

# Spring 2002



## **EEE598D: Analog Filters & Signal Processing Circuits**

Instructor:

Dr. Hongjiang Song

Department of Electrical Engineering

Arizona State University

# EEE598D, Tuesday March 19, 2002



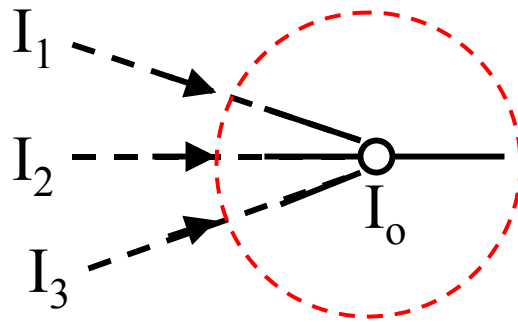
## Today: Current-Mode CT Filter Realization

- Current-Mode Active RC Filters
- Current-Mode Gm-C Filters

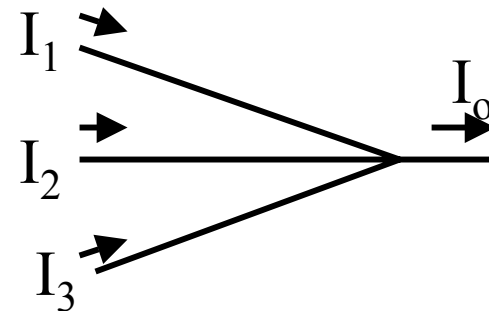
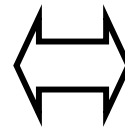
# Current-Mode Active RC Circuits



- Addition
  - It is straightforward to realize addition in current



A) SFG

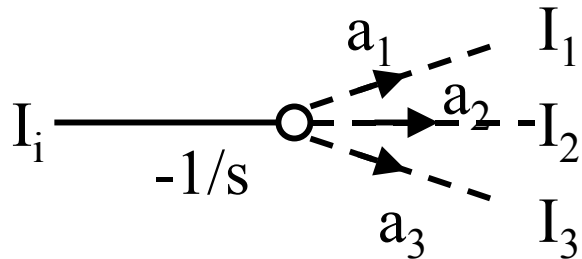


B) Circuit

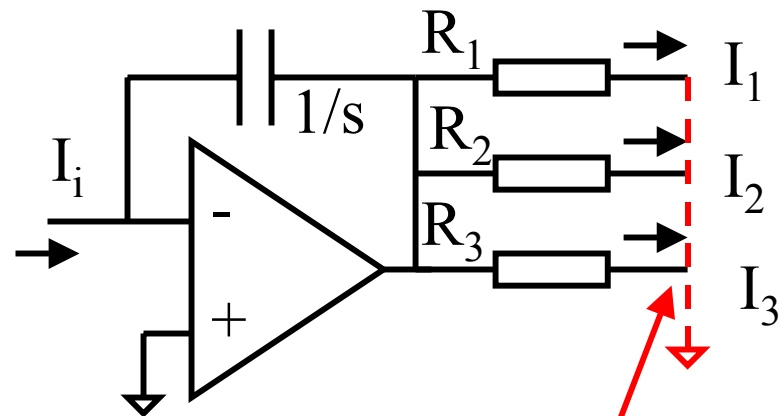
# Current-Mode Active RC Circuits



- Integration with weighted current output



A) SFG



B) Circuit

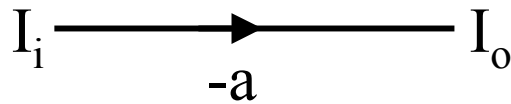
Virtual ground

$$R_i = 1/a_i \quad \{i = 1, 2, 3\}$$

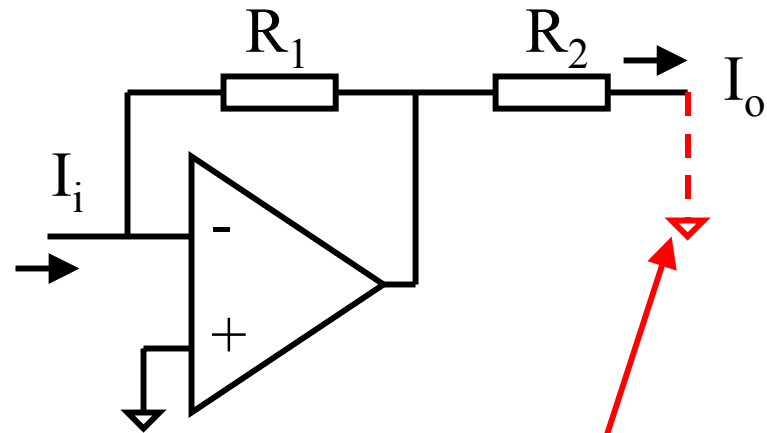
# Current-Mode Active RC Circuits



- Scaling



A) SFG



B) Circuit

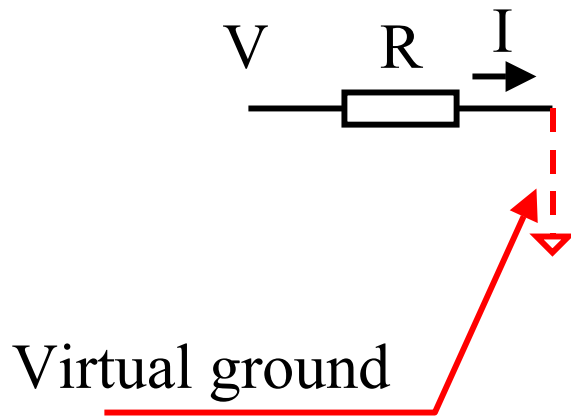
Virtual ground

$$a = R_1/R_2$$

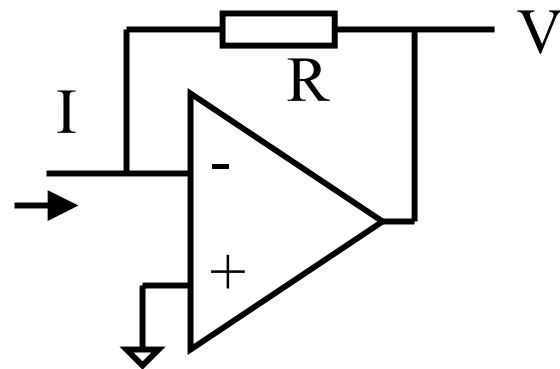
# Current-Mode Active RC Circuits



- V/I and I/V conversion



$$I = V/R$$

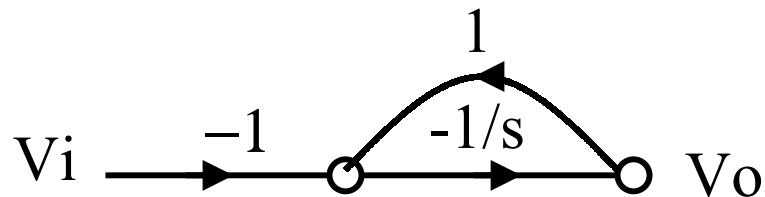
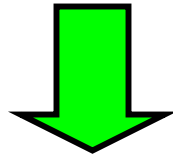


