Department of Computer Science and Engineering (CSE)

BRAC University

CSE 251: Electronic Devices and Circuits
Fall 2023

Lecture 04: Operational Amplifier

→(i) Some More Configurations
→(ii) Design Problems
→(iii) A real life Application

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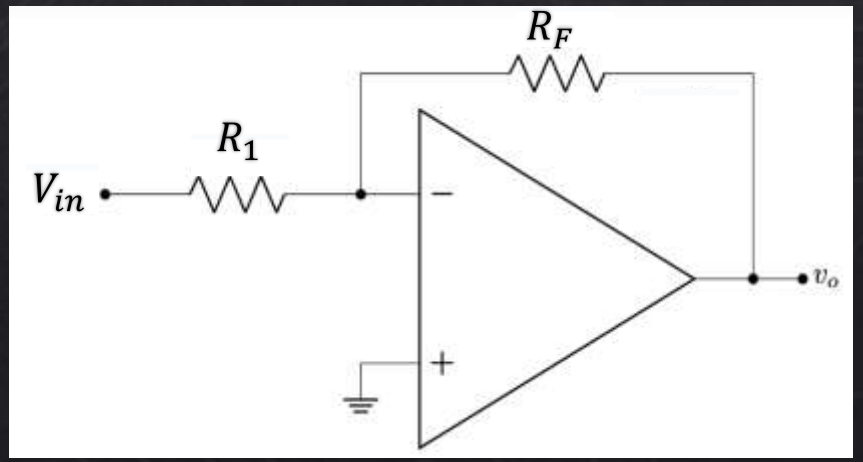
From Last Lecture (Config-1,2)

