EE-517: Bio-Nano-Chip Design

Exercises 10: Opamp-based circuits

November 17, 2020

Problem 1

Consider a sensing platform that outputs two signals $V_1(t)$ and $V_2(t)$. Design a circuit based on operational amplifiers that integrates the difference of these two signals. Make sure that the integrator does not saturate during operation.
The design specifications are listed hereunder:

- $-0.5\,V \leq V_1(t) \leq 0.5\,V$ and $-0.5\,V \leq V_2(t) \leq 0.5\,V$
- *Operational amplifiers:* ideal, rail-to-rail with symmetric supply voltages $V_{cc} = 2.5\,V$
- *Digital clock:* $f_{clk} = 10\,kHz$
- *Resistances:* $R_{min} = 10\,k\Omega$

Problem 2

Design a circuit that takes two voltages $V_1(t)$ and $V_2(t)$ as inputs and computes the weighted sum

$$V_{out}(t) = \frac{3}{4}V_1(t) + \frac{5}{4}V_2(t)$$

Use ideal operational amplifiers and resistors.

Problem 3

Consider an electrochemical cell in a three-electrode configuration, involving a *Working Electrode* (WE), a *Reference Electrode* (RE), and a *Counter Electrode* (CE). Design a circuit that applies 650 mV between WE and RE while converting the faradaic current in the WE–CE path into a voltage.

Use ideal operational amplifiers and resistors.

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