$$V = -RI$$

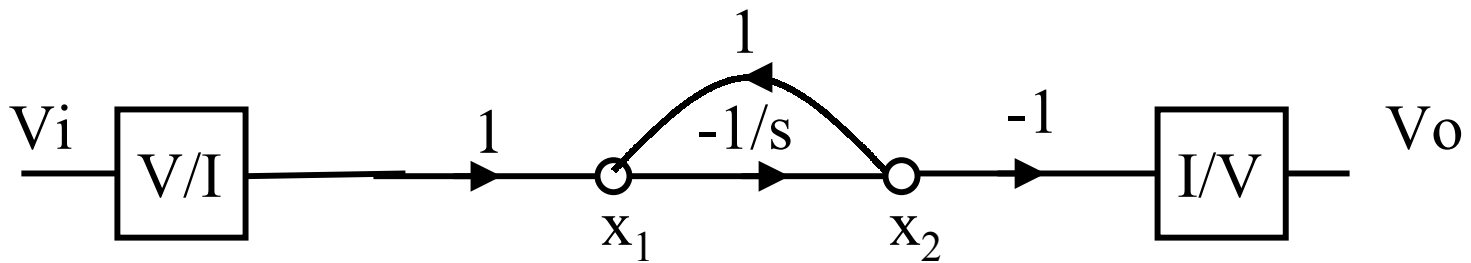
# Example: 1st-Order Filter Realization



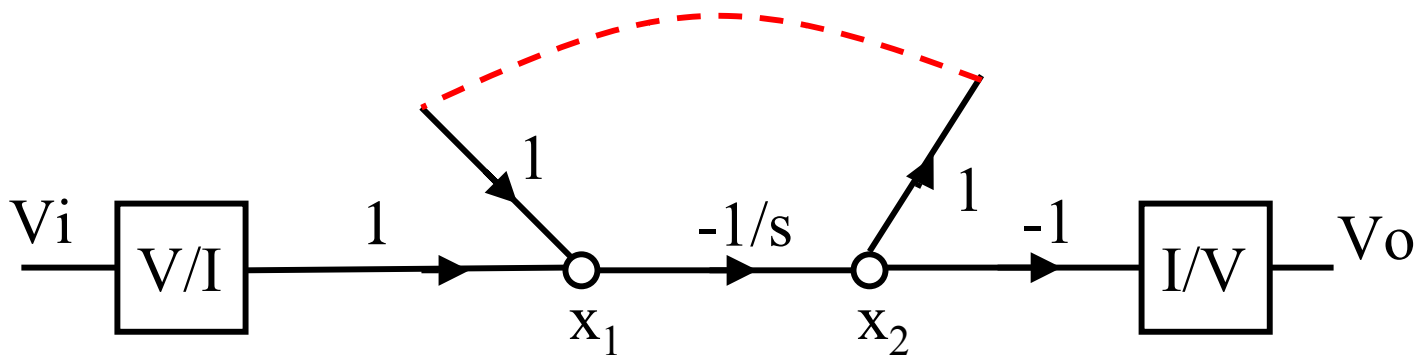
$$H(s) = \frac{V_o(s)}{V_i(s)} = \frac{1}{s+1}$$