$$v_0 = -\frac{R_F}{R_1} V_{in}$$

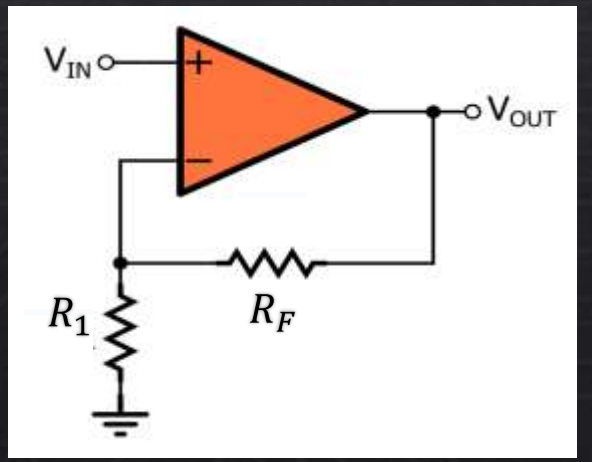
$$Gain = -\frac{R_F}{R_1}$$



Inverting Amplifier

$$v_0 = \left(1 + \frac{R_F}{R_1}\right) V_{in}$$

$$Gain = \left(1 + \frac{R_F}{R_1}\right)$$

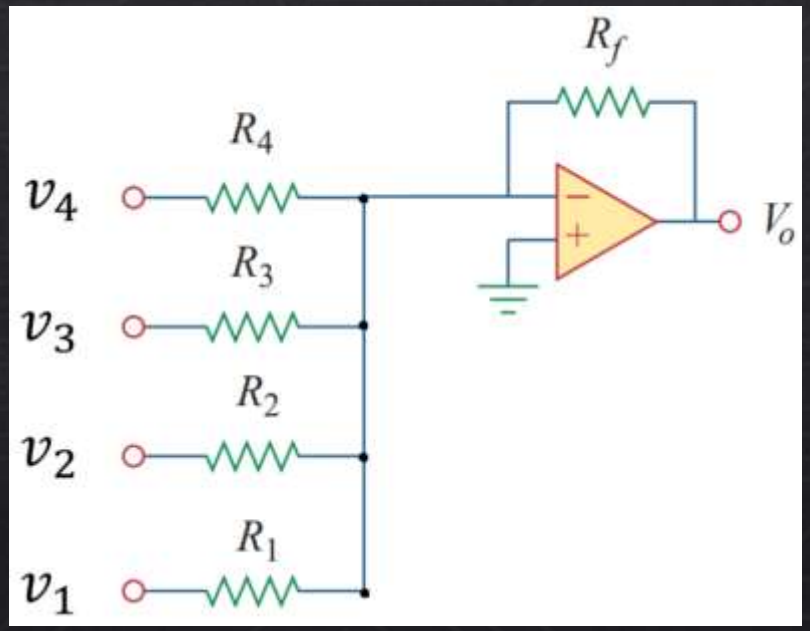


Non-Inverting Amplifier

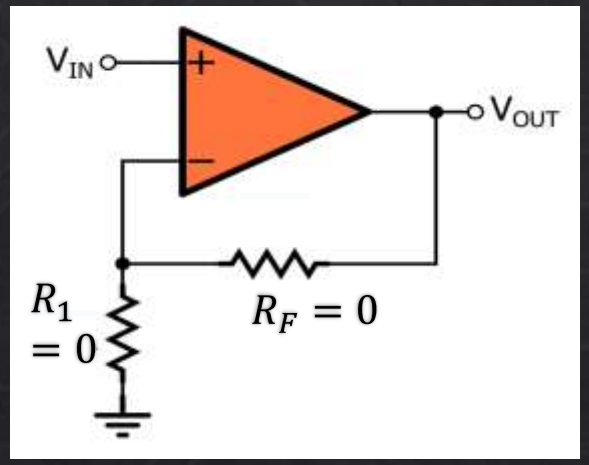
From Last Lecture (Config-3)

$$v_0 = -\left(\frac{R_f}{R_1}v_1 + \frac{R_f}{R_2}v_2 + \frac{R_f}{R_3}v_3 + \frac{R_f}{R_4}v_4\right)$$

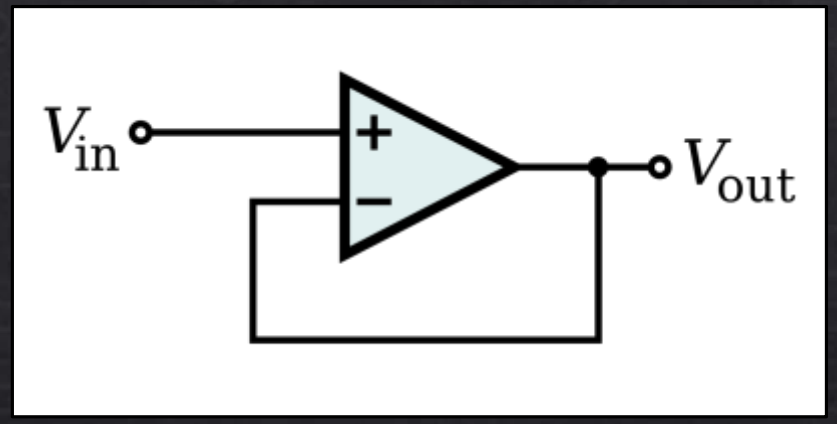
Inverting Adder



Buffer Configuration (Config-4)



Non-Inverting Amplifier



$v_0 = V_{in}$

$Gain = 1$

A **buffer** is one that provides electrical impedance transformation from one circuit to another, with the aim of preventing the signal source from being affected by whatever currents (or voltages, for a current buffer) that the load may impose

Design Problems

- **Examples :**

Construct the necessary circuit designs with op-amps that will take voltages as inputs and provide an output in the forms given below:

$$(i)\quad V_0 = -4V_1 + V_2/4$$

$$(ii)\quad V_0 = -3V_1 + 4V_2 + 0.5V_3$$

Differentiator (Config-5)

