Department of Computer Science and Engineering (CSE)

BRAC University

CSE 251: Electronic Devices and Circuits
Fall 2023

Lecture 02:

(i) KVL & KCL
(ii) Nodal Analysis & Practice Problems
(iii) Operational Amplifier: Introduction

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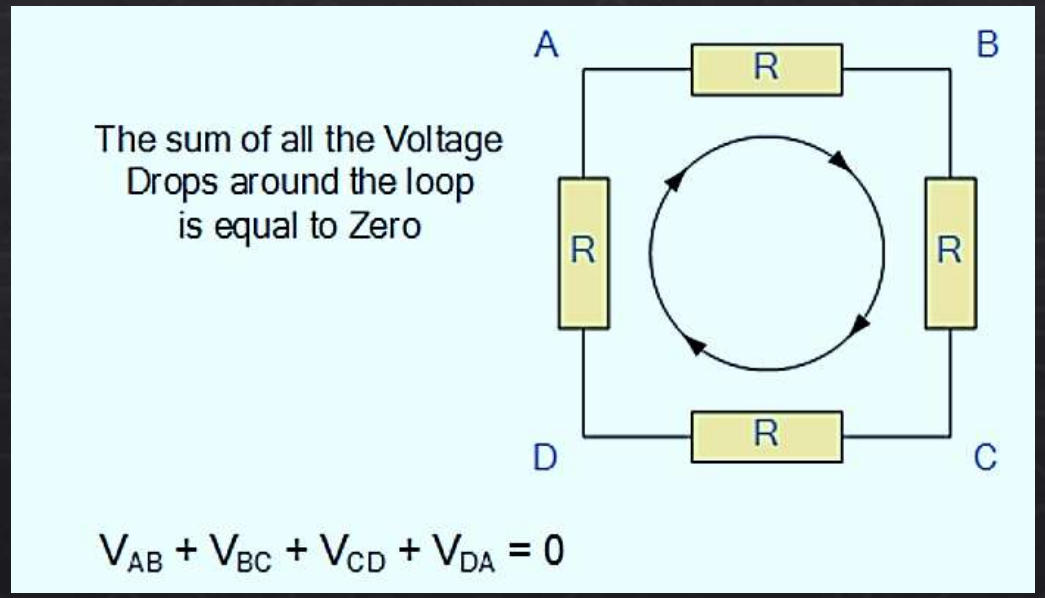
KVL & KCL

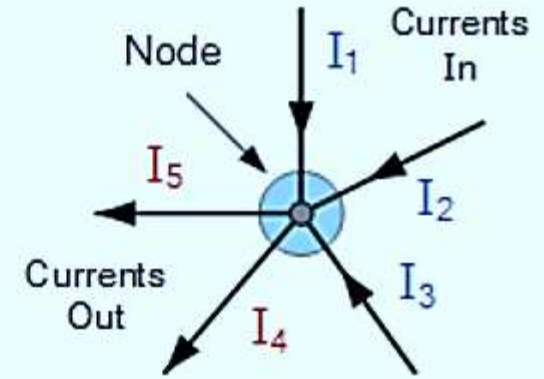
KVL: "In any closed loop network, the total voltage around the loop is equal to the sum of all the voltage drops within the same loop"



KVL & KCL

KCL: "Total current entering a junction or node is exactly equal to the charge leaving the node as it has no other place to go except to leave, as no charge is lost within the node"

Currents Entering the Node
Equals
Currents Leaving the Node



$$I_1 + I_2 + I_3 + (-I_4 + -I_5) = 0$$

Nodal Analysis

"**Nodal analysis** is a method that provides a general procedure for analyzing circuits using node voltages as the circuit variables."

Keep note:

