German Jordanian University
School of Applied Medical Sciences
Department of Biomedical Engineering

BM323: Medical Signal Processing Lab

Course Catalog
1 Credit hour (3 hrs laboratory) Software experiments illustrating the basic principles and techniques of digital signal processing in order to process and analyse different physiological signals. Topics covered include sampling theorem, oversampling and aliasing phenomena, designing IIR and FIR filters for band pass, band stop, low pass and high pass filters, block convolution, signal smoothing, filtering of long duration signals, analysis of physiological signals that have valuable information in useless form, spectral analysis, and amplitude modulation.

Lab Instructor	
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Evaluation		
Assessment Tool	**Weight**	**Expected Due Date**
Lab Reports	30%	Each report is due at the beginning of the next lab session
Quizzes	10%	At any time in any lab session
Midterm Exam	20%	Assigned at the beginning of each semester
Final Exam	40%	Assigned at the beginning of each semester
Total	100%	After completing the final exam

Topics Covered		
Week	**Experiment No**	**Topic**
1	----------	Lab Introduction
2	Experiment 1	Introduction to MATLAB
3	Experiment 2	Complex Number
4	Experiment 3	Sampling Theorem
5	Experiment 4	Fourier Transform
6	Experiment 5	Digital Filters
7	**Exam**	**Midterm Exam**
8	Experiment 6	EMG Signal Processing (part 1)
9	Experiment 7	EMG Signal Processing (part 2)
10	Experiment 8	Amplitude Modulation
11	Experiment 9	EOGUI
12	Experiment 10	Wavelet transform
13	**Exam**	**Final Exam**

Objectives and Outcomes	
Objectives	**Outcomes**
1. Understand the sampling theorem, oversampling and aliasing phenomena.	1.1. Plot signals in continuous and discrete forms using MATLAB. 1.2. Establish a connection between sounds, their frequencies and sinusoids using MATLAB. 1.3. Apply sampling theorem and aliasing phenomena using MATLAB.
2. Analyze the signals in frequency domain.	2.1. Apply and analyze the Fourier Transform Theorem using MATLAB. 2.2. Establish a connection between human speech signal, their frequencies and sinusoids using MATLAB.
3. Understand digital filters and their working principle.	3.1. Recognize the main noise sources that distort the ECG signal. 3.2. Design different FIR and IIR filters using MATLAB. 3.3. Plot the frequency response of different FIR and IIR filters using MATLAB. 3.4. Filter the ECG signal using different filters using MATLAB.
4. To expose the students to signal processing methods applied for quantifying human performance by analyzing EMG signals for *total muscle effort* over a given task.	4.1. Process the EMG signal using MATLAB by doing the following steps (remove the bias, rectification, filtration, and integration). 4.2. Compare the total effort of different muscles, different trials and different weights.
5. To gain a clearer understanding of the amplitude modulation (AM).	5.1. Simulate modulation/demodulation systems for AM using MATLAB for synthetic & real signals (such as

	Photoplethysmography). 5.2. Recognize the basic principle of Photoplethysmograph signal and calculate the heart rate from this signal.
6. To explore the importance of using wavelet transform in analysing signals.	6.1. Denoise the ECG signal through wavelet transform using MATLAB. 6.2. Calculate the timing for each wave and segment in the ECG signal and compare them with the normal values.
7. Understand the using of free MATLAB software with graphical user interface (GUI) to analyze the EOG signal.	7.1. Recognize the EOG signal, define and mark different events in the raw signal. 7.2. Analyze saccades in the vertical and horizontal channel as well as blinks in the vertical channel using EOGUI software.

Lab Report Requirements	
Report section	**Description**
Introduction	This section should provide the context and motivation for the experiment, briefly explain relevant theory in sufficient detail, introduce any relevant laws, equations or theorems, and clearly state the aim or research question that the experiment is designed to address. You should try to write it in your own words, rather than paraphrasing the lab manual (but if you have to, be sure to include the appropriate references). It's always a good idea to read the entire experiment in the manual before you begin your introduction.
Procedure	This section must include a description of the procedure followed. It should not simply be a re-statement of the procedure section of this manual. You should interpret the procedure section and develop your own step-by step method.
Results	In this section, you present the main data collected during your experiment. Each key measurement needs to be reported appropriately. Data are often presented in graphs, figures or tables. These need to be labelled appropriately to clearly indicate what is shown. Tables should be labelled numerically above the table as Table 1, Table 2, etc. Everything else (graphs, images, diagrams etc.) is labelled numerically below the figure as Figure 1, Figure 2, etc.
Discussion	This section should demonstrate how will you understand what happened in the experiment. You should identify and comment on any trends you have observed, compare the experimental results with any predictions, identify how any sources of error might impact on the interpretation of your results, suggest explanations for unexpected results, and where appropriate, suggest how the experiment could have been improved.
Conclusion	This section should provide a message summing up what has been learned from the experiment such as: briefly restate the purpose of the experiment (the question it was seeking to answer), identify the main

	findings (answer to the research question), note the main limitations that are relevant to the interpretation of the results, summarize what the experiment has contributed to your understanding of the problem.
References	List all sources that you have referred to in the body of your report. These can include references to accepted literature values or equations you use in your calculations. You should use proper referencing techniques.
Appendix	It contains material that is too detailed to include in the main report, such as tables of raw data, software code or detailed calculations.
Formatting	Font type: Times New Roman. Font size: 12 for the main paragraphs and 14 bold for the titles. Justify the paragraphs. Numbering. Figures should be inserted in the center of the page and they should be labeled below the figure with font size 10. Tables should be inserted in the center of the page and they should be labeled above the table with font size 10.

Policy	
Attendance	Attendance will be checked at the beginning of each lab session. University regulations will be strictly followed for students exceeding the maximum number of absences (20%).
Reports	Each student must hand his\her own separate report. Laboratory reports are due to ***one week after*** the experiment was carried out and it will be collected at the beginning of each laboratory. If any report is not submitted to the TA by the deadline, it will be judged as "**LATE**".
Examinations	The midterm and the final exams are closed book tests. Students who are not able to attend an examination (medical or another emergency) must notify the instructor. Make up tests require a ***valid university*** excuse.
Student Conduct	It is the responsibility of each student to adhere to the principles of academic integrity. Academic integrity means that a student is honest with him/herself, fellow students, instructors, and the University in matters concerning his or her educational endeavors. Cheating will not be tolerated in at all. University regulations will be pursued and enforced on any cheating process.