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COIMBATORE-641 035, TAMIL NADU

DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

Course Name: 23ECT203 LINEAR INTEGRATED CIRCUITS

II YEAR/VI SEMESTER

UNIT II –APPLICATIONS OF OPERATIONAL AMPLIFIERS

Topic :V/I & I/V converters, Voltage Follower, summer, subtractor

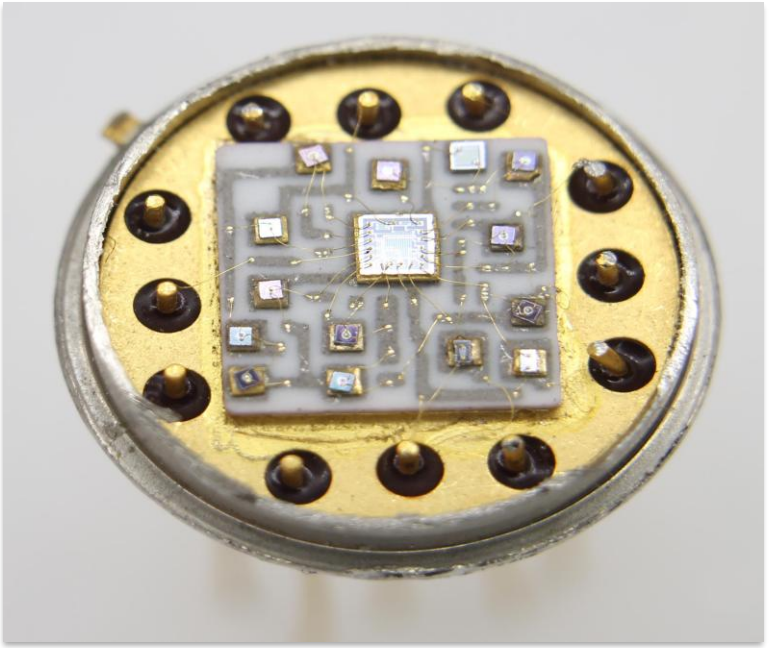
Overview

Operational amplifiers are fundamental building blocks in modern electronics, enabling precise signal processing and control in countless applications.