~~kΩ → Ω~~

~~mA → A~~

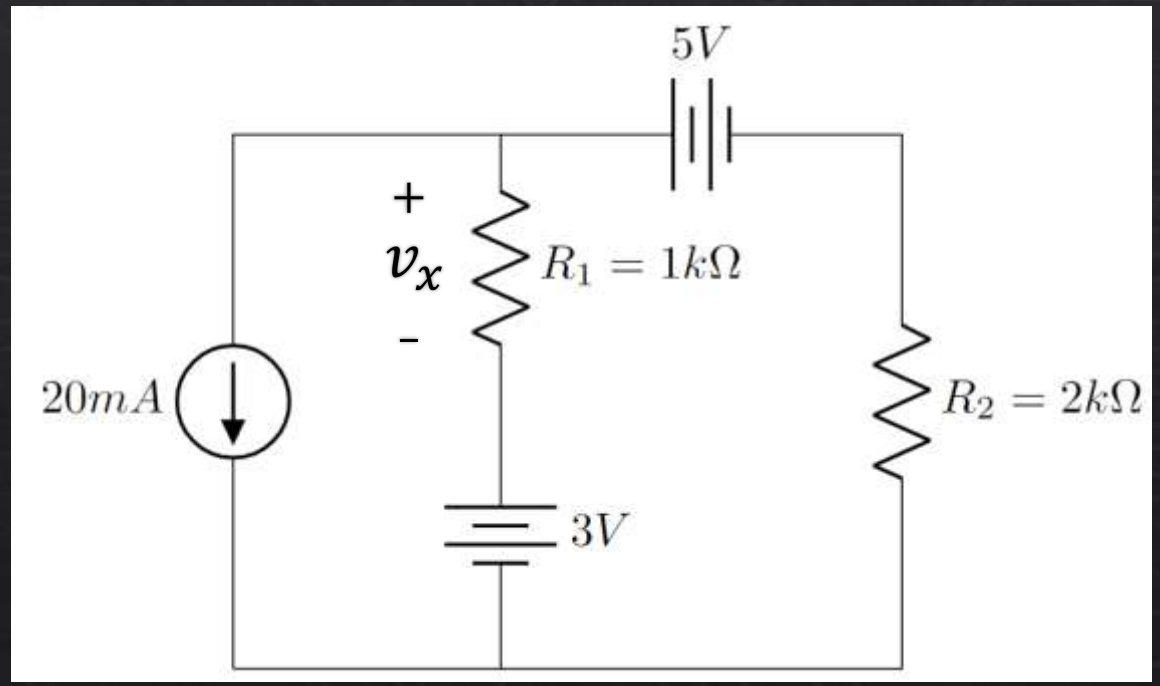
(don't do this for your convenience)

Keep note:

kΩ → kΩ

mA → mA

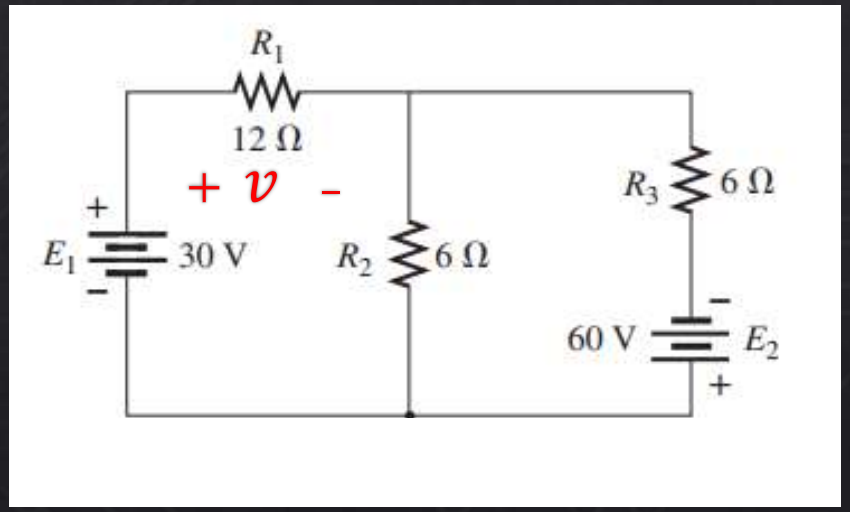
(do this for your own convenience)



Example: Determine v_x

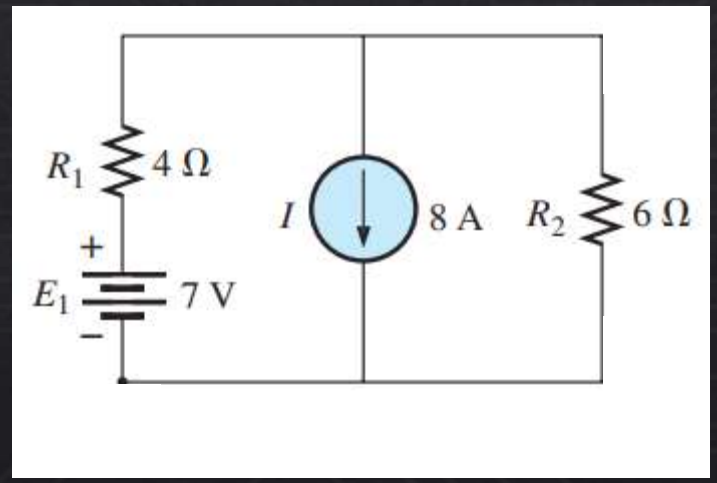
More Examples

Difficulty : 2/5



Example: 2 (Determine v)

