Chapter 7 - Energy Storage Elements

Lecture 25

Section 7.9

MEMS 0031 Electrical Circuits

Mechanical Engineering and Materials Science Department
University of Pittsburgh

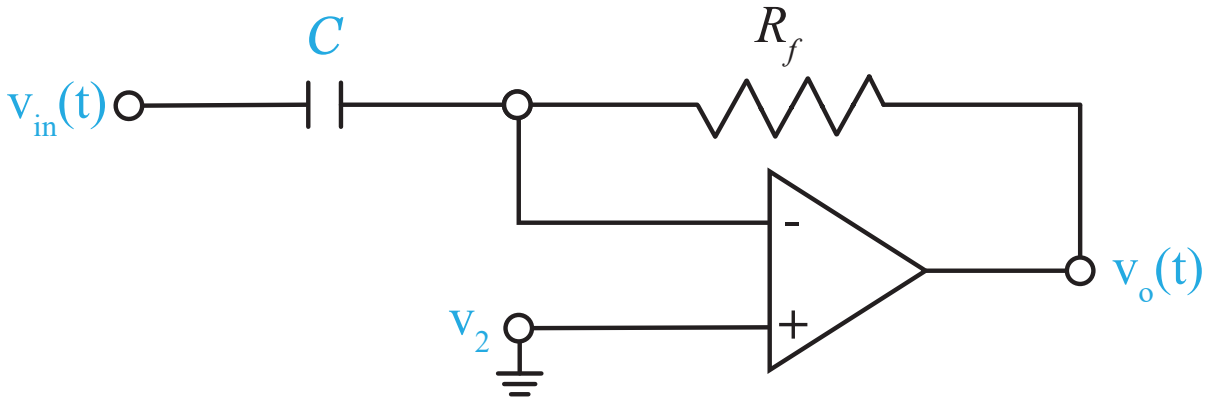
Student Learning Objectives

At the end of the lecture, students should be able to:

- Construct an integrator and differentiator circuit using op-amps and capacitors

Differentiator

- Recall the expression for the output of a differentiator op-amp:



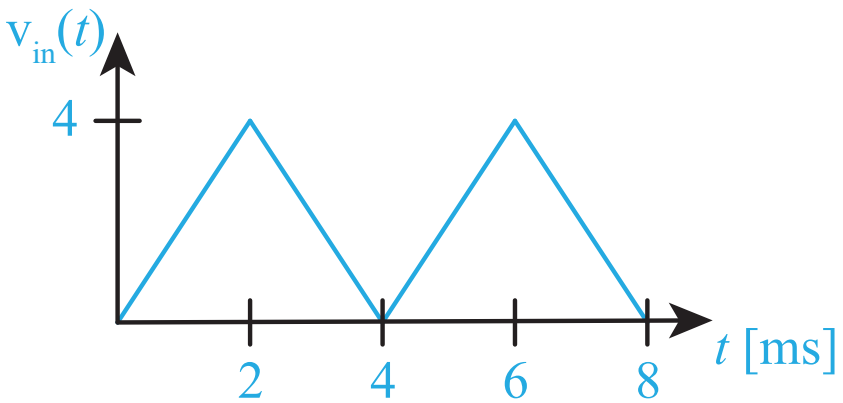
$$V_o(t) = -R_f C \frac{d\,V_{\text{in}}(t)}{dt}$$

Example #1

- Given a differentiator op-amp with C=0.2 [μF] and R_f=5 [kΩ], and the following input voltage

$$V_{\text{in}}(t) = \begin{cases} 2,000t & 0 < t < 2\,[\text{ms}] \\ 8 - 2,000t & 2 < t < 4\,[\text{ms}] \end{cases}$$

