Project #2 for Electronic Circuit II

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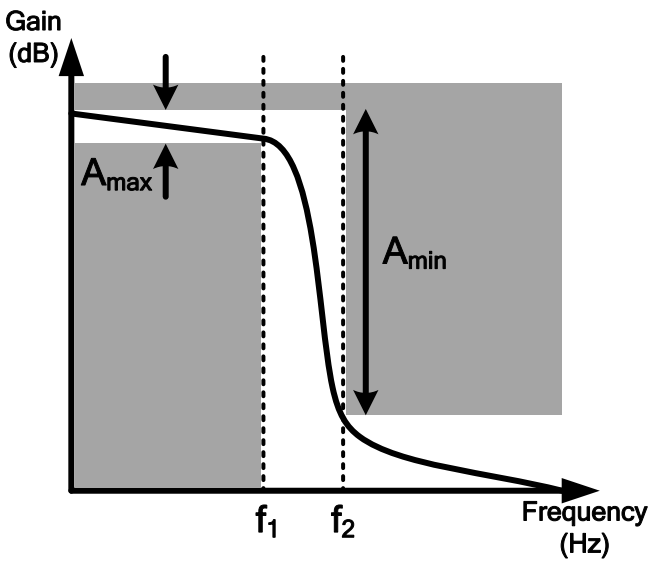
- Deadline : 6:00 pm on May 24, 2015. **Penalties for late hand-in.**

- Team

Students are expected to form a team of two members to do the project and hand in one project report. Equal grades will be given to the members of the same team. Each team must do its own simulation and analysis.

- Goal

You are expected to design two types of LPFs (a high-order active-RC Butterworth Low Pass Filter (LPF) and a switched-capacitor LPF) that satisfy the following specifications.



- Specification

1. **Filter DC Gain = 0dB**
2. **A_{max} < 0.25dB and A_{min} > 20.3dB**
3. **f_1 = 7kHz, f_2 = 18kHz**

Ⅰ. Determine a high-order Butterworth LPF. (10 points)

(a) Determine the filter transfer function that satisfies the given specifications.
(b) Using MATLAB, confirm your answer for (a).

Ⅱ. Design an active-RC Butterworth LPF that satisfies the given specifications. (30 points)

(a) Using the Tow-Thomas biquad shown in Fig. 1 as your building block, design an active RC Butterworth LPF. Make sure R ≤ 2MΩ and 10pF ≤ C ≤100pF in your circuit.
(b) Optimize your design by minimizing the total sum of capacitances in your circuit.

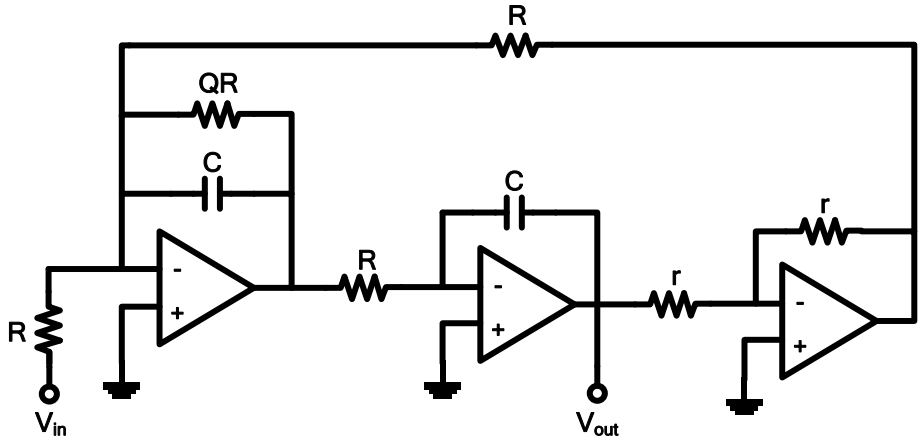


Fig 1. Tow-Thomas Biquad Low Pass Filter

Ⅲ. Design a switched-capacitor LPF that satisfies the given specifications.
(40 points)

(a) Replace R's in the active-RC filter realized in Ⅱ with switched capacitors. Make sure 10pF ≤C ≤100pF and use the sampling clock frequency of 500KHz.
(b) Optimize your design by minimizing the total sum of capacitances in your circuit. The smaller total capacitance your design has, the more points you will get.* You may have to change R, C values from those used in the active RC filter in order to realize the switched cap filter with the optimal performance.
(c) Compare performances of the active-RC Butterworth LPF and the switched capacitor LPF filter.

IV. Design Report (20 points)

Write a clear and well-organized report in which you provide answers to above questions and describe your design process. You must include your simulation results with clear explanations how your simulations were done.

Three best designs will be selected and their designers will be given opportunities to present their results in class in English for extra 5 points.

*** The design optimization process will be graded with the following standard.**

Grade A (5 teams)	**10 points**
Grade B (5 teams)	**8 points**
Grade C (5 teams)	**6 points**
Grade D (4 teams)	**4 points**
Grade E (4 teams)	**2 points**

**** Maximum Report pages : 10 (Not including the cover page)**