Difficulty : 2/5

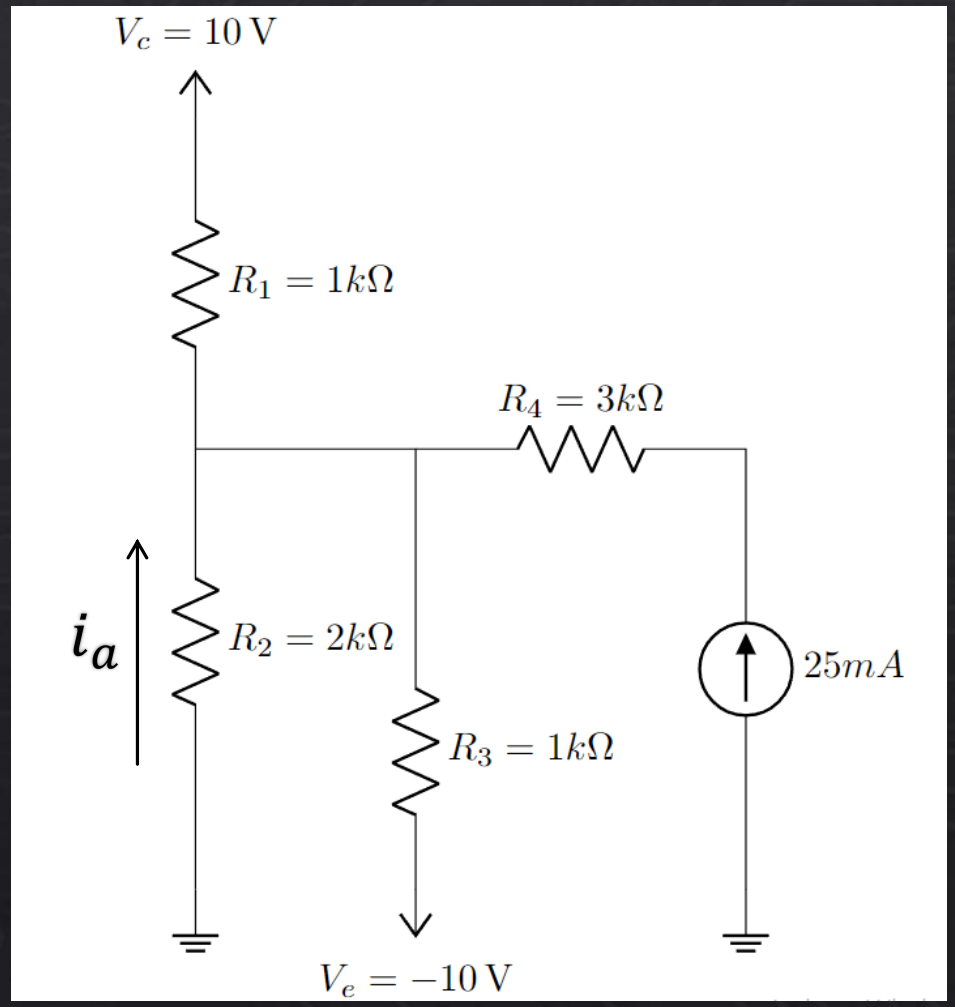


+
v
-

Example: 3 (Determine v)

More Examples (Line diagram)

