Yıldız Technical University
Computer Engineering
2023-2024 Spring
BLM3620 Digital Signal Processing
Homework 1

Question 1) Dual Tone Multi Frequency (DTMF) is a group signaling method that uses mixture of two pure tones (sinusoids) to discriminate the key pressed on the phone.

4 by 4 phone keypad has the following pure tone mixtures. For instance when key "1" is pressed two sinusoids with frequencies of 697 Hz and 1029 Hz are added.

	1209 Hz	1336 Hz	1477 Hz	1633 Hz
697 Hz	1	2	3	A
770 Hz	4	5	6	B
852 Hz	7	8	9	C
941 Hz	*	0	#	D

Given a waveform recorded from a sequence of DTMF tones, each with a duration between 0.3 seconds and 0.5 seconds, separated by 0.1 seconds of silences, can you determine the sequence of keys pressed? You are not allowed to use any library in Matlab other than primitive functions.

You can read the provided wav file using the following command:

[y,Fs] = audioread('input.wav')

y is the data itself and Fs is the sampling frequency, for he provided wav 8000 samples correspond to 1 seconds of recording.

Question 2) Let x(t) be the signal

$$x(t) = [10 + 5 \cdot cos(2000\pi t + \pi/5)] \cdot cos(10000\pi t)$$

a) Use the Euler's relation to expand x(t) as a sum of complex exponential signals and show that it can be expressed in the Fourier series form

$$x(t) = \sum_{k=-\infty}^{\infty} a_k \, e^{jk\omega_0 t}$$

b) Determine the fundamental frequency ω_0 of the signal.

c) Determine the DC value of the signal.

d) Determine all of the non-zero coefficients a_k of the signal and plot the spectrum of the signal.