1)fi** Hz

How is **fi** related to **Ts** ?

Intuitively, Ts is smallest time interval being observed (smallest time resolution)

As a consequence, fs=1/Ts is the largest frequency you could possibly measure

Conclusion: **fs=N.fi** (Notice, N is large enough so that N-1≈N)

**Notice** that because we manipulate real-valued signals, the spectrum will be symmetrical (redundant). We study the first half of it. Also, we are often interested in the magnitude only of the complex-valued spectrum

**Experiment 1**

To Generate a mixture of sinusoidal signals and to verify that the spectrum is as predicted by theory

i/ Set the sampling period to 0.2ms and the time interval to [0,4s]

Generate the signal x(t)= sin(2000t+56) sin(56-6000t)+2 cos(4000t)

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| a) Plot the magnitude spectrum of x(t). | b) Plot the magnitude spectrum of x2(t)**.** |

ii/ Set the sampling frequency to 5KHz and the time interval to [0,2s] **(No help will be provided)**

Generate the signal x(t)= cos (2000t2) +0.01\*sin(2000t) +0.01\*sin(10000t);

Insert plot here

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| --- | --- |
| **Experiment 2**  Consider the following power spectrum of some signal x(t)  Write a MATLAB code that generates a signal y(t) with the same power spectrum  Replace the present figure by yours |  |

**Experiment 3**

Load (TP 1) the signal from *'holiday\_offer.mat'*

It has been sampled at the rate of 11025 samples/second

Plot the associated power spectra. **Insert here**

|  |  |
| --- | --- |
| Your plot | The solution |

**Experiment 4**

i/ Set the sampling period to 0.5ms

Set the time interval to [0,2s]

Generate the signal x(t)= sin(4000t)+2 cos(4000t-32)+cos2(2000t)

Plot the magnitude spectrum with the horizontal axis properly labeled in Hz**.**

ii/ Set the sampling frequency to 5KHz

Set the time interval to [0,2s]

Generate the signal *x(t)= 0.1 sin (2000t1/2) +0.01 sin(4000 t) +0.01 cos(7000 t)*

Plot the magnitude spectrum with the horizontal axis properly labeled in Hz**.**

**Insert plots here**

|  |  |
| --- | --- |
| i/ | ii/ |

**Experiment 5**

**S**et the time interval to [0,0.4s]. Consider the signal

*x(t)= cos(2π+20000t) sin(2π 30000t)+2 cos(22000t)*

i) Using the Fourier spectral theory, list the frequencies that form the signal

*……………………………………………………………………………….*

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ii) Choose an appropriate sampling period Ts and plot the magnitude spectrum of x(t).

**Experiment 2 (10 points. No help)**

Set the sampling period to 0.5ms

Set the time interval to [0,2s]

Plot the magnitude spectrum of the signal x(t)= sin(4000t)+2 cos(4000t-32)+cos2(2000t)

**Experiment 6**

**Spectral Analysis of the raised cosine waveform**

The objective is to generate and analyze the so-called raised cosine pulses used in communication systems

The raised cosine pulse is defined as follows



For this experiment, set T=2 ms and β=0.5

Consider generating the pulse for t in [-10T,10T]

Denote **Ts** as the sampling period, set to *0.13 T*

**a/** Generate the pulse **h** and plot it. Label the x-axis in ms. Insert your plot here

**b/** Compute spectrum **H** of **h**. Plot the magnitude spectrum with the y-axis labeled in Hz. Insert plot here

|  |  |
| --- | --- |
| Time domain | Frequency domain |

**c/** Measure the signal bandwidth. Bandwidth**=..............................**

**d/** Repeat steps b-d with β =0.25

|  |  |
| --- | --- |
| Time domain | Frequency domain |

Bandwidth**=..............................**