AV314 - Programming assignment 4

Out : 13/8/18

Due : 20/8/18

Fourier transform and its properties.

a) Computation of the Fourier transform on a computer.

Suppose $x(t)$ is a real valued signal with finite energy. Then the Fourier transform of $x(t)$ is defined to be $\int_{-\infty}^{\infty} x(t)\, e^{-j2\pi f t}\, dt$; we denote the Fourier transform by $X(f)$.

We need to compute $X(f)$ on a computer. There are two main difficulties associated with this :

(a) $X(f)$ is a function of real valued variable f. But we cannot find and store $X(f), \forall f$.

(b) the $X(f)$ is computed via an integral, which cannot be done on a computer.

(a) is handled by discretizing f : instead of $f \in (-\infty, \infty)$, we consider $f \in$ a discrete and finite set $\{-Nfs, (-N+1)fs, \cdots -2fs, -fs, 0, fs, 2fs, 3fs \cdots, Nfs\}$.

(b) is handled by approximating the $\int$ by a sum.

$$\int_{-\infty}^{\infty} x(t) e^{-j2\pi f t} dt = \sum_{k=-\infty}^{\infty} x(kTs)\, e^{-j2\pi f kTs} \cdot Ts.$$

or on a computer we get $X(nfs) \approx \sum_{k=-\infty}^{\infty} x(kTs) \cdot e^{-j2\pi f kTs} \cdot Ts, \; \forall n \in \{-N, \cdots 0, \cdots N\}$

Since $x(t)$ is usually time limited the sum in the above expression runs over a finite number of indices.

i) compute the F.T of $x(t) = u(t) - u(t-1)$. Try out different values for Ts and fs. Derive the F.T of $x(t)$ by hand and compare with what you have computed.

ii) compute the F.T of $x(t) = (u(t) - u(t-1)) \cos(2\pi 10 t)$. Again try out different values of Ts and fs. Derive the F.T of $x(t)$ by hand and compare with what you have computed.