Assignment 2: Frequency Domain Filter Design

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1 Introduction

The second assignment of the BCS course places its emphasis on:

- system analysis and design;
- the application of frequency domain methods in control systems.

The focus of this assignment is on:

- system analysis and modelling;
- applying frequency domain analysis in practical design problems;
- reasoning and verification skills on existing system;
- presentation skills;
- teamwork.

2 Deliverables

Each team needs to finish 2 tasks described below and compile their solutions in a single slide-pack using Microsoft Powerpoint.

The final product of your assignment 2:

1. a single pdf file with all slides for task 1 and 2 inside.
2. a 8 minute (min 6 min, max 10 min) presentation consists of:
    - task 1 findings;
    - Q&A from the audience.

Note that you only need to present the findings for task 1, you only include your solutions of task 2 in the slide pack. The Q&A session will only be about task 1.

3 Grading

The grading of this assigment will be from a scale of 0 to 17.5 and will takes up 17.5% of your final grade if a student's peer-review factor is 1.0 . Details are as follows:

- $\mathcal{X} \in [0, 5]$ presentation skills, rubric seen appendix.
- $\mathcal{Y} \in [0, 4]$ design effectiveness in task 1, rubric seen appendix.

- $\mathcal{Z} \in [0, 8.5]$ solutions to the problems in task 2. The grading needs to be done in the following manner:
  - $\mathcal{A}$: *completeness of answers*. If you have submitted answers to all questions, you get 0.5 point otherwise 0.
  - Each question will be graded as *wrong* 0, *partially correct* 0.3, *mostly correct*0.7, *fully correct* 1. In case of un-readable solution, the corresponding question will be graded as *wrong*.
  - A *correctness* score equals to the sum of all questions $\mathcal{B} \in [0, 10]$ is calculated.
  - $\mathcal{Z} = \lceil \mathcal{A} + 0.75\mathcal{B} \rceil$
- total score $\alpha = \mathcal{X} + \mathcal{Y} + \mathcal{Z}$

4 Task 1

For each group, you should provide your favorite song. You need to build 3 filters such that:

1. (almost) does not change the song in the frequency domain;
2. (almost) eliminates the song in the frequency domain;
3. design a band-pass filter, the pass-band will be group specific based on your favorite song.

You will need to

1. clearly provide the 3 transfer functions in your slides;
2. demonstrate with small music clips how do your filters perform;
3. provide some Bode plots for each transfer function;
4. analyze the stability of the transfer functions. Motivate why do you want to analyze the stability of your transfer function? If you do not think stability analysis is necessary, you can skip the stability analysis but also motivate why do you think it is not needed.

The following tools will be provided:

1. spectrum visualization tool;
2. audio processing tool.

5 Task 2

Solve all questions in 'Stage TWO Problems' and compile your solutions after your presentation slides for task 1.

A Presentation Grading Rubric

Presentation ($\mathcal{X}$)

Criteria	**Description**	**Grade**
Content (1.5)	***Visual aids must exist!*** *Graphs and images must be readable, meaningful, and relevant. The slides layout, design must be professional and consistent. No un-necessary animation and information.* Slide contents are delightful to read and being carefully designed.	
Delivery (1.5)	*The presentation finishes around 8 mins. The presenters present clearly in voice, body language, and contents. The presentation should tell a logical story.* The presentation is smooth, fluent, and concise in story-telling.	
Teamwork (1)	*Every student in each team needs to be present. All group memebers show professional behavior.* Group members collaborate well in the presentation.	
QA Handling (1)	*The group member must ask for and respond to questions in a professional manner. The responses should make sense.* The response should be correct and to the point. The discussion needs to be fruitful.	
Final Grade	———	

Filter Design ($\mathcal{Y}$)

Criteria	**Description**	**Grade**
Design (2)	*The transfer functions must be present. The LPF, HPF transfer functions must work, the BPF transfer function must be a BPF. Fully motivated why and how these filters are designed.* BPF works, the designs are correct.	
Visualization (1)	*The presentation contents must contain* ≥ 4 *meaningful visualizations* these graphs must be correct and have proper formatting.	
Analysis (1)	*TIf the students choose to do stability analysis, the analysis must have visual aids and proper plots. If the student decide not to do stability analysis a motivation must be given.* The analysis are correct and filter orders are properly discussed.	
Final Grade	———	

For each item in the rubric, 4 grade levels can be given:

Insufficient (0%) Sufficient (50%) Good (75%) Excellent (100%)

The *italic* contents in the description indicates the minimum requirement for obtaining a 'Good'. If there exist further non-italic description, then these act as a guideline for being 'Excellent' in one item. The grade obtained for each item is thus calculated by the max point for this item multiplied by the percentage corresponding to the graded level.
The final grade $\mathcal{X}, \mathcal{Y}$ would be the sum of grades obtained in all items.