EEC516 HW01 (Fall 2018)

Due: **Wednesday, September 12** *at the beginning of lecture*

Problem 1.1

In lecture, we saw that DSP may be viewed as "creation of *alternative patternizations* of signals."

a) *In your own words* describe what the concept of *alternative patternizations* of a signal means to you and illustrate with concrete examples.

b) In lecture, we saw that the Fourier transform can be used to obtain an alternative patternization that does not involve *loss* of information. Give two different examples of alternative patternizations of a signal that involve *loss* of information.

Problem 1.2

Consider the signal $x(t)$ that is the "sinc" function specified as

$$x(t) = \frac{\sin(100\pi t)}{\pi t}$$

a) For what values of *t* is it true that $x(t) = 0$? *Justify your answer*. These values of *t* are generally referred to as the "zeros crossings" of the sinc function.

b) Determine the value of $A = \lim_{t \to 0} x(t)$. *Justify your answer*.

Problem 1.3

The *Finite Sum Formula* and the *Infinite Sum Formula* are very useful in DSP.

a) Show that the *Finite Sum Formula*, given as $\sum_{n=0}^{N-1} \alpha^n = \frac{1-\alpha^N}{1-\alpha}$, is valid for all complex numbers α.

b) Determine the range of complex values α for which the Infinite Sum Formula, given below, is valid. *Justify your answer*.

$$\sum_{n=0}^{\infty} \alpha^n = \frac{1}{1-\alpha}$$

Problem 1.4

Consider a "complex exponential" defined as $e^{j\theta} = \cos(\theta) + j\sin(\theta)$

a) Show that $\cos(\theta) = 0.5e^{j\theta} + 0.5e^{-j\theta}$

b) Show that $j\sin(\theta) = 0.5e^{j\theta} - 0.5e^{-j\theta}$

c) Show that $e^{j(\theta+2\pi k)} = e^{j\theta}$ for all integers *k*.

d) Determine the value of $|e^{j\theta}|$, the magnitude of $e^{j\theta}$. Justify your answer.

e) Plot the "phase" (defined as the arctan of the imaginary part divided by the real part of a complex number) of $e^{j\theta}$ as a function of θ. Justify your answer.

Problem 1.5

The *Sampling Theorem* states that a *real-valued* continuous-time signal can be reconstructed from its uniformly spaced samples provided the sampling frequency is greater than *twice* the highest frequency in the signal.

a) *Explain* why this statement is restricted to real-valued signals.

b) How would you *change* the Sampling Theorem statement so that it applies even to complex-valued signals? Justify your answer.