AIN SHAMS UNIVERSITY
FACULTY OF ENGINEERING

Department of Electronics & Electrical Communications Engineering
Second Year, Electrical Engineering

Spring 2020	**Course Code: *ECE 251***	***Deadline: 15 June @4 pm***

Signal Processing

The instructions are in **Four** Pages. **1 / 4**

تعليمات هامة:

- غير مسموح بالتشابه بين الابحاث المقدمة من الطلاب
- ضرورة مراعاة الامانة العلمية والدقة في عرض المراجع التي تم الاستعانة بها
- ضرورة الالتزام بالقواعد المنصوص عليها المرتبطة بشكل وعدد الصفحات المنصوص عليها بورقة الامتحان
- يتم تجميع ملفات الاجابة في ملف واحد في صورة PDF ويتم رفعه على صفحة المادة المخصصة على منصة LMS
- ضرورة الالتزام بحجم الملفات المطلوب رفعها وفقا لما هو منصوص عليه بمنصة LMS

Course Project
Signal Processing Applications and Implementation

Signal processing is very important in many applications like communication systems, speech synthesis and analysis, audio enhancement, image, and video processing. In this project, it is needed that you research the latest advancements in one of these applications involving signal processing. It is also needed that you implement basic signal processing functions using Matlab/GNU-Octave.

Research Part (60% of the Marks)

- Write a 5-page article (of font 12) on one of the following topics:
  - AM broadcasting systems
  - FM broadcasting systems
  - Time Division Multiplexing (TDM) TV systems
  - Amplitude Shift Keying (ASK) systems
  - Frequency Shift Keying (FSK) systems
  - Nyquist sampling theorem
  - Satellite communication systems
  - Speech synthesis systems
  - Audio enhancement systems
  - Video processing systems

- The article should at least contain the following sections:
  - History
  - Basic principles including the nature of the signals used, their frequency domain representations, types of filters used, bandwidth limitations, etc.
  - Recent developments
  - References

- The article should also include:
  - At least one figure with correct caption
  - At least one table with correct caption
  - At least 5 references; including one dated after 2010

  - Remember that figures, tables, and references should be referred to in the body of the article.

Implementation Part (40% of the Marks)

- Use Matlab / GNU-Octave to perform the following steps:

1. Generate the signal $x(t)$ defined as follows:

$$x(t) = \cos(2\pi f_1 t) + \sin(2\pi f_2 t) + \cos(2\pi f_3 t) + \sin(2\pi f_4 t) + \cos(2\pi f_5 t)$$

where $f_1 = 400\ Hz, f_2 = 800\ Hz, f_3 = 1200\ Hz, f_4 = 1600\ Hz,$ and $f_5 = 2000\ Hz.$

2. Store the generated signal $x(t)$ as an audio file with extension (*.wav).
3. Plot the signal $x(t)$ versus time t from -1 to 1 s with appropriate sampling period.
4. Compute the energy of the signal $x(t)$.
5. Compute the frequency spectrum $x(t)$ of this signal.
6. Plot the magnitude of $X(f)$ in the frequency range $-f_s/2 \leq f \leq f_s/2$, where f_s is the sampling frequency.
7. Compute the Energy of the signal $x(t)$ from its frequency spectrum $X(f)$, and hence you can verify Parseval's theorem.
8. Design a Butterworth low-pass filter with filter order 20 and cut-off frequency of 1.25 kHz.
9. Plot the magnitude and phase response of the Butterworth LPF you've designed.
10. Apply the signal $x(t)$ to this Butterworth LPF and let's denote the output signal as $y(t)$.
11. Store the generated signal $y(t)$ as an audio file with extension (*.wav).
12. Plot the signal $y(t)$ versus time t from -1 to 1 s with appropriate sampling period.
13. Compute the frequency spectrum $Y(f)$ of this signal.
14. Plot the magnitude of $Y(f)$ in the frequency range $-f_s/2 \leq f \leq f_s/2$.
15. Verify steps 4, 5, 6, 7, 9, 13, and 14 by equations and hand analysis.