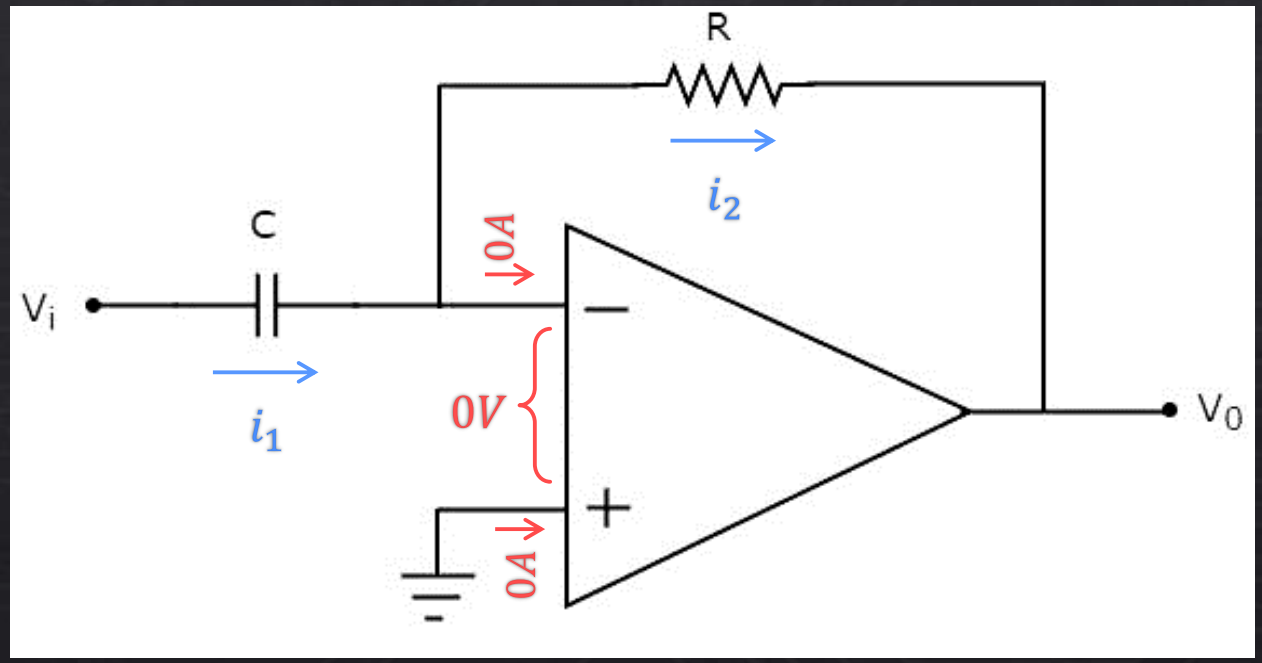
- **Circuit Configuration:**

$$C: \quad i_1 = C\frac{dv_c}{dt} = C\frac{d(V_i - 0)}{dt} = C\frac{dV_i}{dt}$$

$$R: \quad i_2 = \frac{0 - v_0}{R} = -\frac{v_0}{R}$$

$$i_1 = i_2$$

$$\Rightarrow \boldsymbol{v_0 = -RC\frac{dV_i}{dt}}$$



Integrator (Config-6)