Difficulty : 3/5

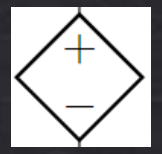


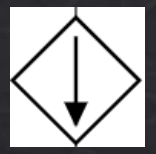
Example: 4

Determine i_a

Operational Amplifier: Introduction

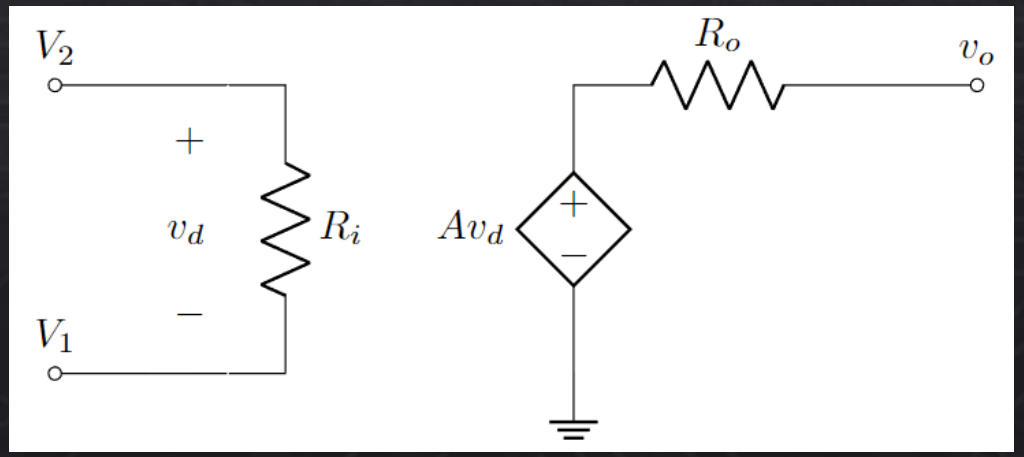
- **Dependent/Controlled Source:** (i) Voltage-Dependent, (ii) Current-Dependent





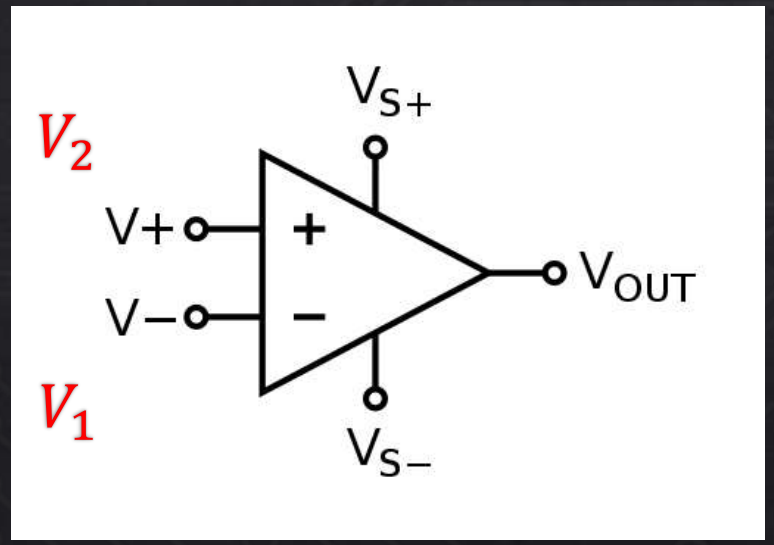
Find the expression for v_0

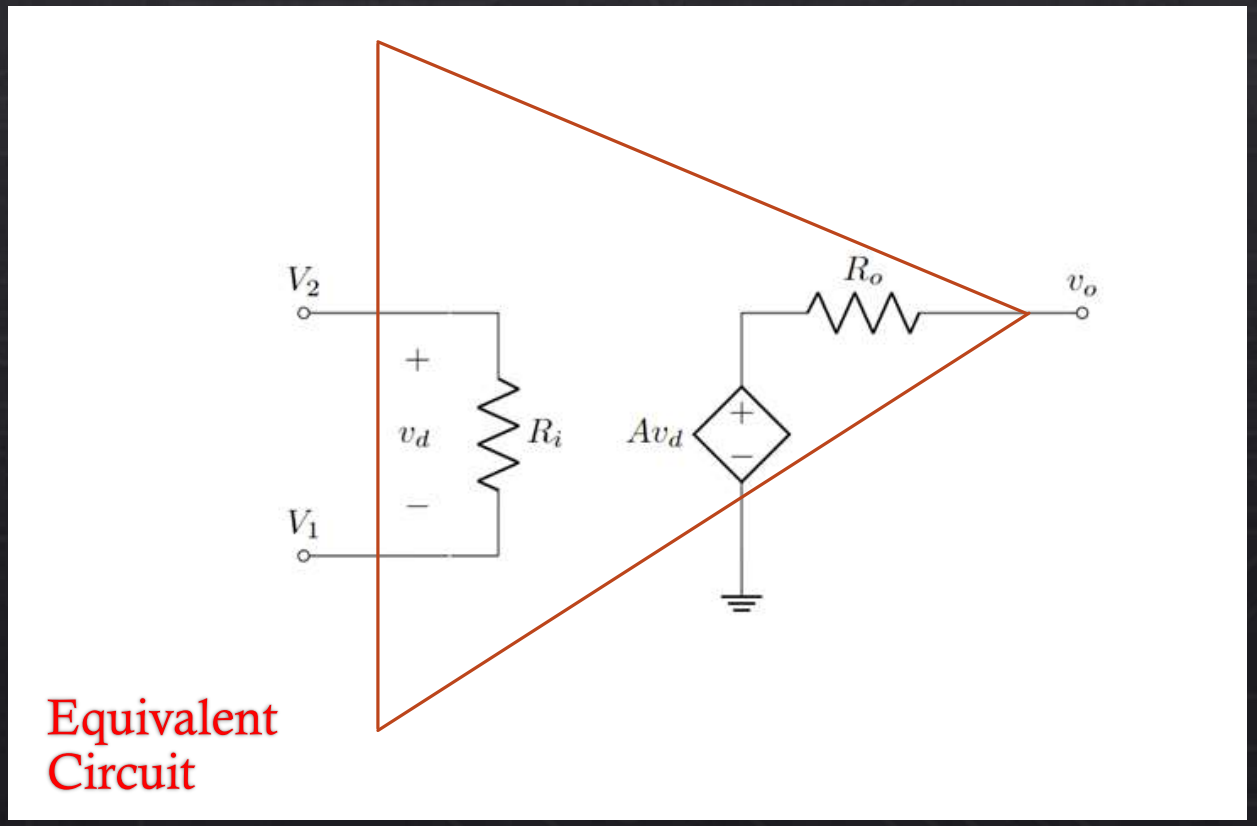
[Keep in mind, a simple KVL/Nodal analysis will do the trick here]