Hint: Use the magnitude only in your hand analysis for steps 9, 13, and 14

Hint: A Low-pass Butterworth filter magnitude is given by $|H(j\omega)| = \frac{1}{\sqrt{1+\left(\frac{\omega}{\omega_c}\right)^{2n}}}$, where n is the order of the filter and $\omega_c$is its angular cut-off frequency.

- Useful Matlab / GNU-Octave Commands:

1. freqz
2. filter
3. butter
4. fft, fftshift
5. audioread, audiowrite

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General Instructions

- This is a group project. Maximum number of students per group is 5.
- Team leader should enter the team member names and IDs to the LMS **no later than 14/5/2020 at 4 PM.**
- The project has to be submitted by the team leader to the LMS. Remember to click the "Submit" button before the deadline.
- **The project deadline is 15/6/2020 at 4 PM.** However, you are encouraged to submit it earlier.
- **Deliver one pdf file** with the following properties:
    - It should be named ECE344_S20_<Team Name>_project_report.pdf
    - It should have a maximum size of 10 MB.
    - It should contain the following:
        - The cover page that will be released by the administration shortly.
        - The plagiarism statement below signed by all the team members.
        - Your 5-page article.
        - Your Matlab/GNU-Octave codes, waveforms, and energy calculations
        - Your hand analysis and calculations
        - A table of the contribution of each student in the project
- The project report will go through a plagiarism check. Reports which show 25% or more similarity will be regarded as **failed**. Reports will be checked against internet databases and other internal papers from other students inside the university.
- The student SHOULD sign the following Plagiarism Statement:

  "I certify that this assignment / report is my own work, based on my personal study and/or research and that I have acknowledged all material and sources used in its preparation, whether they are books, articles, reports, lecture notes, and any other kind of document, electronic or personal communication. I also certify that this assignment / report has not been previously been submitted for assessment for another course. I certify that I have not copied in part or whole or otherwise plagiarized the work of other students and / or persons."

- **Deliver also one zip file** with the following properties:
    - It should be named ECE344_S20_<Team Name>_matlab.zip.
    - It should have a maximum size of 10 MB.
    - It should contain the Matlab/GNU-Octave code (.m) files
    - It should contain the audio (.wav) files

- Due to the COVID-19 pandemic, please take the following pre-cautions:
    - Try to distribute the work among the team members to minimize the need of meetings.
    - Use online meetings for discussions.

Assessment

The report will be graded using the following criteria:

	D(85%-100%)				VG (75%-84%)				G (65%-74%)				P (50%-64%)				F (0-49%)			
	100	95	90	85	84	81	78	75	74	71	68	65	64	60	55	50	49	32	16	0
Relevance & Organization of Ideas in the research article (40%)	• Materials cover the topic widely & deeply. • All main points fully developed. No repetition				• Materials cover the topic widely & deeply. • Clearly structured. All main points valid but not always fully developed. Minor repetition or deviation.				• Most of the materials cover the topic reasonably. • Some structure. Most but not all main points valid & developed. Some repetition.				• Some of the materials are relevant and slightly cover the topic. • Structure not clear. Few valid main points. Repetition or deviation.				• Materials do not cover the topic. • Unstructured. Few, if any, valid main points. Material mostly deviated from the task. Inaccurate or absent.			
Presentation Language (20%)	• Excellent ability to express ideas with proper language and technical vocabulary.				• Good ability to express ideas with proper language and technical vocabulary.				• Normal ability to express ideas with proper language and technical vocabulary.				• Low ability to express ideas with proper language and technical vocabulary.				• Difficult to express ideas with proper language and technical vocabulary.			
Matlab/GNU-Octave (20%)	• Full detailed codes, data, and waveforms with correct values and excellent annotations.				• Full detailed codes, data, and waveforms with correct values.				• Most codes, data, and waveforms with correct values.				• Some codes, data, and waveforms with correct values.				• Fail to present codes, data, and waveforms with correct values.			
Hand Analysis (20%)	• Answers are correct and to the point.				• Most answers are correct.				• Some answers are correct.				• Few answers are correct.				• Most answers are incorrect.			

1st marker Total	----------	1st marker Signature	----------
2nd Marker Total	----------	2nd marker Signature	----------

END of Instructions, Good Luck

Examination Committee
Prof. Wagdy Anis & Dr. Sameh Ibrahim

Submission Deadline: 15th of June, 2020