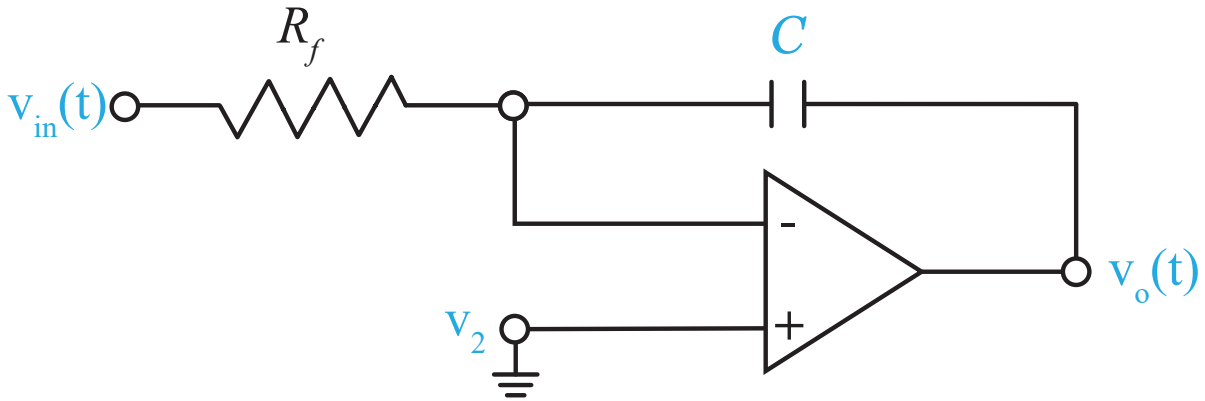
determine $V_o(t)$ given $V_o(0) = 0$



Example #1

Integrator

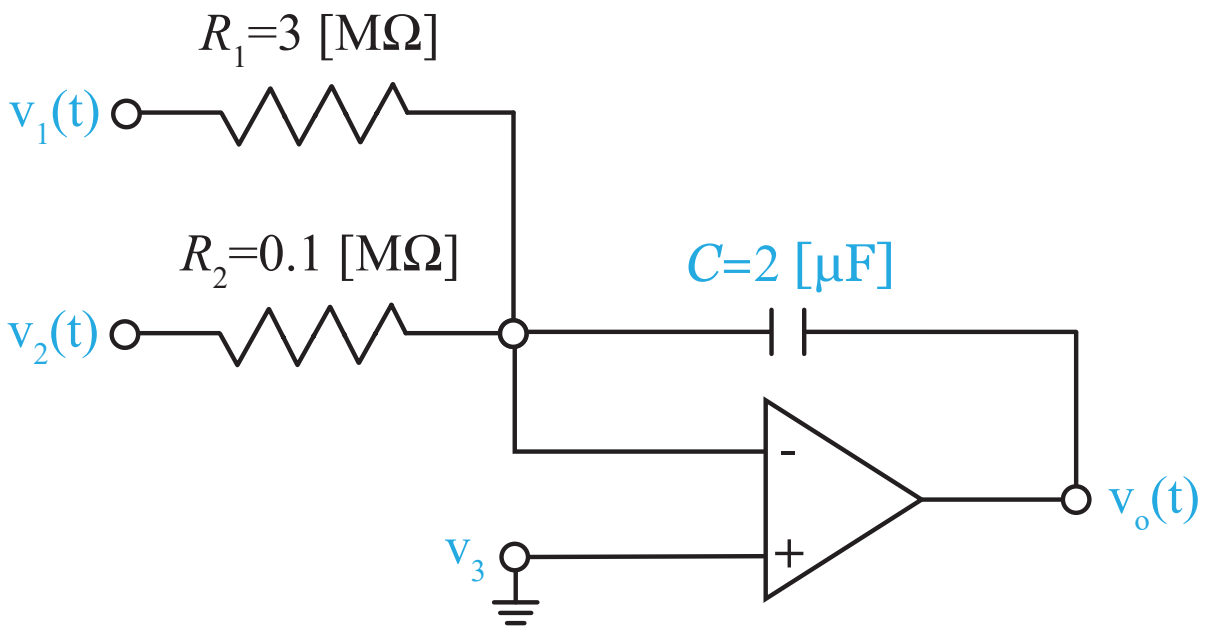
- Recall the expression for the output of an integrator op-amp:



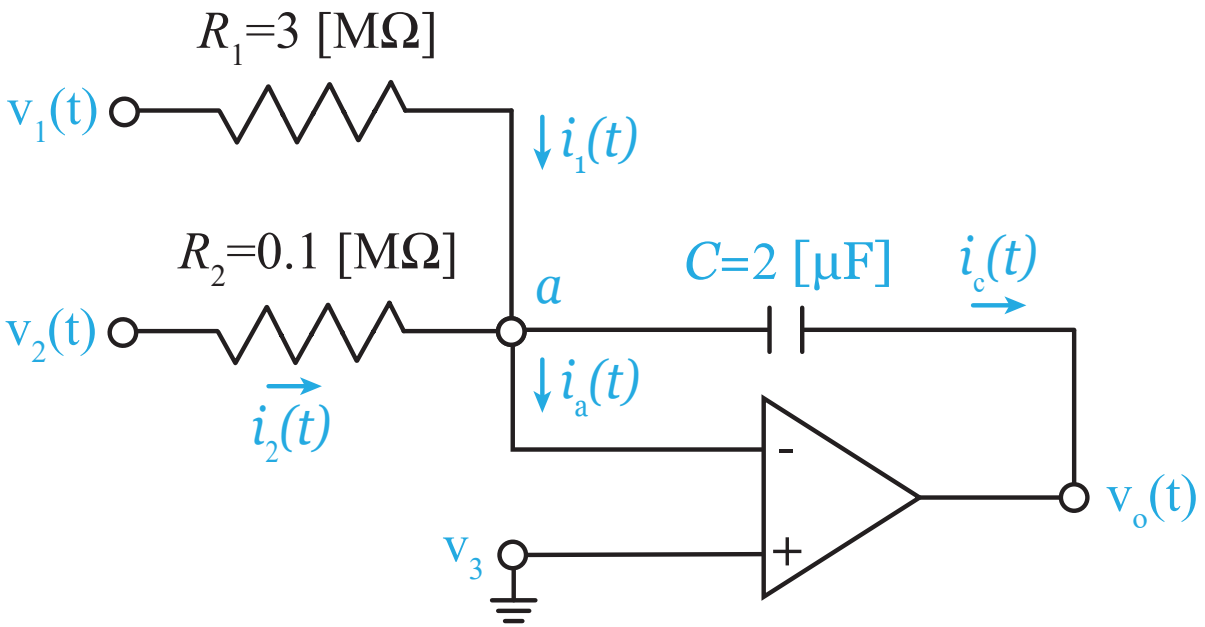
$$V_o(t) = \frac{-1}{R_f C} \int_{t=0}^{t} V_{\text{in}}(\tau)\, d\tau$$

Example #2

- Consider the following summing integrator with $V_1(t)$=10cos(2t) [mV] and $V_2(t)$=0.5t [mV]. Determine $V_o(t)$, assuming the the system is initially at 0 voltage potential.



Example #2



Example #2

Student Learning Objectives

At the end of the lecture, students should be able to:

- Construct an integrator and differentiator circuit using op-amps and capacitors
  - A differentiating op-amp has the same construction as an inverting op-amp, but the input resistance is replaced with a capacitor. An integrating op-amp has the same construction as an inverting op-amp, but the follower resistance is replaced with a capacitor.

Suggested Problems

- Ex. 7.12, for the text does not have unique homework problems associated with solely integrators and differentiators.