Design Thinking Methodology Empathize Define Ideate Prototype Test

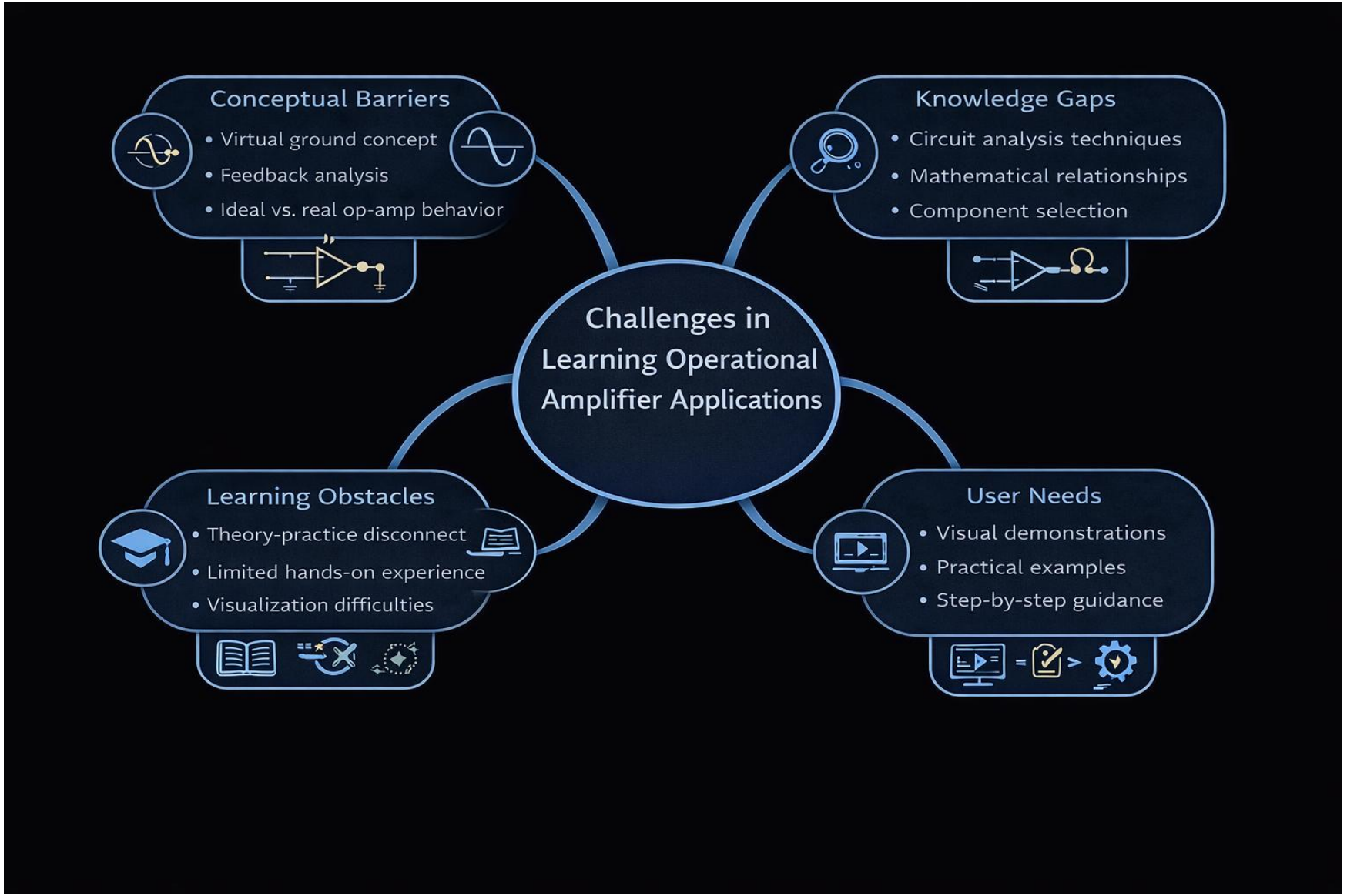
Op-Amp Applications V/I Converters I/V Converters Voltage Followers Summing Amplifiers Differential Amplifiers