Operational Amplifier: Introduction

- **Operational Amplifier (Op-Amp) appears right here:**



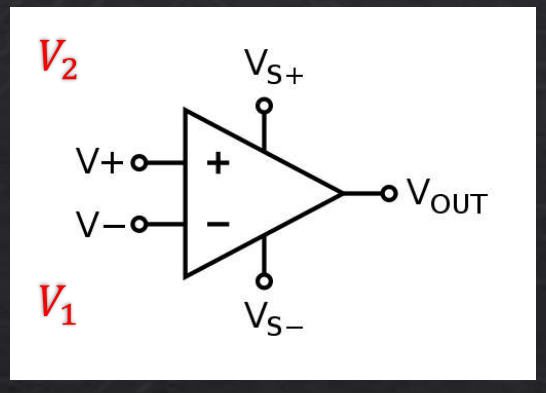


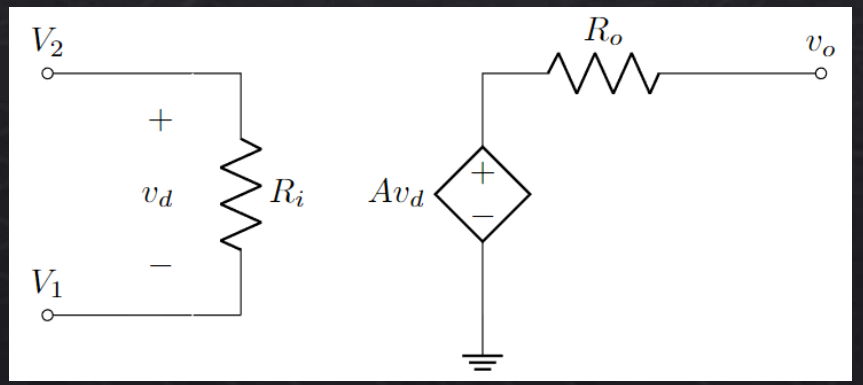
Operational Amplifier: Introduction

- **Why do we need Op-Amps?**
  1. Op-amps are essential for amplifying weak signals to a measurable level in applications such as audio systems and instrumentation.
  2. They play a crucial role in signal conditioning tasks by filtering noise, adjusting signal levels, and performing mathematical operations on signals in areas like telecommunications and control systems.
  3. Op-amps can be configured as comparators, enabling the comparison of input voltages and producing digital outputs for tasks such as threshold detection and level sensing.
  4. In feedback control systems, op-amps provide stability and precise control by comparing actual outputs to reference inputs, making them vital for applications like power supplies, motor control, and temperature regulation.

Operational Amplifier: Introduction

- **Terminologies:**





$V_1 = V_-$	Inverting Terminal
$V_2 = V_+$	Non-Inverting terminal
$v_d = V_2 - V_1$	Differential Input Voltage
A	Open Loop Gain (ideally ∞)
R_i	Input Resistance (ideally ∞)
R_o	Output Resistance
V_s^+, V_s^-	Positive & Negative Saturation Voltage

****Why are they named Saturation Voltage?****