

Chapter 7 - Energy Storage Elements

Lecture 24

Section 7.9

MEMS 0031 Electrical Circuits

Mechanical Engineering and Materials Science Department
University of Pittsburgh



Student Learning Objectives

Chapter 7 - Energy
Storage Elements

MEMS 0031

Learning Objectives

7.9 Op-Amp and
Linear Differential
Equations

Summary

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

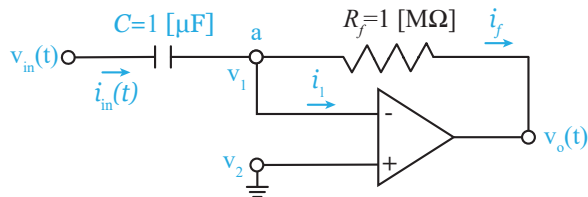
- ▶ Construct an integrator and differentiator circuit using op-amps and capacitors



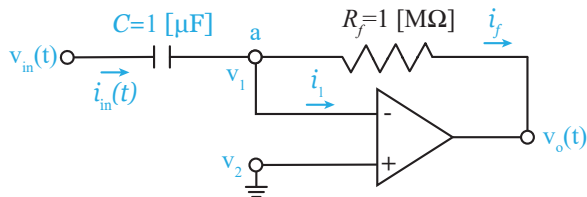
- ▶ These circuits are used to integrate or differentiate signals
- ▶ For instance, acceleration is the second derivative of displacement, or we can integrate the signal from an accelerometer to get velocity or displacement
- ▶ These circuits can also be used to solve differential equations
- ▶ They can simulate physical, dynamic systems with circuit components



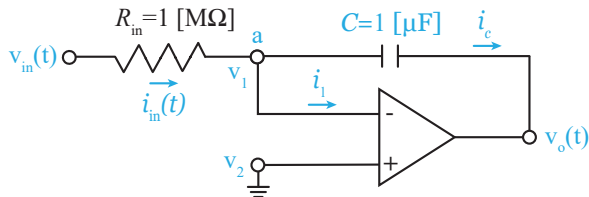
- Determine the output signal of the following circuit:



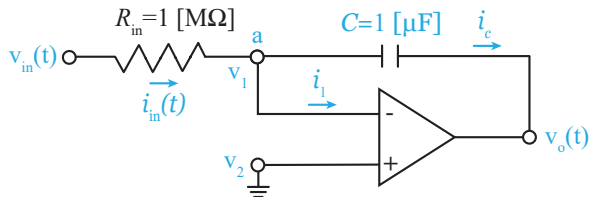
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Example #1

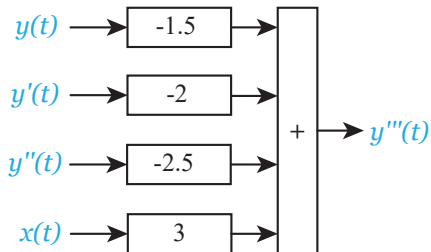
- Solve the following differential equation

$$2\frac{d^3y(t)}{dt^3} + 5\frac{d^2y(t)}{dt^2} + 4\frac{dy(t)}{dt} + 3y(t) = 6x(t)$$



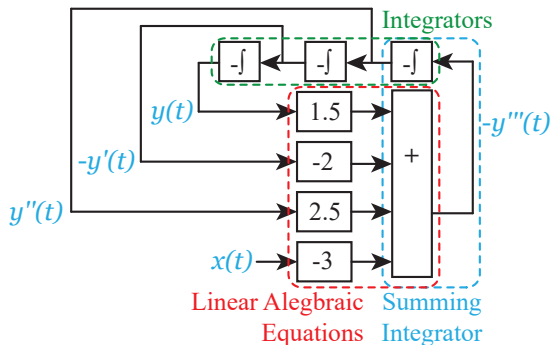
Example #1

- The block diagram, in configuration form, is:



Example #1

- The block diagram, for integrating the input, is:



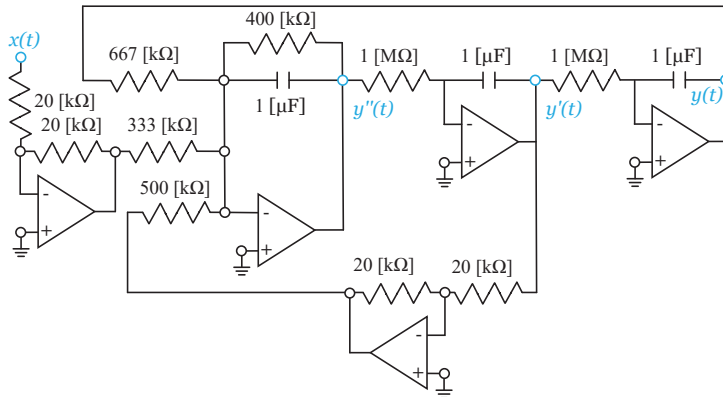
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- Schematically, the integration circuit is:

Learning Objectives

7.9 Op-Amp and Linear Differential Equations

Summary



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

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► 7.9-1, 7.9-2, 7.9-3, 7.9-4

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Summary

