

# ECE 401 Signal and Image Analysis

## Homework 1

UNIVERSITY OF ILLINOIS  
Department of Electrical and Computer Engineering

Assigned: 8/24/2022; Due: 8/31/2022  
Reading: *DSP First* pp. 12-34, 50-58, 61-71

### Problem 1.1

Find  $\angle z$  as a function of  $a$  and  $b$ .

$$z = e^{ja} + e^{jb} \quad (1.1-1)$$

### Problem 1.2

In standard tuning, the middle A note on a piano (A4) has a frequency of 440Hz. Consider the note

$$x(t) = 14 \cos(2\pi 440t + 0.88\pi)$$

Sketch one complete period of  $x(t)$ , from its first peak after  $t = 0$  until its second peak after  $t = 0$ . Label the times of both peaks, and the value of  $x(t)$  at both peaks.

### Problem 1.3

Suppose you're given the signal

$$x(t) = \cos(2\pi 440t) + 3 \sin(2\pi 440t)$$

Find the phasor representation of  $x(t)$ , and simplify it to polar form. You might want to take advantage of facts like  $\sin(x) = \cos(x - \frac{\pi}{2})$ , and  $\sin(\frac{\pi}{2}) = 1$ , and  $\cos(\frac{\pi}{2}) = 0$ .

### Problem 1.4

Kwikwag's beat-tones example on Wikipedia adds two tones, at the frequencies 110Hz and 104Hz:

$$x(t) = \cos(2\pi 110t) + \cos(2\pi 104t)$$

Find a sequence of frequencies and phasors,  $\{(f_{-2}, a_{-2}), \dots, (f_2, a_2)\}$ , such that

$$x(t) = \sum_{k=-2}^2 a_k e^{j2\pi f_k t}$$