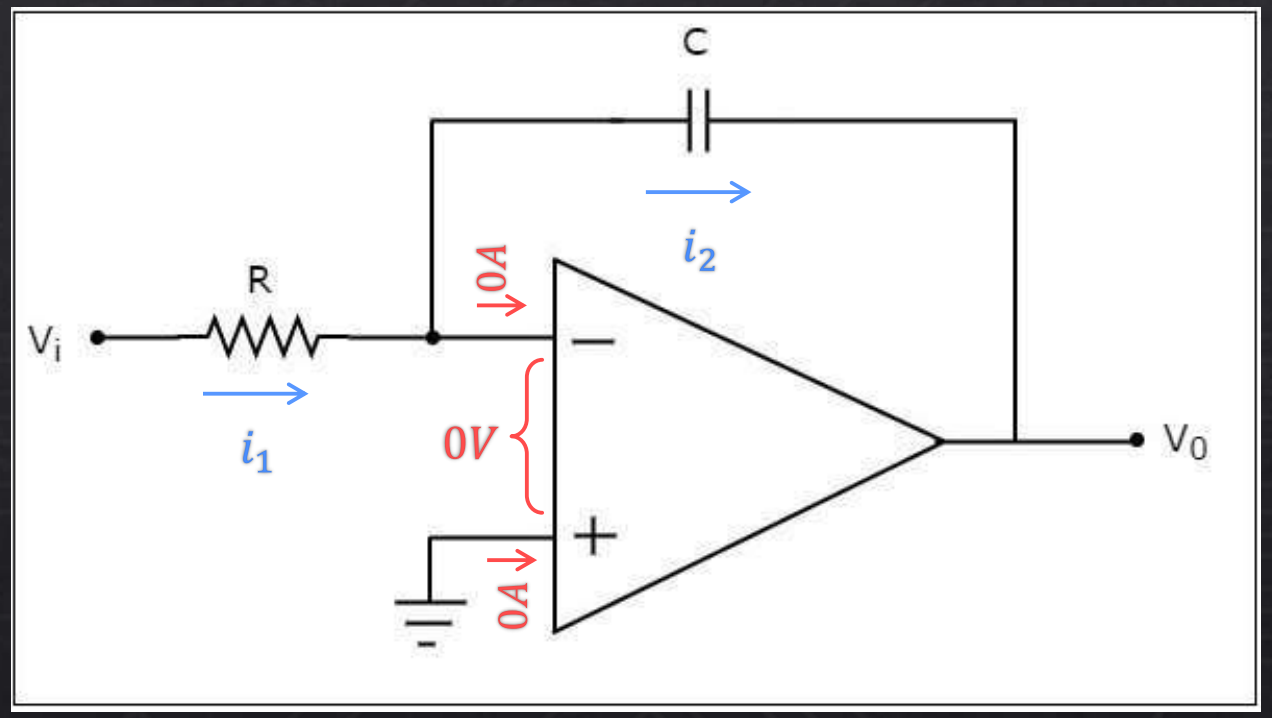
- **Circuit Configuration:**

$$R:\ i_1 = \frac{(V_i - 0)}{R} = \frac{V_i}{R}$$

$$R:\ i_2 = C\frac{dv_c}{dt} = C\frac{d(0 - v_0)}{dt} = -C\frac{dv_0}{dt}$$

$$i_1 = i_2 \Rightarrow \frac{dv_0}{dt} = -\frac{V_i}{RC}$$

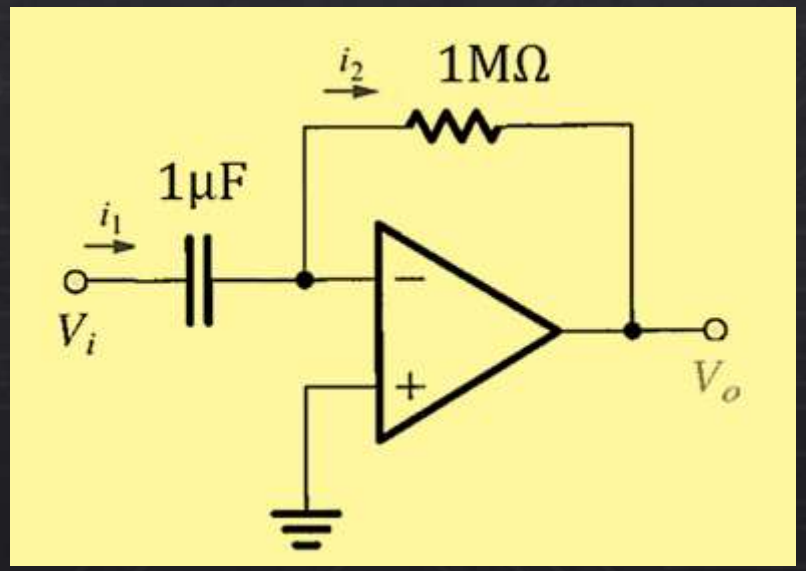
$$\Rightarrow \boldsymbol{v_0 = -\frac{1}{RC}\int V_i\ dt}$$