Practical Implementation Circuit Design Simulation Testing Applications

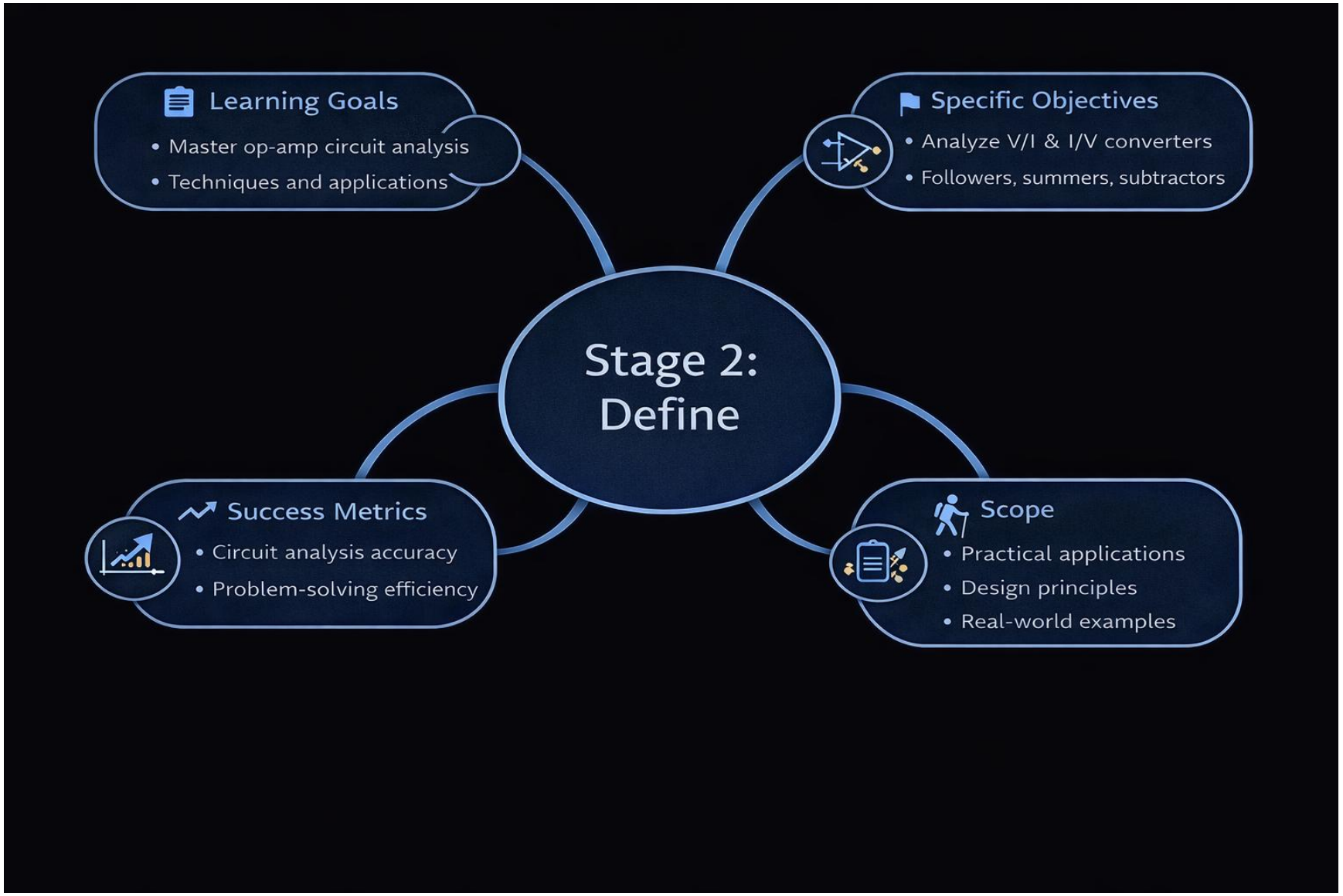


Modern operational amplifier integrated circuit

Stage 1: Empathize



Stage 2: Define



Stage 3: Ideate

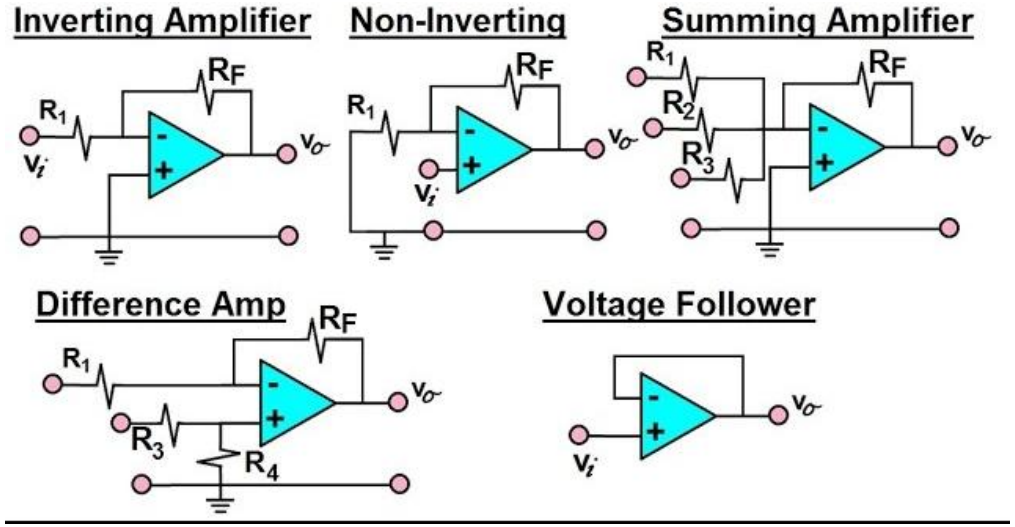
Brainstorming approaches to analyze and design operational amplifier circuits.

