The American University in Cairo
Computer Science and Engineering Department
Fall 2022

CSCE 363/3611 – Digital Signal Processing

Assignment #1

(Due on: October 15, 2022 at mid-night)

(The assignment is individual – Submit on Blackboard as one .zip file)

Problem 1

Consider the discrete-time signal given by:

$$x(n) = \{-1, -2, 0, 1, 1, 1, 0, 0\}$$
$$\uparrow$$

Sketch and label carefully each of the following signals:

a) $x(n-5)$
b) $3x(n+2)$
c) $x(-n-7)$
d) $x(n)u(n)$

Problem 2

Represent the system given by the following input-output equation as a block diagram:

$$y(n) = x(n-2) + 2x(n-3) + x^2(n-2) + y(n-5)$$

Problem 3

For each of the following systems, determine whether it is static or dynamic, time variant or time invariant, linear or nonlinear and causal or non-causal. Justify your answer:

a) $y(n) = x(n-7) + 2x(n-3)$
b) $y(n) = (n+1)x(n)$
c) $y(n) = \cos(x(n)) + x(n-3)$

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Problem 4

Implement the following functions using MATLAB or Python:

- Downsample: A function that takes as input the file name of an input audio file, the downsampling factor (integer only), and the file name of the output downsampled audio file. This function should change the sampling rate of the input audio from F_s to (F_s/downsampling factor) without changing the duration of the audio.
- IncreaseSpeed: A function that takes as input the file name of an input audio file, the speeding factor (integer only), and the file name of the output increased speed audio file. This function should change the duration of the input audio from T to (T/speeding factor) without changing the sampling rate.

Deliverables:

- Your code (either MATLAB .m files or Python .py or Jupyter notebook files).
- Apply the Downsample function to the audio file provided "Audio1.wav" using a downsampling factor of 2, 3, and 10. Name the output files "Audio1_Down_2.wav", "Audio1_Down_3.wav" and "Audio1_Down_10.wav", respectively. The sampling rate of the original audio is 14.4 KHz.
- The file "Audio1.wav" represents the following signal:

$$x_a(t) = 0.1\sin\left(2\pi \times 1000t\right) + 0.9\sin\left(2\pi \times 3000t + \frac{\pi}{3}\right)$$

  Comment on which of the downsampling factors results in a noticeable change in the audio and the reasons for such a change.
- Apply the Downsample function to the audio file provided "Audio2.wav" using a downsampling factor of 2, 10, and 35. Name the output files "Audio2_Down_2.wav", "Audio2_Down_10.wav" and "Audio2_Down_35.wav", respectively. The sampling rate of the original audio is 44.1 KHz.

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- Comment on the quality of the audio obtained after downsampling the file "Audio2.wav".
- Apply the IncreaseSpeed function to the audio file provided "Audio1.wav" using a speeding factor of 2, 3, and 4. Name the output files "Audio1_Inc_2.wav", "Audio1_Inc_3.wav" and "Audio1_Inc_4.wav", respectively.
- Apply the IncreaseSpeed function to the audio file provided "Audio2.wav" using a speeding factor of 2, 3, and 4. Name the output files "Audio2_Inc_2.wav", "Audio2_Inc_3.wav" and "Audio2_Inc_4.wav", respectively.

Important Notes:

- All deliverables should be included in one .zip file.
- For Problems 1, 2 and 3, write your answer in a Word or PDF file and include it in the .zip file.
- For Problem 4, you need to implement the downsampling and increasing speed from scratch. Don't used ready made functions that you might find available in MATLAB or Python.
- This is an individual assignment.