Open Ended Lab

Department of EEE, AUST

EEE 3218 (Digital Signal Processing I Lab)

Fall 2022, Section- ALL Sections

1. Experiment Details:

Title: Design and analysis of Digital Filter and its application to remove noise from ECG signal.

Objectives:

Students will set their own objectives based on the tasks assigned.

Equipment/Software:

Students will be free to choose any software tools (MATLAB/OCTAVE) those are available to be used in the lab. Students are encouraged to choose their own suitable methods or blocks or functions with proper reasoning. It is not mandatory to use the functions those were demonstrated during classes. Students can choose/built their own functions with justification.

Tasks:

The experiment will have two parts. In Part 1, you have to design a filter to separate a frequency from a signal generated in MATLAB. In part 2, you have to design a filter to remove noise from a real-world signal i.e., ECG signal.

Part 1: Generate a signal which has four frequency components of frequency f_1, f_2, f_3, and f_4 (all in Hz), where; f_1=20*(L+1), f_2=13*(M+2), f_3=18*(N+3) and f_4=10*(L+M-N+4) (Take the absolute value of L+M-N+4). Here, L, M, N are the last three digits of your student ID. XXXXXX**LMN.**

Now, design a digital filter (using MATLAB) which will remove f_2 or f_3 frequency (choose f_2 if N is even, else f_3) from the signal. You are not allowed to use filter design toolbox during demonstration. You must have to justify the reason behind your choice of filter type.

After the design, you must verify your filter operation by analyzing the following plots.

i. Time domain and Frequency domain plots of generated signal
ii. Impulse response and frequency response of the designed filter
iii. Time domain and Frequency domain plots of the filtered signal

Part 2: Design a digital filter using MATLAB which can separate noise from ECG signal (Data set will be provided). You have to optimize the parameter: stop band attenuation, pass band ripple, width of transition band and filter kernel. You are not allowed to use any inbuilt functions of FIR filter or filter design toolbox during demonstration.

The design should be tested to-

i. Verify the removal of noise by frequency analysis.
ii. Verify the optimization of mentioned parameters by time domain and frequency domain analysis of filter characteristics.

A data set will be provided. You have to verify your filter operation by removing noise from any two signal. Choose the data of the row number (L+N) and 5*(M+N) of the given data set.

The database contains 310 ECG recordings, obtained from 90 persons. Each recording contains:

- ECG lead I, recorded for 20 seconds, **digitized at 500 Hz** (sampling frequency) with 12-bit resolution over a nominal ±10 mV range.
- 10 annotated beats (unaudited R- and T-wave peaks annotations from an automated detector)

2. OEL Activities

Activities	Time Frame
OEL Assignment Given	3-4 weeks before the assessment day
Students discuss among themselves on the task and its design	Within the 3-4 weeks' timeframe
Students simulate the experiment	Before the assessment
Students prepare the OEL report	Before the assessment
Students perform and demonstrate the OEL experiment	On the assessment day (Date fixed by respective course teacher)
Student Submit the OEL report	During or before the assessment (Both Hardcopy and Softcopy)

3. CO-PO-KPA mapping with assessment strategy

Sl. No.	CO Statement	POs	Bloom's Domain			K	P	A	Teaching Learning Strategy	Assessment Method
			C	A	P					
1	Use suitable simulation tools and knowledge of DSP to **Develop** laboratory experiments for solving real life problems	3	6		3	K1-K4, K5, K6,	P1, P2, P3, P4, P7		Lab Demonstration	OEL Demonstration, OEL Report

P's (Complex Engineering Problems) addressed through this open ended lab

P1: This OEL requires knowledge of

i. Digital signal processing and programming (K3)
ii. Design Knowledge (K5)
iii. Simulation and Testing (K6)

P2: Conflicting technical requirements

Optimization of parameters have several conflicting technical requirements.

P3: Depth of analysis

The filter can be designed in different ways according to the requirements, as such it has no obvious solution and requires innovative thinking.

P4: Familiarity of issues

The experiment is involved with infrequently encountered issues. To remove noise from ECG signal, student must know about many things related to medical sciences.

P7: Interdependence

The design has several subsystems like sampling, filter design, frequency domain, and time domain analysis, etc.

4. Assessment Criteria and Rubrics

i. OEL Report Template

Your OEL report should include the following sections:

- ✓ **Cover page**

Usual cover page with proper title and identification

- ✓ **Purpose/Objectives**

This is a statement of the problem to be investigated. It provides the overall direction for laboratory investigation and must be addressed in the conclusion.

- ✓ **Equipment/Software**

A list of all laboratory equipment/tools used in the investigation. A detailed and labeled flow diagram to illustrate the experiment. List of all the different functions used.

- ✓ **Procedure**

Step-by-step procedure carefully explained in a numbered sequence. All experimental variables identified and named. Brief description of the approaches to meeting independent variable constraints.

Hint: Your audience is not necessarily composed of engineering students. Someone who was not present during the lab should be able to understand.

- ✓ **Results and Discussion:**
  - **Data**

What data needs to be collected before designing the system? What are the different design constraints involved in designing the system?