Simulation Approaches Virtual ground concept, nodal analysis, circuit simulation tools

Analysis Techniques Nodal analysis for V/I & I/V converters, superposition principle

Problem-Solving Methods Step-by-step circuit analysis, mathematical modeling

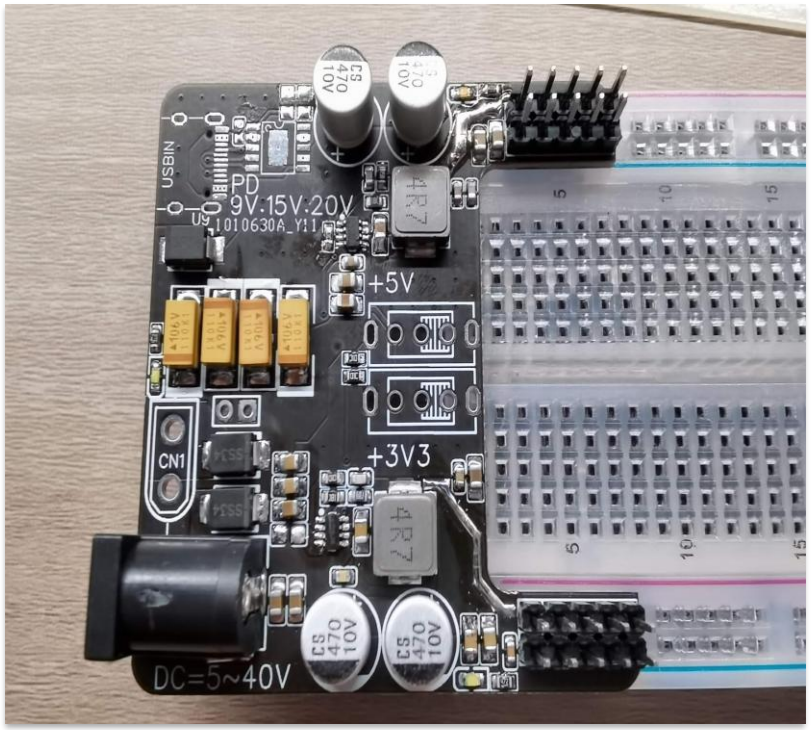
Collaborative Design Group brainstorming, peer review, knowledge sharing



Stage 4: Prototype

Building and testing circuit prototypes for operational amplifier applications.

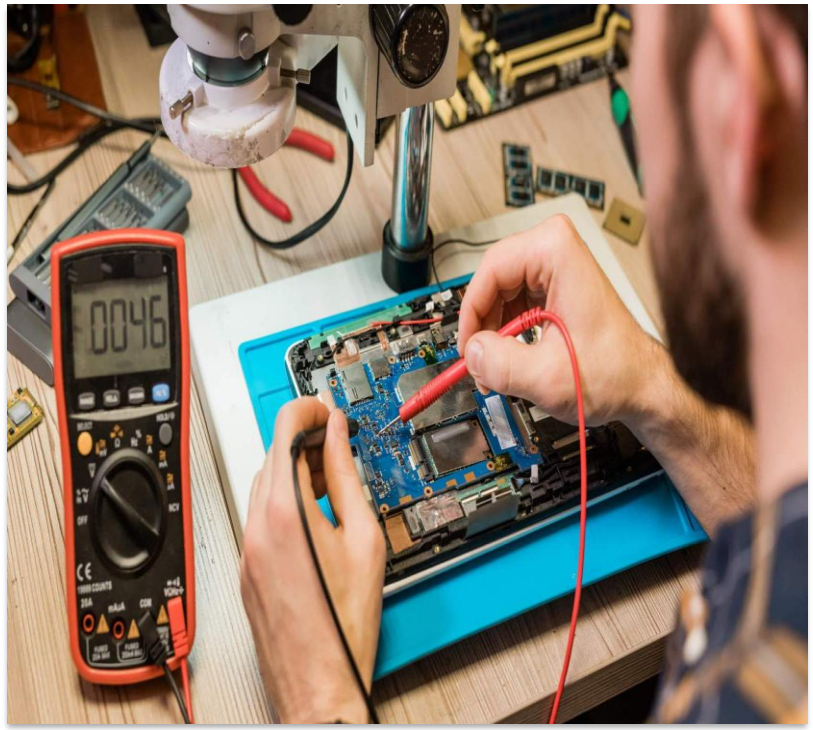
- **Circuit Prototypes** V/I & I/V converters on breadboards with real components
- **Breadboard Implementations** Voltage followers with actual op-amp ICs and supporting components
- **Simulation Models** Summer and subtractor circuits tested in simulation software
- **Iterative Refinement** Component value adjustments for optimal performance