# Example: 1st-Order Filter Realization

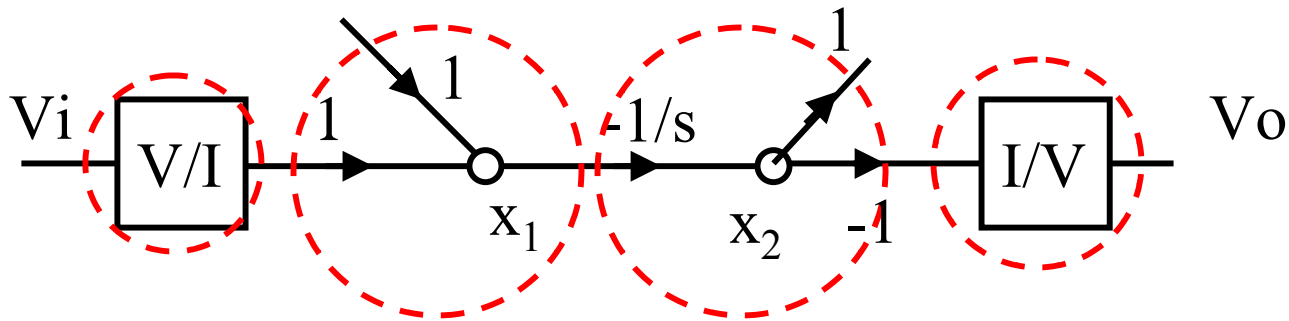


Mapping

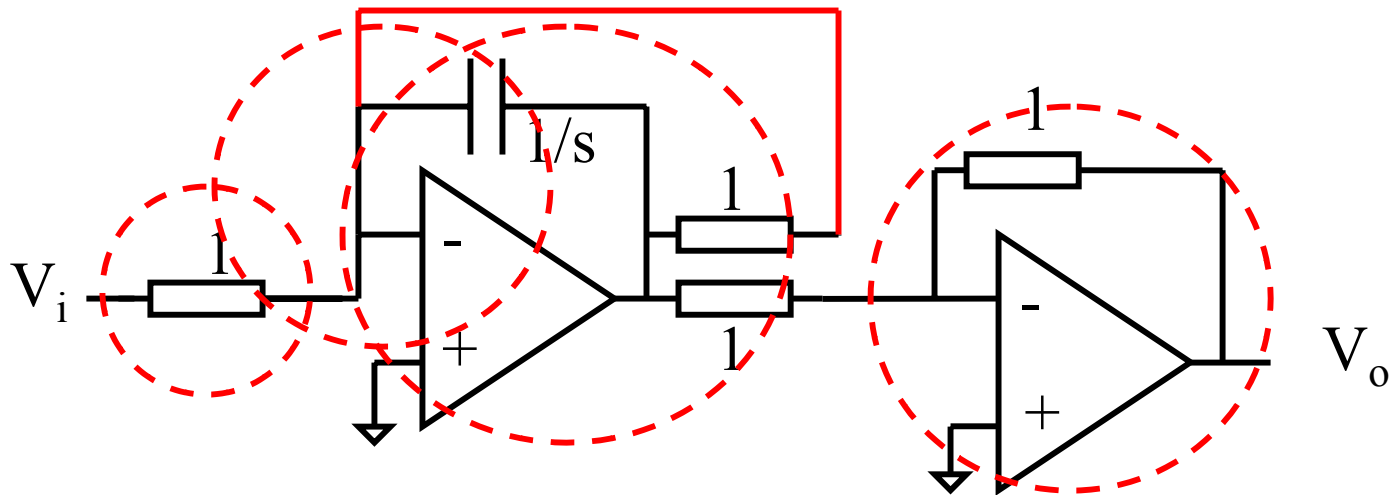




# Example: 1st-Order Filter Realization



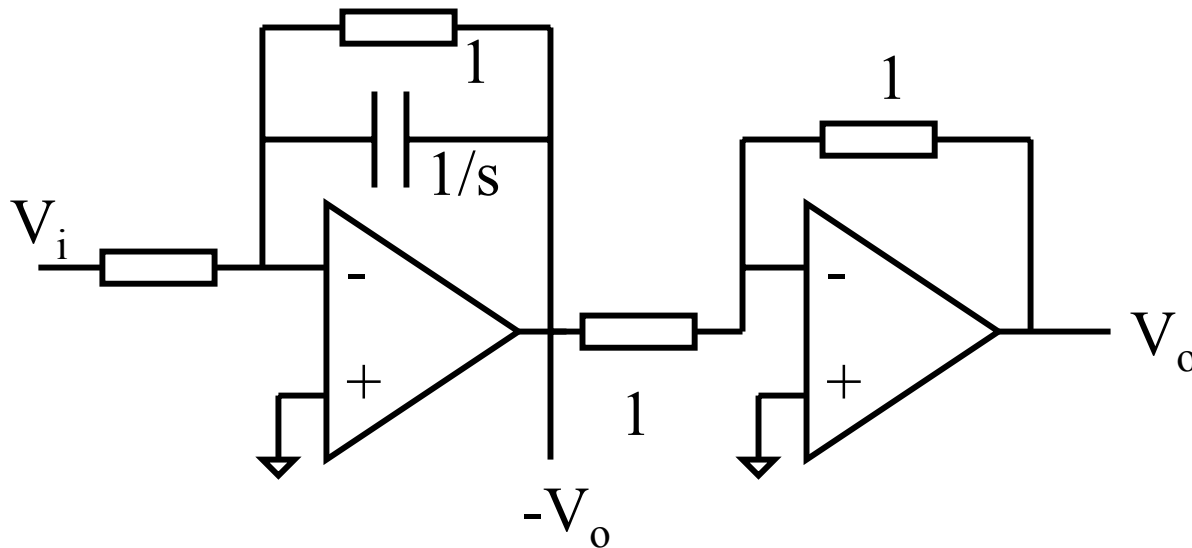
Mapping



# Example: 1st-Order Filter Realization



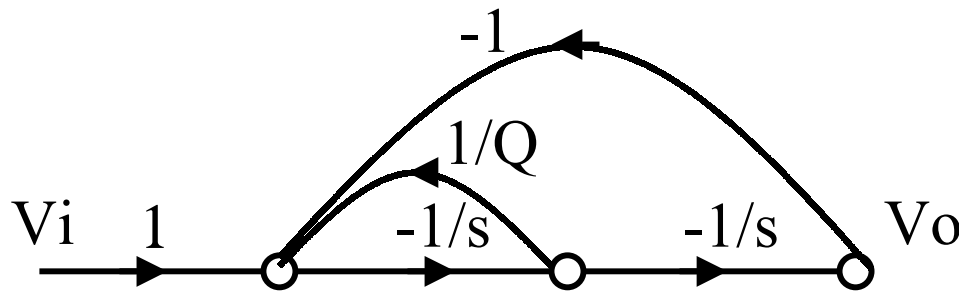
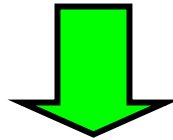
 Re-organize



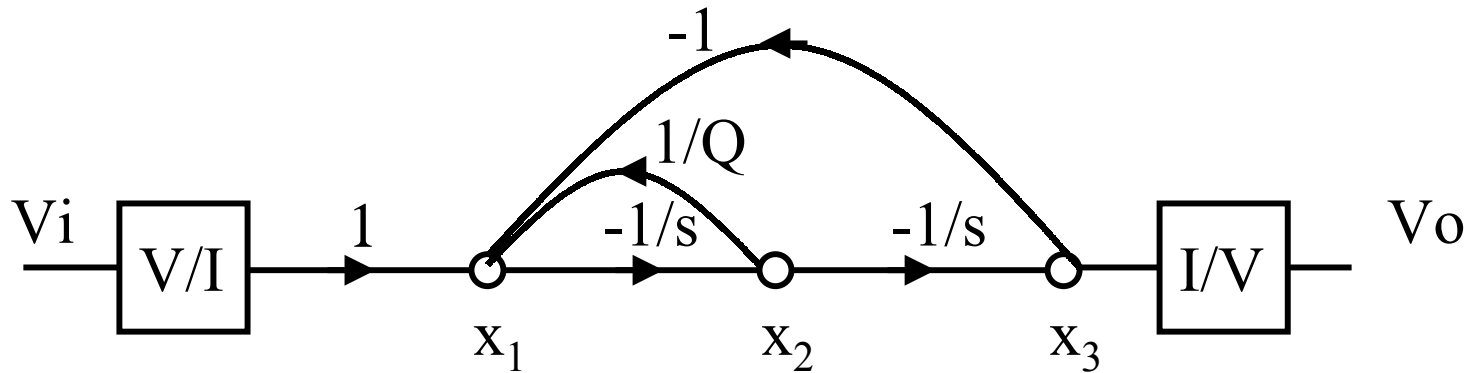
# Example: 2nd-Order Filter Realization



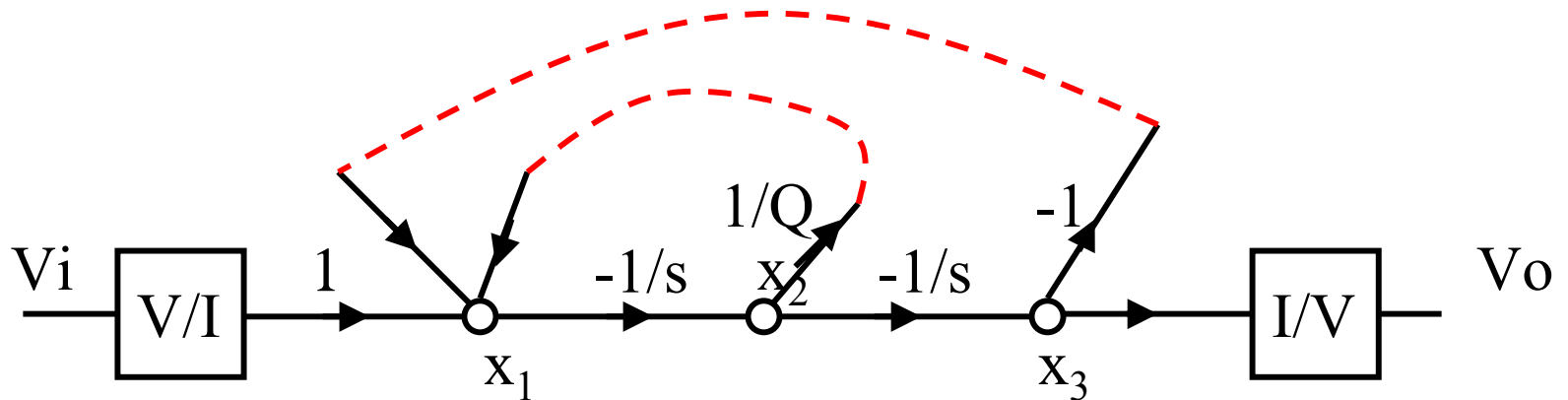
$$H(s) = \frac{V_o(s)}{V_i(s)} = \frac{1}{s^2 + \frac{1}{Q}s + 1}$$