  - **Data Analysis**

How do you interpret data? Include all graphs/images, analysis of graphs.

- ✓ **Conclusions**

Discuss any questionable data or surprising results. Explain the possible sources of errors or any questionable results. Suggest changes in experimental design that might test your explanations.

ii. Performance:

You have to demonstrate the output of the experimental design in the lab within the lab time period.

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iii. Assessment Rubrics

Total Marks :20

SN	Components			Level of Achievement					Assessment Method and Marks
				Excellent	Good	Basic	Acceptable	Unacceptable	
1	**Background Knowledge & Design capabilities (10 Marks)**			**10/9**-Through study and all the questions have answered correctly	**8/7**-Adequate study and more than half of the questions have answered properly	**6/5/4**-Sufficient study and half of the questions have answered properly	**3/2**-In-adequate study and less than half of the questions have been answered correctly	**1/0**-No study and none/very few of the questions have been answered correctly	Demonstration/Q-A during OEL demonstration (**Marks 10**)
2	**Report Writing (12 Marks)**	Report Organization (**1 Mark**)		All the necessary information's (cover page, name of the experiment, objectives etc.) are written correctly and followed the given template		All the necessary information's are there but with some minor mistakes and almost followed the given template		Major mistakes and disregarded the given template	Checking Report (**Marks 10**)
		Filter design and coding (5 **Marks**)		Meets all design specification and code is correctly written	Meets most of the specifications	Design meets at least 50% of the requirements		Design does not meet the requirements	
			Part 1	**2**	**1.5**	**1/0.5**		**0**	
			Part 2	**3**	**2/1.5**	**1/0.5**		**0**	
		Results and analysis (4 **Marks**)		All plots are given accordingly with sufficient analysis	Plots are given but insufficient analysis		Plots are given but no analysis	Section is absent	
			Part 1	**2**	**1**		**0.5**	**0**	
			Part 2	**2**	**1.5/1**		**0.5**	**0**	

Appendix: A
Supportive Documents

1. What is Open Ended Lab (OEL)?
   a) An open-ended laboratory is where students are given the freedom to develop their own experiments, provided with clear rubrics, autonomy, and opportunities to self-reflect on their performance, instead of merely following the already set guidelines from a lab manual or elsewhere.
   b) Creativity and innovation flourishes in place where open ideas are promoted
   c) No pre-planned lab manual is given by the instructor.
   d) No help from the faculty or lab demonstrator.
   e) Problems and constraints are given to address Knowledge, complex engineering Problem and Activities (KPA)s conforming to CO/PO/PEO.
   f) Objectives are to measure the **students' teamwork, report writing, and presentation (attitude/behavior test)**; demonstration of practical skills through the practical tests to measure the psychomotor ability.
   g) It will create the students to think critically and also out of the box.
   h) The students here have to devise their own strategies and back them with explanations, theory and logical justification.

The concept of different levels of openness was discussed by many researchers. The areas of concern are categorized as problems, ways and means, and answers. One such level of openness is shown in Table 1.

Table-1: Level of Openness in OEL

Level	Problems	Ways & Means	Answers	Common Name	Degree of Openness
0	Given	Given	Given	Close	0%
1	Given	Given	Open	Partial Open	33%
2	Given	Open	Open	Partial Open	67%
3	**Open**	**Open**	**Open**	**Fully Open**	**100%**

2. In a fully open-ended laboratory activity- Students will be exposed to a practical problem to measure their skills Provides a suitable method to measure the students' psychomotor ability.

They are required (as a group) to determine the objectives and scopes, identifying the required apparatus and preparing the methodology, running the experiment, presenting or demonstrating the work, and finally submitting the technical report.

3. First 5 weeks have regular lab session and then provide an OEL. The EOL should be Fully Open. Student will conduct an EOL based on the experiments they have done in the lab and knowledge earned from the theory course.

4. Table for different domains in Bloom's Taxonomy

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Level	Cognitive	Affective	Psychomotor
1	Remember	Receiving	Imitation
2	Understand	Responding	Manipulation
3	Apply	Valuing	Precision
4	Analyze	Organization	Articulation
5	Evaluate	Characterization	Naturalization
6	Create		

I. Imitation: Observing and copying basic actions or movements.
II. Manipulation: Performing learned skills with some degree of proficiency and coordination.
III. Precision: Demonstrating accurate and controlled performance of skills with refinement and consistency.
IV. Articulation: Adapting and combining skills to create more complex and coordinated actions.
V. Naturalization: Performing skills automatically and with a high level of proficiency, often without conscious effort.

5.

P1	**Depth of knowledge required:** Cannot be resolved without in-depthengineering knowledge at the level of one or more of WK3, WK4, WK5,WK6 or WK8 which allows a fundamentals-based, first principles analytical approach
P2	**Range of conflicting requirements**
P3	**Depth of analysis required:** Have no obvious solution and require abstract thinking, originality in analysis to formulate suitable models
P4	**Familiarity of issues**
P5	**Extent of applicable codes**
P6	**Extent of stakeholder involvement and level of conflicting requirements**
P7	**Interdependence:** Are high level problems including many component parts or sub-problems