Stage 5: Test

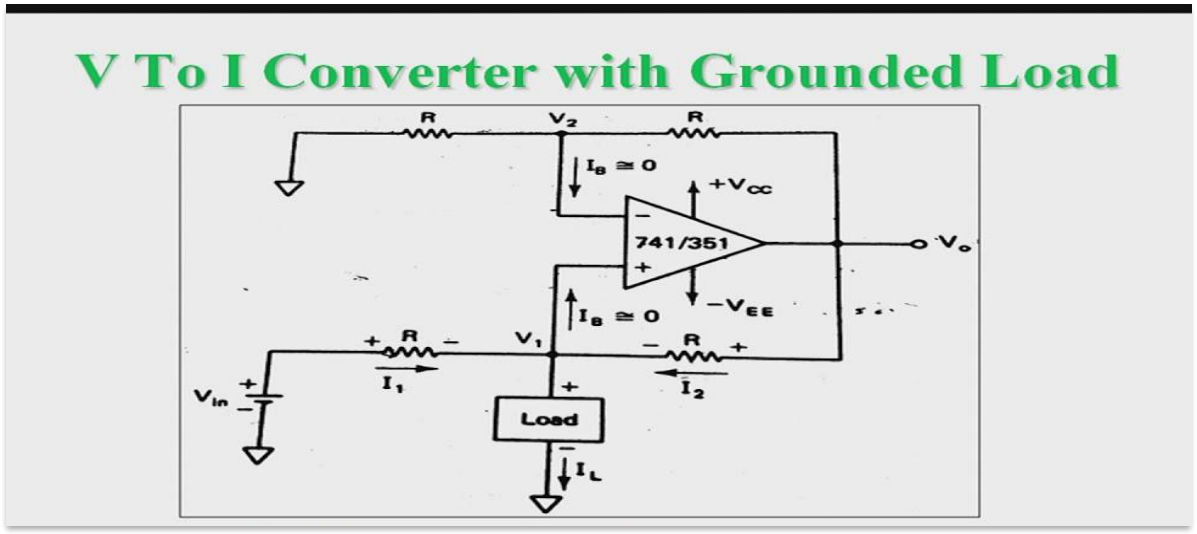
Testing and evaluating operational amplifier circuits to validate design performance.

- **Measurement Tools** Oscilloscopes and multimeters for signal analysis
- **Performance Analysis** Gain verification for V/I & I/V converters
- **Troubleshooting** Identifying issues in follower, summer, subtractor circuits
- **Feedback Collection** Comparing measured vs. theoretical values



