BRUFACE
MA1 Civil Engineering

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Dynamics of Structures
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Session 2 : Signal Processing

Exercise 1

Consider the function $u(t) = sin(\omega t)$, where t goes from 0 to 10 seconds, and whose frequency is equal to $1Hz$.

- plot the function $u(t)$ as a function of the time
- Use the fft function in Matlab to compute:
  a) The discrete Fourier transform of $u(t)$. Use the obtained c_n coefficients to compute the a_n and b_n coefficients (see lecture notes). Check what is the influence of the time step Δt used to sample the function $u(t)$. What is the usefull frequency interval in this computation and how does it change with Δt ?
  b) The continuous Fourier transform of $u(t)$. Compare the results obtained with the theory and discuss on the influence of the length of the sampled signal, starting from $T = 10s$.

Exercise 2

Consider the same 1-DOF system as in session 1 with $k = 1000N/m$, $m = 1kg$ and a damping coefficient $\xi = 0.01$.

- Give the expression of the impulse response $h(t)$.
- Compute the continuous Fourier transform of $h(t)$ and give the link with the transfer function $H(\omega) = \frac{X}{F}$
- Give the expression of $H(\omega)$, plot it and compare with the continuous Fourier transform of $h(t)$ on the same graph
- Compute the continuous Fourier transform of $h(t)$ using a time interval $\Delta = 1/8sec$. Compare with the previous graphs. What happens and why ?

Exercise 3

Consider the recorded base acceleration signal given in the $quake.mat$ file, corresponding to the 1989 Santa Cruz earthquake.

- Compute the continuous Fourier transform of $e(t)$

- Represent the amplitude and the phase of the Fourier transform as a function of the frequency
- Identify the range of frequencies which are excited by the earthquake

To load the time and signal vectors in Matlab:

```
load quake
% Scaling factors
g = 0.0980; e = g*e/100;
dt = 1/200; t = dt*(1:length(e))';
```