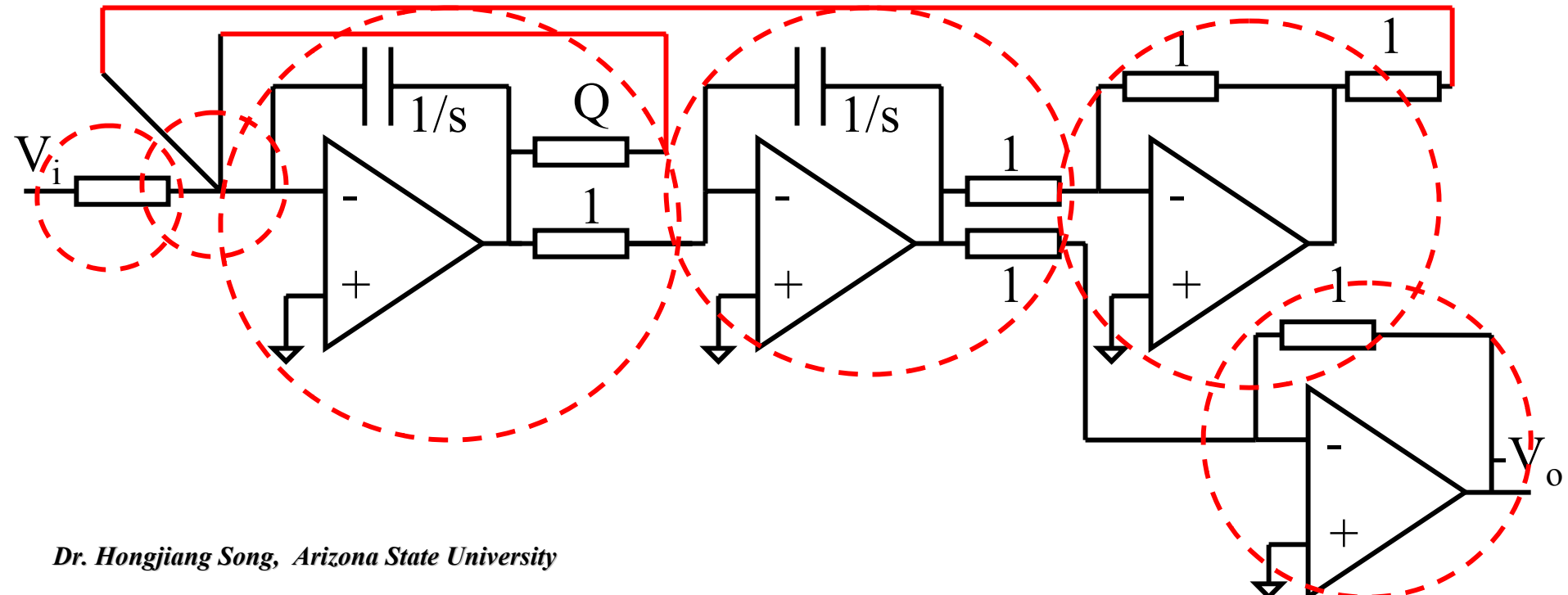
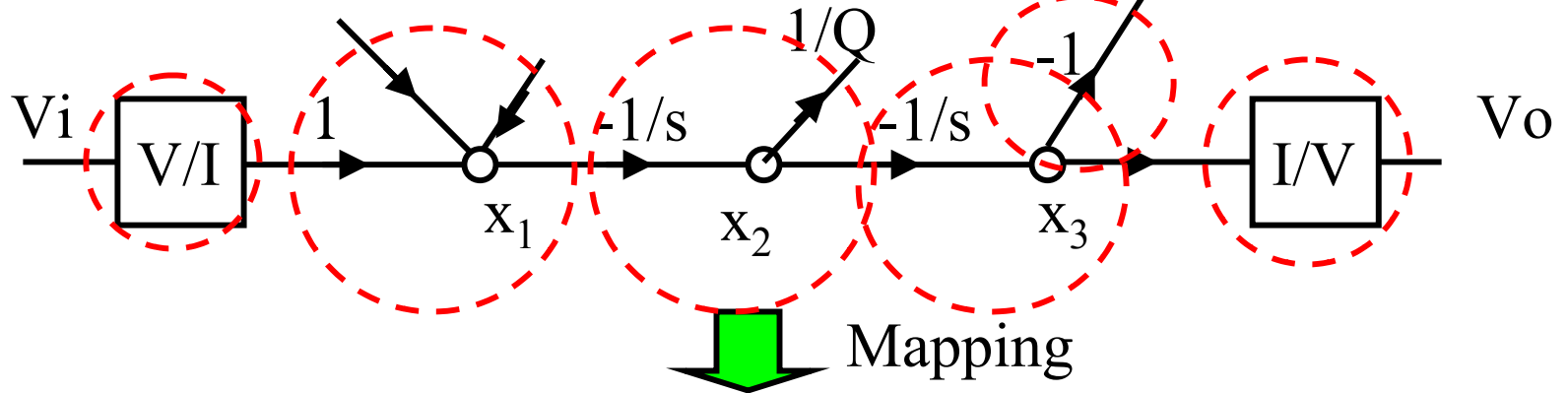
# Example: 2nd-Order Filter Realization