Testing operational amplifier circuits with measurement equipment

Voltage-to-Current Converters



$$I_{out} = V_{in} / R$$

Key Components

Op-amp, input resistor, grounded load

Conversion Function

Linear voltage-to-current transformation

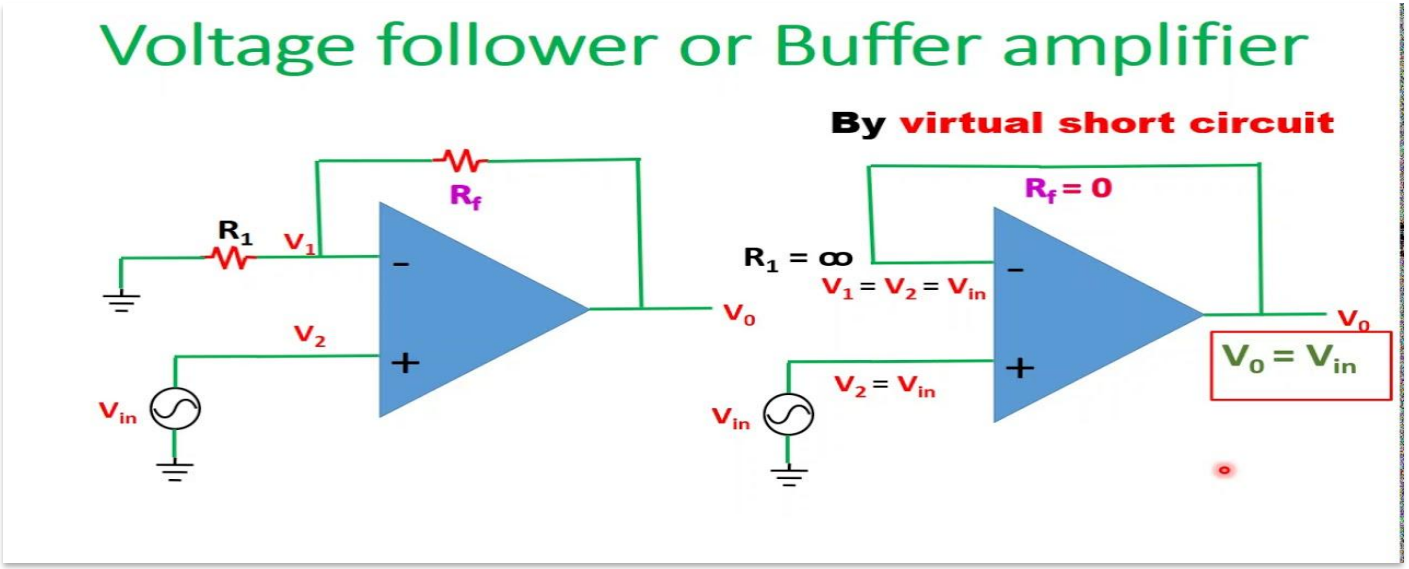
Applications

LED drivers, current sources, sensor interfaces

Design Considerations

Load resistance, input voltage range, stability

Voltage Follower



Vout = Vin

Configuration

Output connected to inverting input

Unity Gain Buffer

Signal isolation without amplification

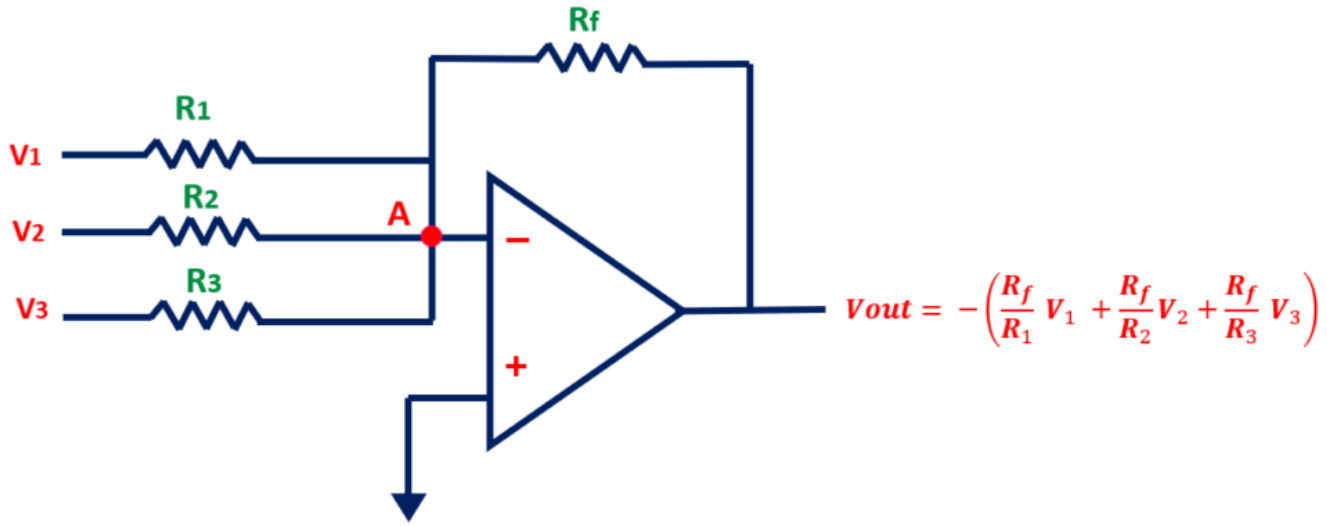
Applications

Impedance matching, signal buffering

Design Considerations

Slew rate, bandwidth, stability

Summer (Summing Amplifier)



