

# EXPERIMENT 1

## SAMPLING THEORY

### OBJECTIVES

In this experiment you will investigate Sampling Theorem.

### PRE-LAB ASSIGNMENT

Given signal  $x(t) = \text{sinc}(t)$ :

1. Find out the Fourier transform of  $x(t)$ ,  $X(f)$ , sketch them.
2. Find out the Nyquist sampling frequency of  $x(t)$ .
3. Given sampling rate  $f_s$ , write down the expression of the Fourier transform of  $x_s(t)$ ,  $X_s(f)$  in terms of  $X(f)$ .
4. Let sampling frequency  $f_s = 1\text{Hz}$ . Sketch the sampled signal  $x_s(t) = x(kT_s)$  and the Fourier transform of  $x_s(t)$ ,  $X_s(f)$ .
5. Let sampling frequency  $f_s = 2\text{Hz}$ . Repeat 4.
6. Let sampling frequency  $f_s = 0.5\text{Hz}$ . Repeat 4.
7. Let sampling frequency  $f_s = 1.5\text{Hz}$ . Repeat 4.
8. Let sampling frequency  $f_s = 2/3\text{Hz}$ . Repeat 4.
9. Design a Matlab function to calculate the Fourier transform of a sampled signal  $x_s(t)$ ,  $X_s(f) = \sum_k x(kT_s) \exp(-j \cdot 2\pi f \cdot kT_s)$ . This is necessary in your experiments.

**NOTE:** In Matlab and this experiment,  $\text{sinc}(t)$  is defined as  $\text{sinc}(t) = \sin(\pi t)/(\pi t)$ . Under this definition:  $\text{sinc}(2Wt) \rightarrow 1/(2W) \text{rect}(f/2W)$ .

### PROCEDURE

1. Design Matlab programs to illustrate items 4-8 in Prelab. You need to plot all the graphs.
2. Compare your results with your sketches in your Prelab assignment and explain them.