Mapping



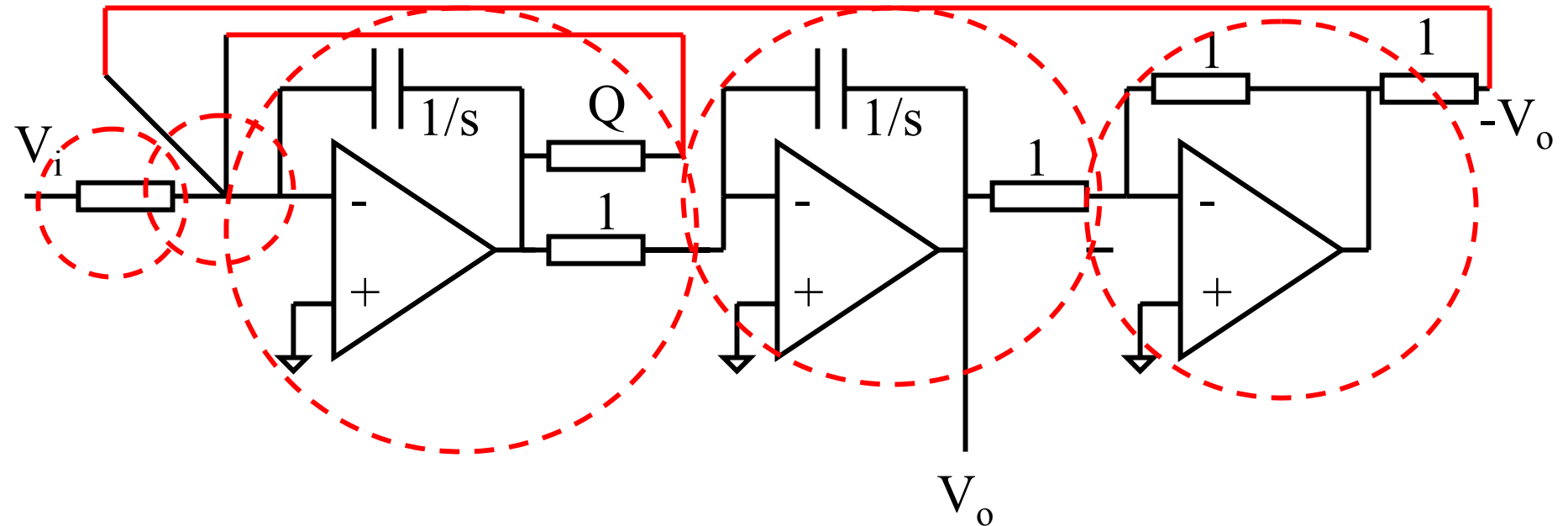
# Example: 2nd-Order Filter Realization



# Example: 2nd-Order Filter Realization



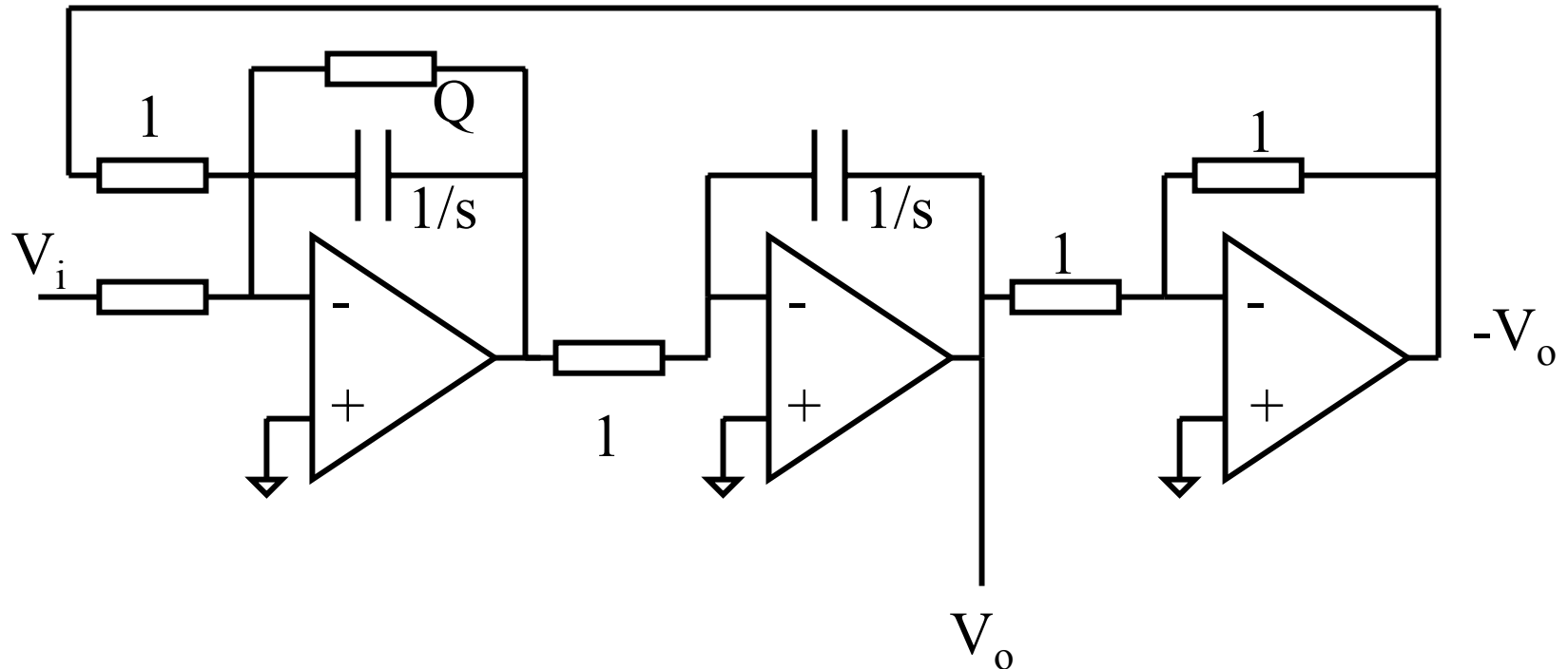
 Merge



# Example: 2nd-Order Filter Realization



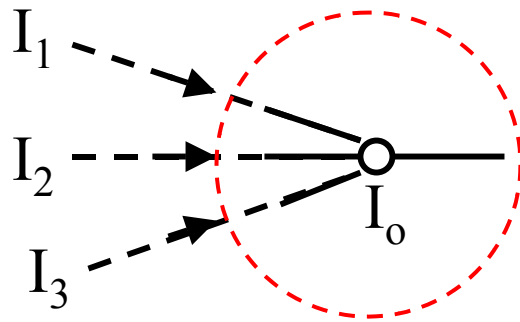
 Re-organize



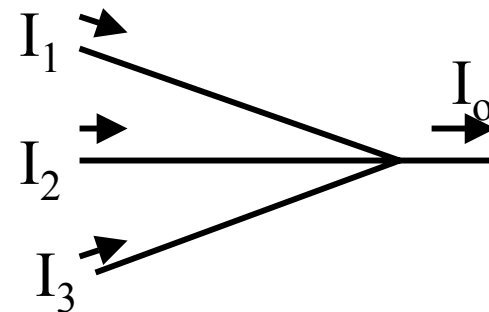
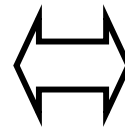
# Current-Mode Gm-C Circuits



- Addition
  - It is straightforward to realize addition in current



A) SFG



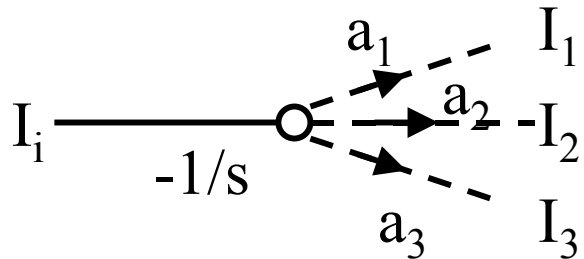
B) Circuit



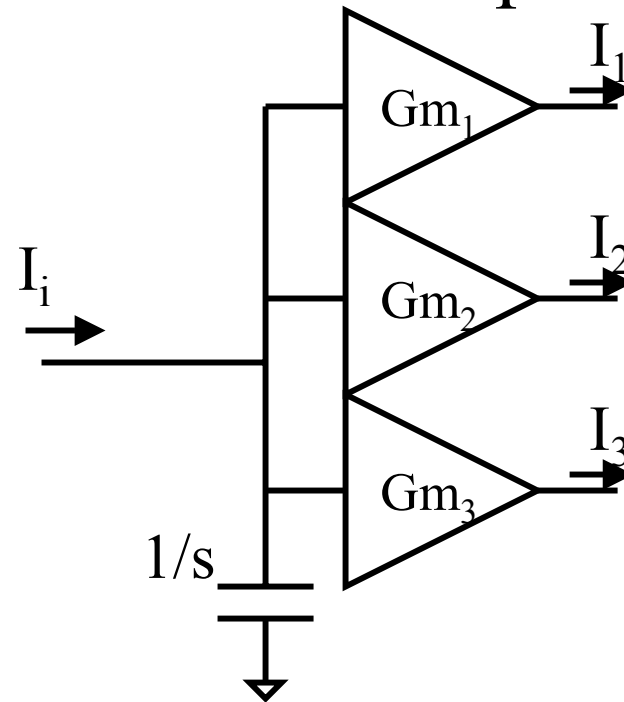
# Current-Mode Gm-C Circuits



- Integration with weighted current output



A) SFG



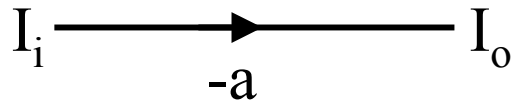
B) Circuit

$$Gm_i = a_i \quad \{i = 1, 2, 3\}$$

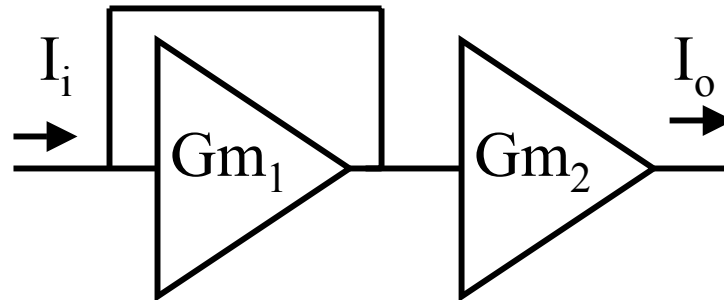
# Current-Mode Gm-C Circuits



- Scaling



A) SFG



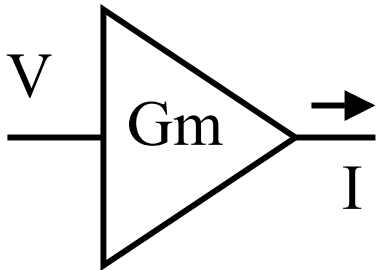
B) Circuit

$$a = Gm_2 / Gm_1$$

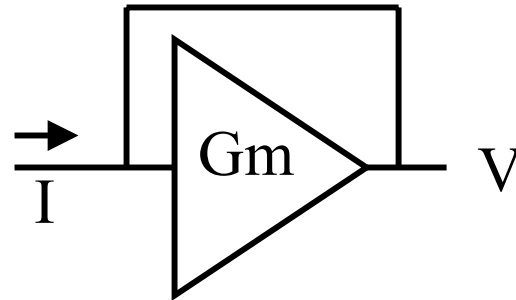
# Current-Mode Gm-C Circuits



- V/I and I/V conversion



$$I = -G_m V$$

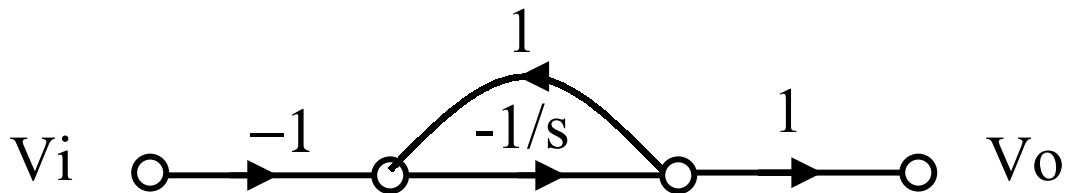
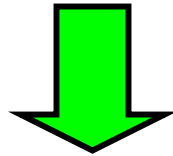