Vout = -Rf(V1/R1 + V2/R2 + V3/R3)

Configuration

Multiple input resistors, feedback resistor, op-amp

Addition Function

Multiple input voltage summation

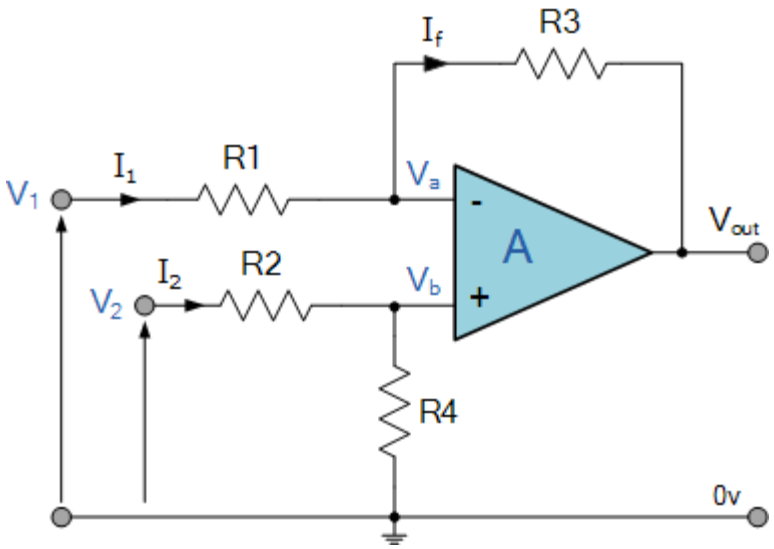
Applications

Audio mixing, digital-to-analog conversion

Design Considerations

Input resistor values, saturation limits

Subtractor (Differential Amplifier)



$$V_{out} = (R_f/R_1)(V_2 - V_1)$$

Configuration

Two input paths with matched resistor ratios

Subtraction Function

Output proportional to input difference

Applications

Signal difference measurement, noise rejection

Design Considerations

Resistor matching, CMRR, bandwidth

Activity

Quick hands-on implementation of a voltage follower circuit to reinforce theoretical concepts.

