UNIVERSITY OF ILLINOIS
Department of Electrical and Computer Engineering
ECE 417 Multimedia Signal Processing

## Lecture 1 Sample Problems

## Problem 1.1

Consider the signal

$$
x(t)=\sin (14000 \pi t)+3 \cos (16000 \pi t)
$$

Suppose $x(t)$ is sampled at $F_{s}=10,000 \mathrm{~Hz}$ without an anti-aliasing filter. Find $x[n]$-normalize the frequencies of both sinusoids so they're between 0 and $\pi$.

## Problem 1.2

Same signal as in Problem 1. Find the CTFT, $X(j \Omega)$, and the DTFT, $X\left(e^{j \omega}\right)$. Sketch them both, showing the frequencies and areas of the four impulses.

## Problem 1.3

Consider the signal

$$
x(t)=e^{-100 \pi t} \sin (1000 \pi t) u(t)
$$

Find $X(j \Omega)$, using the formula $\int_{0}^{\infty} e^{a t} d t=\frac{1}{a}$. Sketch $|X(j \Omega)|$, showing the approximate frequencies, heights, and widths of the two peaks.

## Problem 1.4

Suppose, now, that the signal $x(t)$ from problem 3 is sampled at $F_{s}=2000$ samples/second without an anti-aliasing filter, so that $x[n]=x\left(n / F_{s}\right)$. Find its DTFT using the formula $\sum_{n=0}^{\infty} x^{n}=\frac{1}{1-a}$, which, as you know, is valid only if $|a|<1$. Sketch $\left|X\left(e^{j \omega}\right)\right|$, showing the approximate frequencies, heights, and widths of the two peaks. Note: in order to find the frequencies, heights, and widths of the two peaks, you may find it useful to approximate $e^{a} \approx 1+a$.