$$V = I / G_m$$

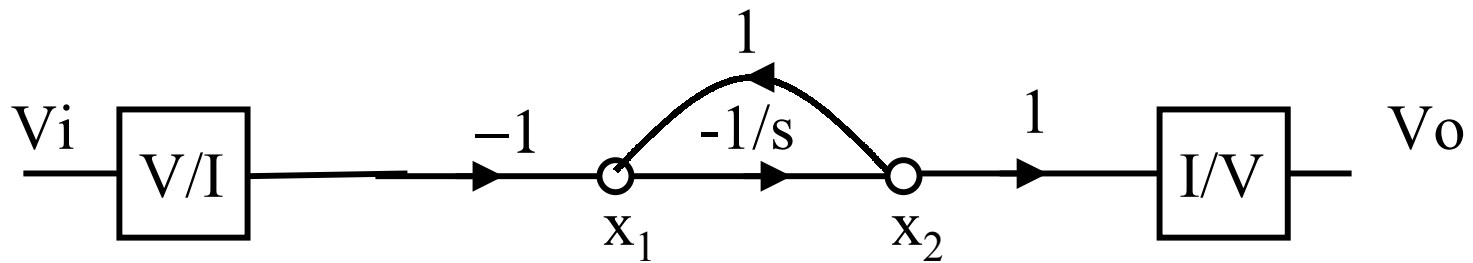
# Example: 1st-Order Filter Realization



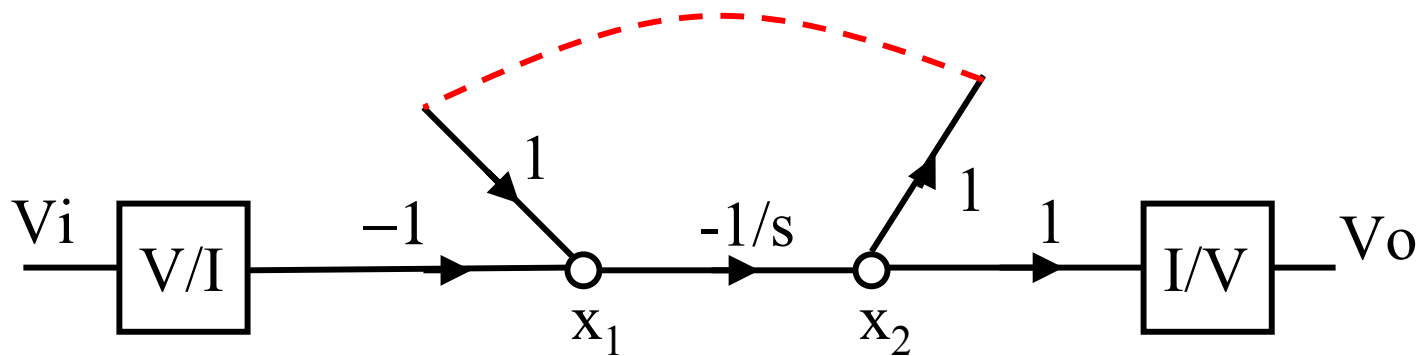
$$H(s) = \frac{V_o(s)}{V_i(s)} = \frac{1}{s+1}$$