Quick Circuit Build

Build a simple voltage follower with minimal components

- Connect op-amp
- Wire feedback
- Apply power

Rapid Testing

Verify unity gain operation

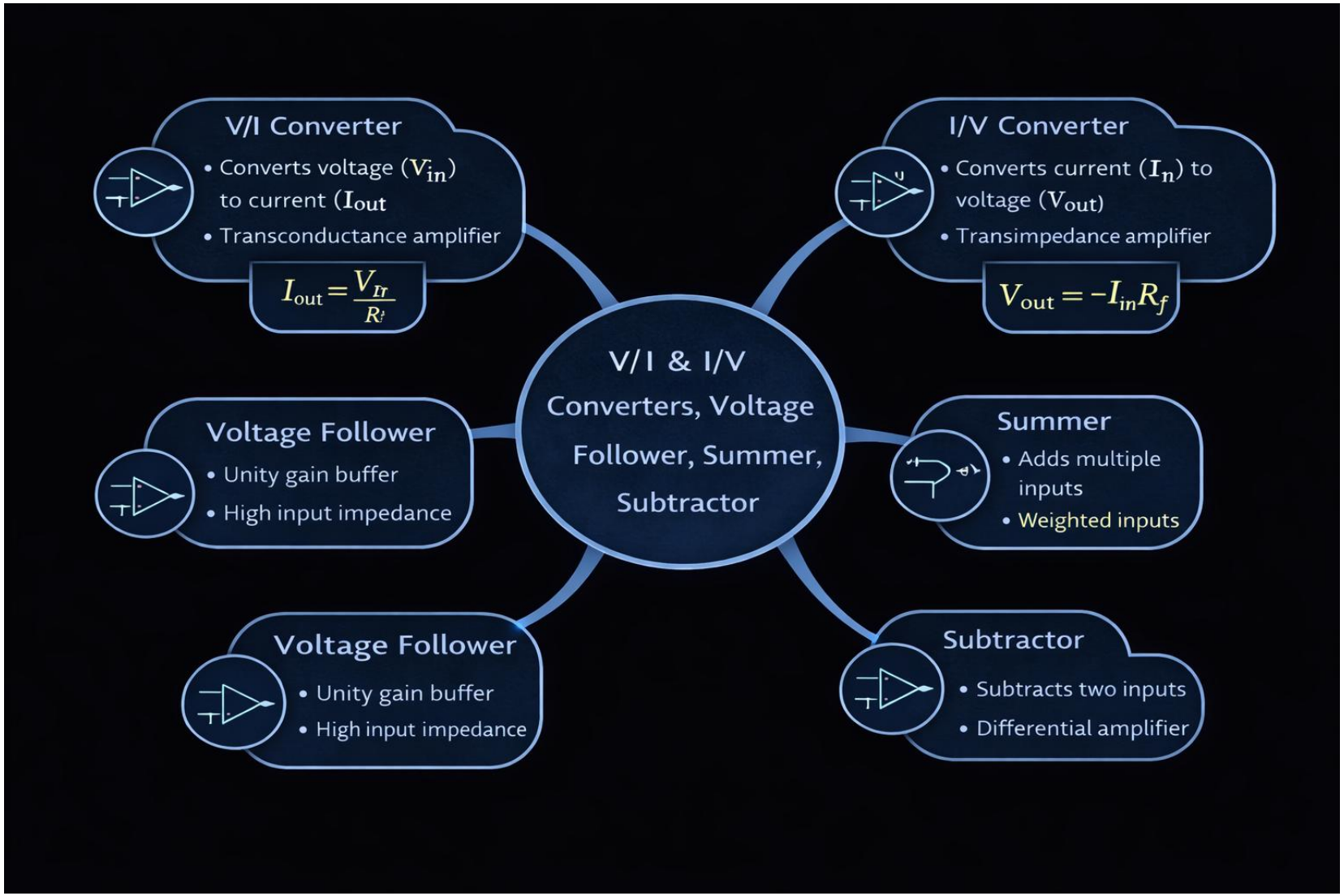
1. Apply input
2. Measure output
3. Compare values

5 Minutes

Minimal Materials

- Breadboard
- Op-amp IC
- Power supply
- Jumper wires

Concept Map


V/I & I/V Converters, Voltage Follower, Summer, Subtractor
V/I Converter
• Converts voltage (V_{in}) to current (I_{out}
• Transconductance amplifier
$I_{out} = \frac{V_{in}}{R_f}$
I/V Converter
• Converts current (I_n) to voltage (V_{out})
• Transimpedance amplifier
$V_{out} = -I_{in}R_f$
Voltage Follower
• Unity gain buffer
• High input impedance
Summer
• Adds multiple inputs
• Weighted inputs
Voltage Follower
• Unity gain buffer
• High input impedance
Subtractor
• Subtracts two inputs
• Differential amplifier

References

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Carter, B. & Mancini, R. Op Amps for Everyone 5th Ed., Newnes, **2018**

Sedra, A.S. & Smith, K.C. Microelectronic Circuits 8th Ed., Oxford University Press, **2020**

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Thank You