ENGG1300 Audio Filter Design Task and Report (Flexible)

Introduction:

In this activity, you will take on the role of an audio engineer who is in the middle of a crisis. Edgar Allen Poe's 212th birthday is this year, and the Brisbane City Council has organised a grand event to commemorate the occasion. As a crowning achievement, James Earl Jones (the voice of Mufasa and Darth Vader) has recorded a thirty second clip of him reading Poe's "The Raven", which will be broadcast over the loudspeakers at the beginning of the event; however, during a test run you realise that somehow the recording has been corrupted with high-frequency noise, apparently ruining it!

Fortunately, as a past student of ENGG1300 you realise that you may be able to use a filter to remove the noise from the recording before it is broadcast through the speakers. The fate of this prestigious event rests on your shoulders. Can you fix the problem in time, or will you be driven to madness like the subject of the poem?

The Task:

Your task is to design, implement and test a passive filter (using resistors and/or capacitors and/or inductors) to remove high-frequency noise from a provided audio recording, while preserving the quality of the original signal. Your filter should be comprised of no more than two components.

You must choose your components from the following values (which are available in the ENGG1300 Lab):

- Inductors: 22mH, 47mH with tolerance of +/-20%
- Capacitors: 0.1uF, 0.22uF, 0.47uF with tolerance of +/-20%
- Resistors: From the E24 series with values available from 10Ω to 100 kΩ, with tolerance of +/-2%

While you have a wide range of resistors available, it is strongly recommended that you restrict your design to circuits which use resistors with values between 40Ω and 1 kΩ (this will minimise the impact of "loading effects".

The original signal is a voice recording containing frequencies predominantly below 3 kHz, and the noise is a single, constant tone at a frequency of 12.5 kHz.

On Blackboard, you have been provided with the audio files "noisy_1%.wav", "noisy_10%.wav", and "noisy_50%.wav", which contain the original recording plus noise with 1%, 10%, and 50% of the magnitude of the original signal respectively. For your reference, you have also been provided with the file "original_recording.wav", which contains the original audio recording without any noise.

After choosing a filter topology and picking component values, you should construct your filter on a breadboard and, using the same set-up as in Activity 3 and 4 of Lab XI, listen to the output of your filter when each noisy signal is used as its input through the provided speakers, noting how effective your filter is at achieving the desired result in each case.

Note that you are not expected to be able to design a filter that perfectly removes the noise without affecting the quality of the original signal; it is likely that the noise will still be audible after filtering, the quality of the recording will be degraded compared to the original, or both. The aim of this task is to instead give you experience with the process of designing and testing a solution to a specified problem, and we are more interested in how you follow this process.

Hints:

You may find the following hints to be useful for this task:

- Remember, the cut-off frequency is the frequency at which the filter has a gain of -3dB. This corresponds to the "half-power" level, but actually only represents a 23% change in how "loud" the signal sounds to your ears. Keep this in mind when choosing your cut-off frequency.
- When choosing component values, you will likely need to arbitrarily pick the value of one component and then use this to calculate the value of the other(s). Given that the range of capacitors and inductors available in the lab is much smaller than the range of resistors, it is usually easier to pick the value of the inductor/capacitor from the available selection first, and then calculate remaining component values.

Laboratory Access:

Laboratory Sessions 9B and 10B have been allocated for you to work on practical parts of this activity. *No laboratory access will be available to work on this assessment outside of these scheduled class times.*

It is strongly recommended that you complete your theory and design parts of this activity prior to these classes so you can make best use of this time you have in the lab to conduct the required experiments.

Assessment:

You should document your design and results in a brief, two-page report structured under the headings provided in the template "ENGG1300_DesignReport_Template.docx". This template details what should be included under each heading.

This template is provided on blackboard in the following folder: "Assessment" -> "Audio Filter Design Report (10%)".

The report will be graded out of **40 marks**; and are allocated to the content within the headings of the template as follows:

1. Selection of Filter Type **(2 marks)**
2. Selection of Cut-off Frequency **(4 Marks)**
3. Circuit Design Details **(16 Marks)**
4. Theoretical and Experimental Bode Plots **(8 marks)**
5. Discussion **(4 marks)**

In addition, **6 marks** is allocated to the quality of your professional writing and presentation (including spelling and grammar).

This report should be no longer than two A4 pages (not including the cover page) with the following formatting:

- 2cm margins all-round
- 11-point Times New Roman Font
- Single line spacing

If a longer report is submitted, only the first two pages after the cover-page will be marked.

Your report must be submitted electronically as a single pdf document with the following name convention: "ENGG1300_DesignReport_4XXXXXX.pdf" (where you must replace 4XXXXXX with your UQ student number).

An assignment submission link will be provided on blackboard in the following folder: "Assessment" -> "Audio Filter Design Report (10%)" Folder.

Due Date: 2pm Thursday 13th of May.

Collaborative Work and Plagiarism:

This assessment should be completed individually. All students must complete the theory and design part of this assignment individually; and the written report must be entirely your own work.

You ***are*** permitted to work together in the laboratory to experimentally evaluate your circuits with 1-2 other students who share your lab station. *However, it is expected that each of you have completed your theory and design work prior to this. The data you present in your report* ***must*** *be the data associated with the circuit you designed.*

Serious penalties apply for plagiarism, and reports will be automatically screened for plagiarism using Turnitin. See:

- Compulsory Academic Integrity Modules: https://my.uq.edu.au/information-and-services/manage-my-program/student-integrity-and-conduct/academic-integrity-and-student-conduct
- School of ITEE guidelines: https://www.itee.uq.edu.au/itee-student-misconduct-including-plagiarism

References:

It is anticipated that all work in this assessment can be completed using the ENGG1300 course materials; and as such, references are not required or expected. However, if use of other materials has impacted your design decisions or response to questions, these must acknowledged using in-text citations in Harvard format (https://guides.library.uq.edu.au/referencing/uqharvard). The reference list is included in the 2-page limit.