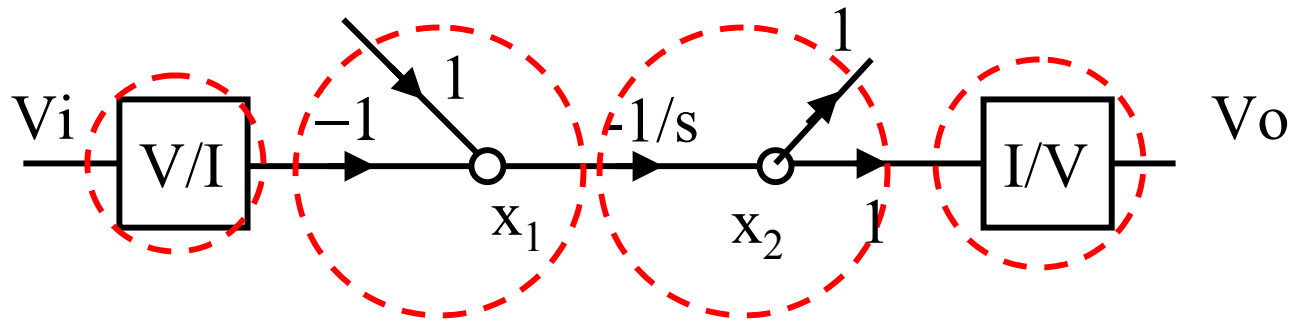
# Example: 1st-Order Filter Realization



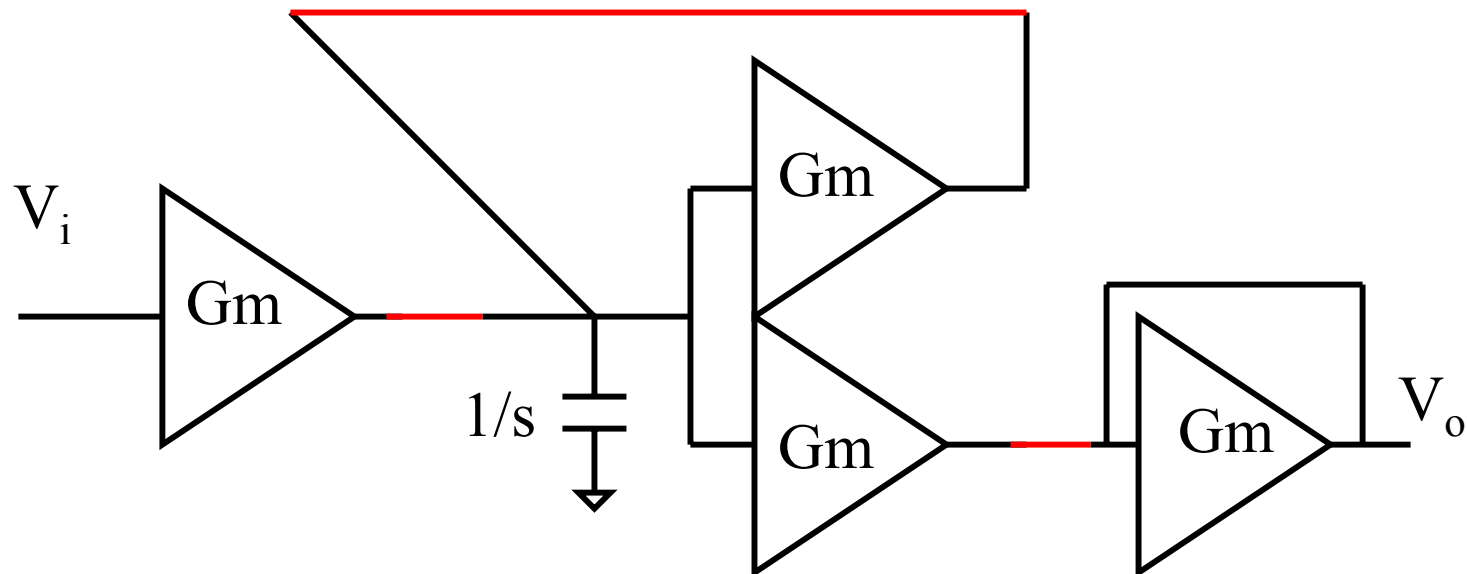
Mapping



# Example: 1st-Order Filter Realization



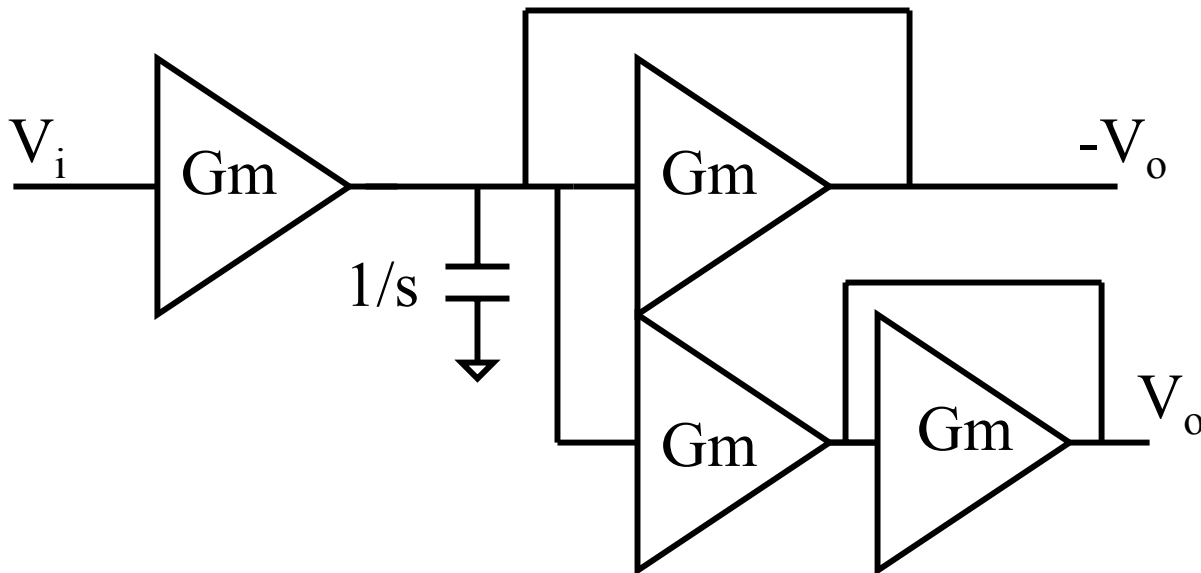
Mapping



# Example: 1st-Order Filter Realization



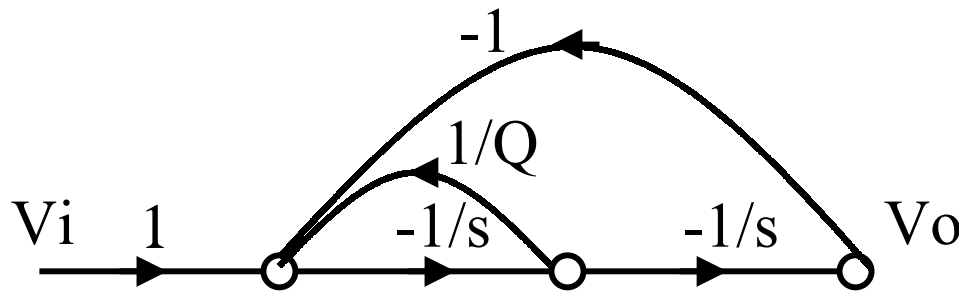
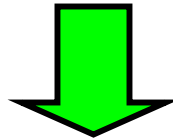
Re-organize



