# EC3400: Computer Assignment 1

In this project we address the problem of sampling sinusoidal signals to understand analog frequencies, digital frequencies and aliasing.

**Problem 1**. (pencil and paper)

Consider the signal $x(t) = 5\cos(4000\pi t + 0.1)$.

Q1. Determine its Fourier Transform $X(F) = FT\{x(t)\}$ and sketch it;

Q2. Let $F_s = 5kHz$ be the sampling frequency and call $x[n] = x(nT_S)$ the sampled sequence. Determine $X(\omega) = DTFT\{x[n]\}$ and sketch it for $-\pi \le \omega \le \pi$. Determine the digital frequencies of this signal.

Q3. Same as Q2 with $F_s = 3kHz$. Which other frequency $F$ (in Hz) has the same samples?

**Problem 2 (Matlab)**

In this problem we make use of the FFT, as an approximation of the DTFT. In particular we use the following fact:

FACT: Let $x[n], n = 0,...,N-1$ be a sequence of length $N$, and $X[k] = FFT\{x[n]\}, k = 0,...,N-1$ be its $N$-point FFT. Then, if $N$ is "large enough",

$$X[k] \simeq X(\omega)\big|_{\omega = k\frac{2\pi}{N}}, \; k = 0,...,N-1$$

with $X(\omega) = DTFT\{x[n]\}$.

Consider the same signal $x(t) = 5\cos(4000\pi t + 0.1)$.

Q1. Generate $N = 1024$ samples $x[n] = x(nT_s), n = 0,...,1023$ with sampling frequency $F_s = 5kHz$. Plot the magnitude of the FFT in the range $0 \le k < N/2$ and verify that it has a peak at $\omega \simeq \omega_0$ as from Problem 1, Q2;

Q2. Same, for $F_s = 3kHz$ and compare with Problem 1, Q3.

**Matlab Commands**:

n=0:N-1; x=A*cos(w0*n+alpha); to generate a vector of cos. with digital frequency w0;

X=fft(x); yields the fft of the vector x

Note: Matlab has no zero or negative indeces

k=0:N/2-1; plot(k, abs(X(1:N/2))) to plot the FFT as a function of the index "k".