An Example

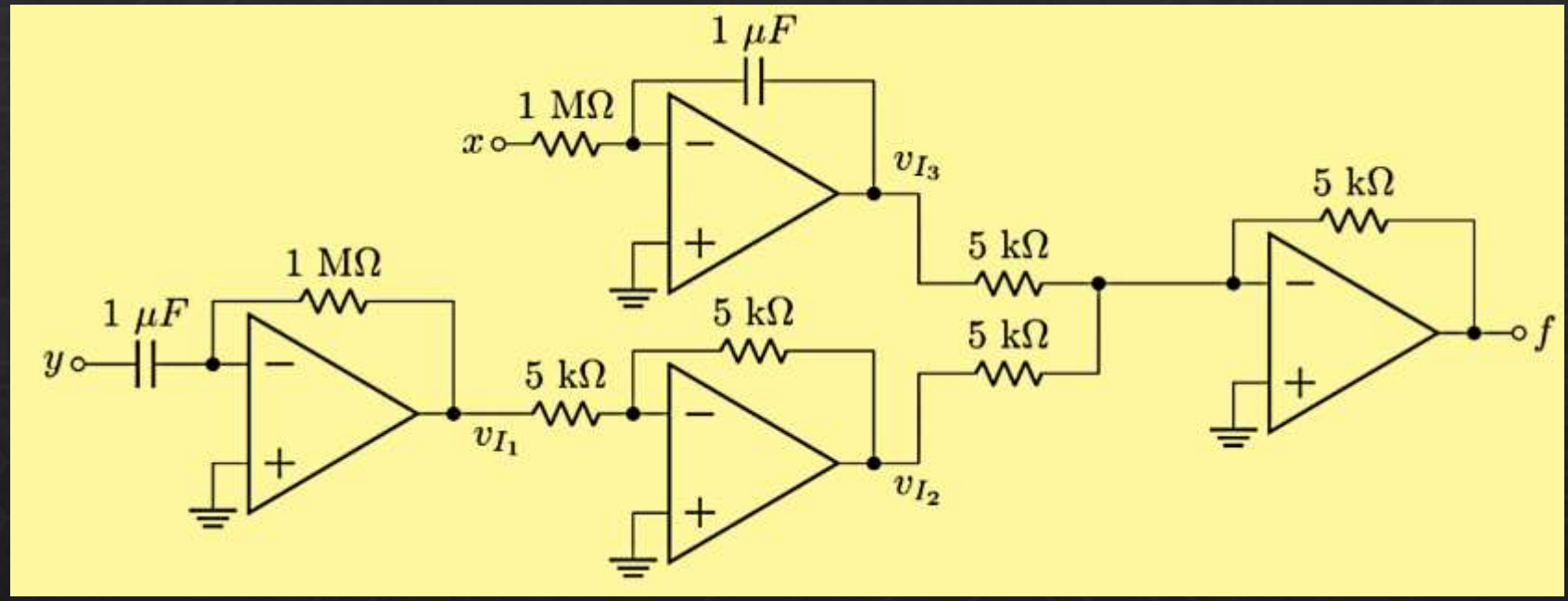
- **Determine v_0, i_1, i_2:**

Given, $V_i = 0.25\sin(20t)$



An Important Example

- **Determine f :**



Smoke Detector Circuit