# Example: 2nd-Order Filter Realization

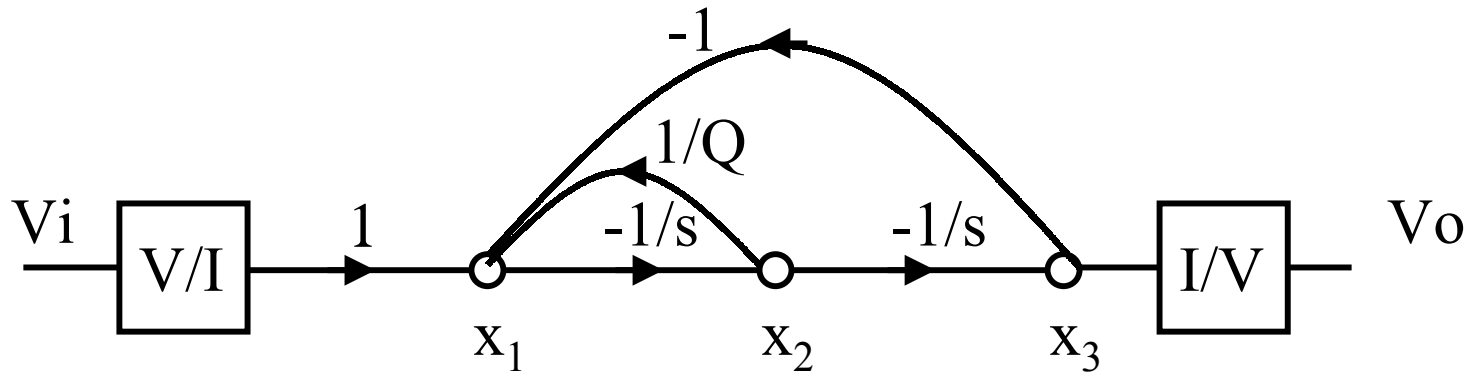


$$H(s) = \frac{V_o(s)}{V_i(s)} = \frac{1}{s^2 + \frac{1}{Q}s + 1}$$

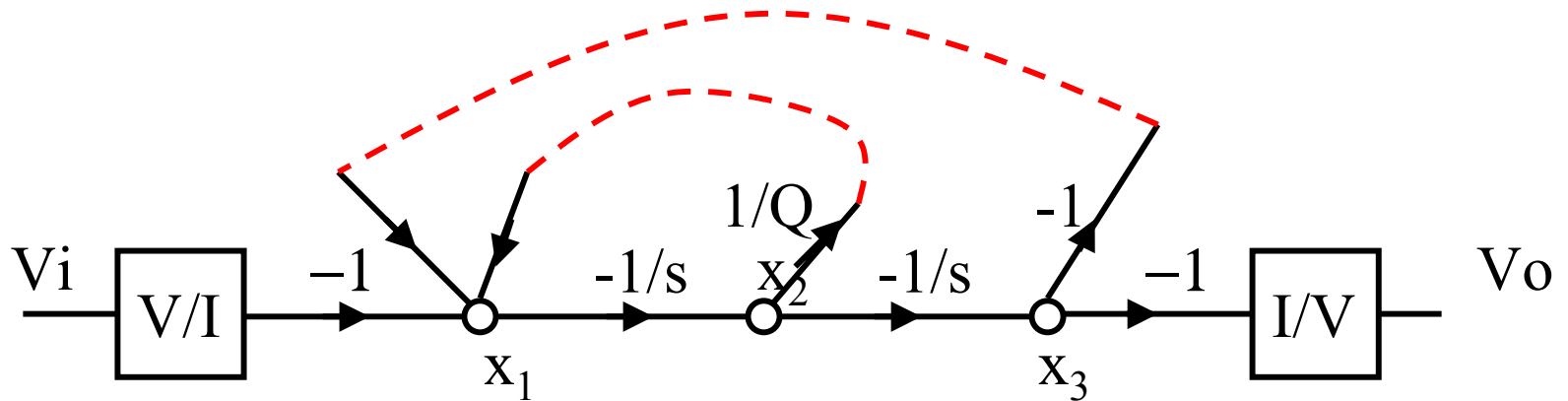




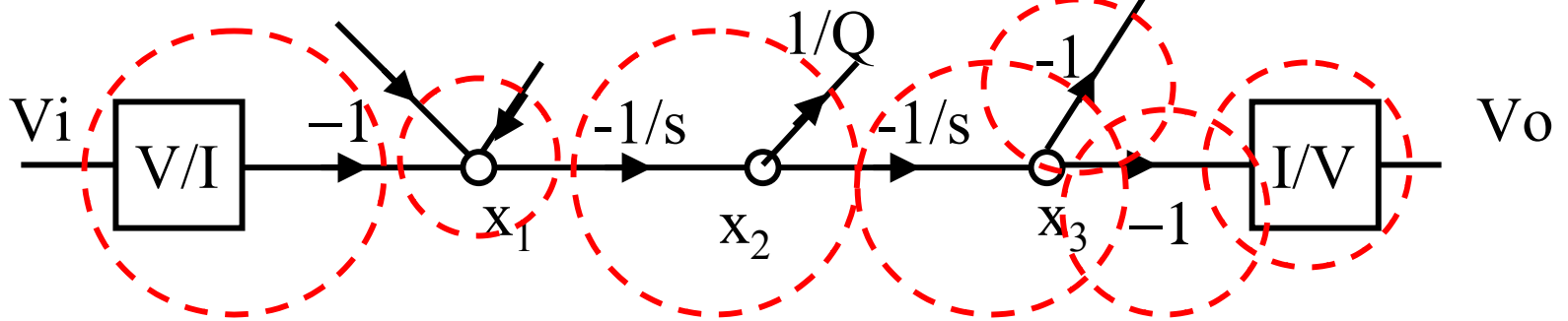
# Example: 2nd-Order Filter Realization



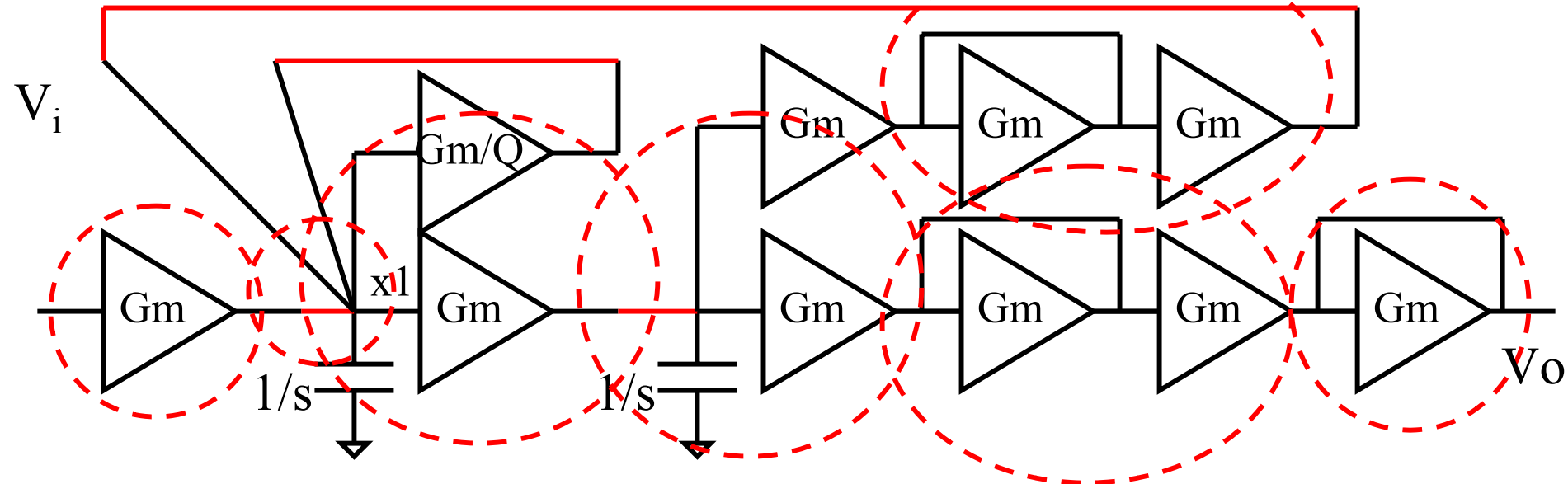
Mapping



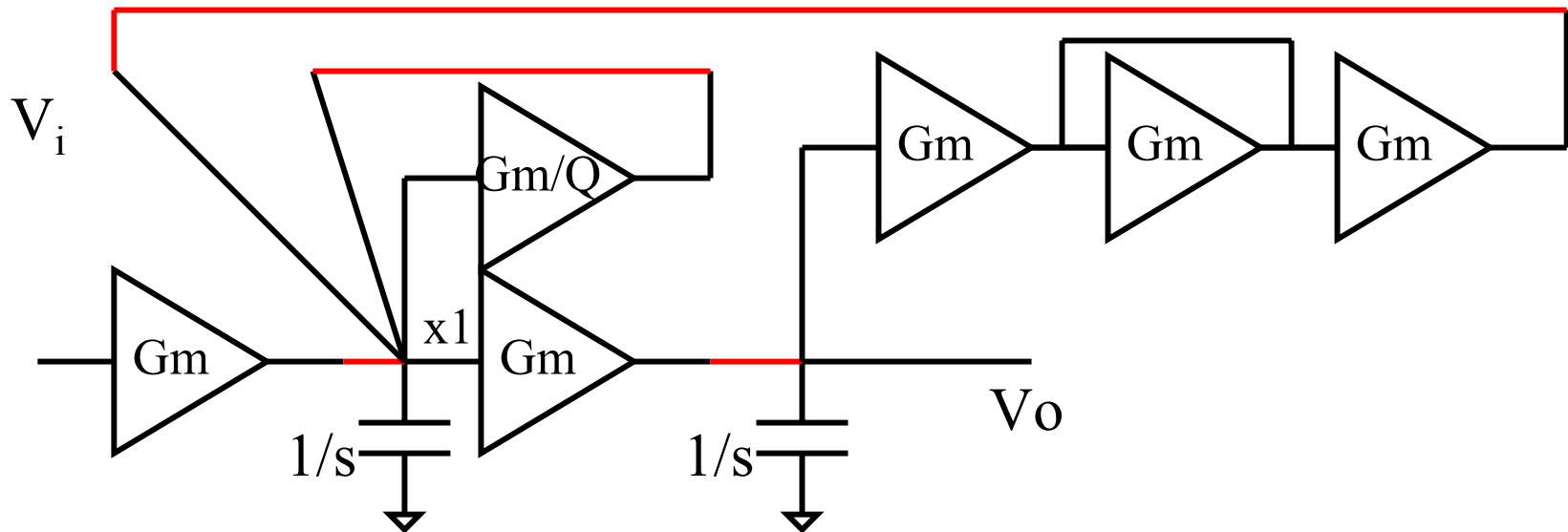
# Example: 2nd-Order Filter Realization



Mapping



# Example: 2nd-Order Filter Realization



# Example: 2nd-Order Filter Realization



 Re-organize

