SNS COLLEGE OF TECHNOLOGY

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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 I –BASICS OF OPERATIONAL AMPLIFIERS

Topic :Slew rate

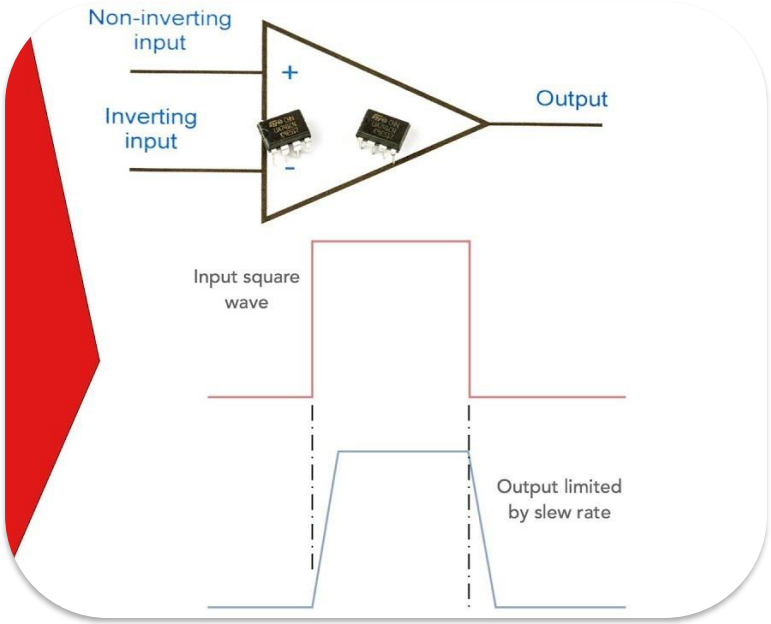
Introduction to Slew Rate

⍰ What is Slew Rate?

- Maximum rate of **voltage change** at output
- Measured in **V/µs** (volts per microsecond)

! Why is it important?

- Limits **high-frequency performance**
- Causes **signal distortion** for fast signals
- Critical for **audio and video applications**
- Determines **maximum usable frequency**

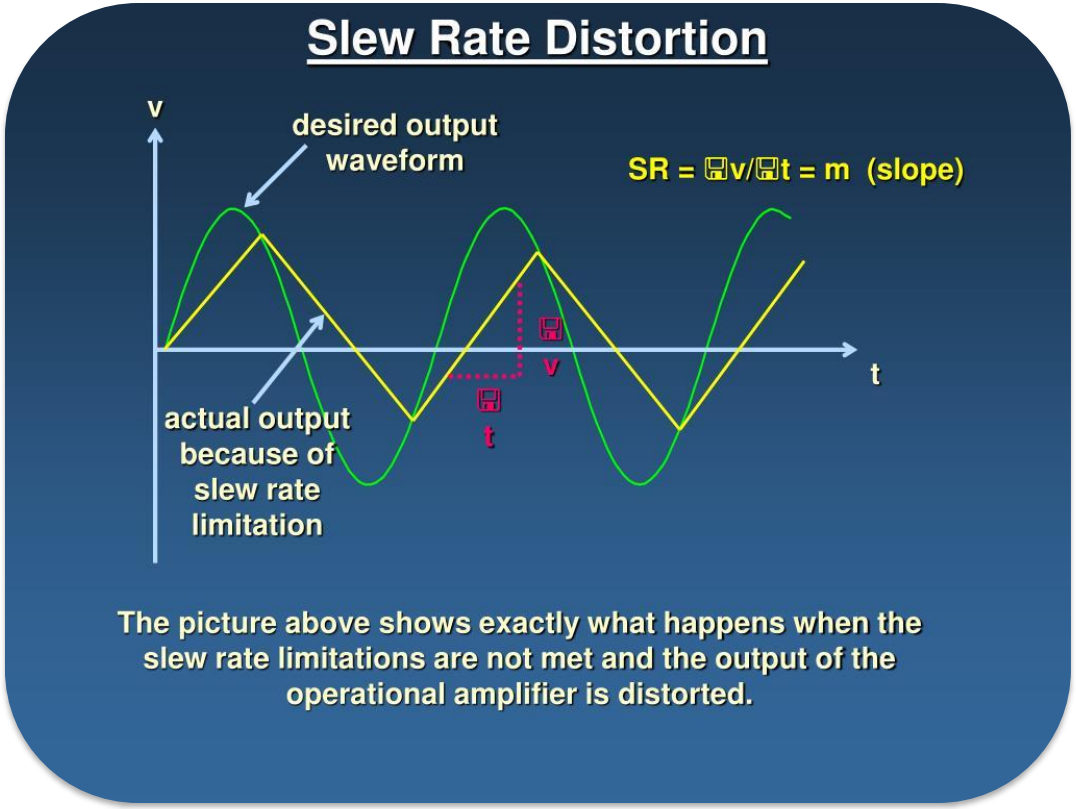


Stage 1: Empathize

Understanding challenges in analyzing slew rate limitations

Student Challenges

- **Abstract concept** of voltage change rate
- **Small time scales** (microseconds) hard to visualize
- **Confusion between** slew rate and bandwidth
- **Difficulty connecting** slew rate to real-world applications



Stage 2: Define

Defining requirements for understanding slew rate parameters

Learning Goals

- Define key parameters: **Definition**, **Causes**, **Effects**, **Calculations**
- Understand **physical origin** of slew rate limitations
- Learn to **calculate slew rate** and its impact on signals
- Determine **maximum frequency** for given slew rate

Definition

Maximum rate of voltage change

Causes

Internal capacitance and current limitations

Effects

Signal distortion for fast signals

Calculations

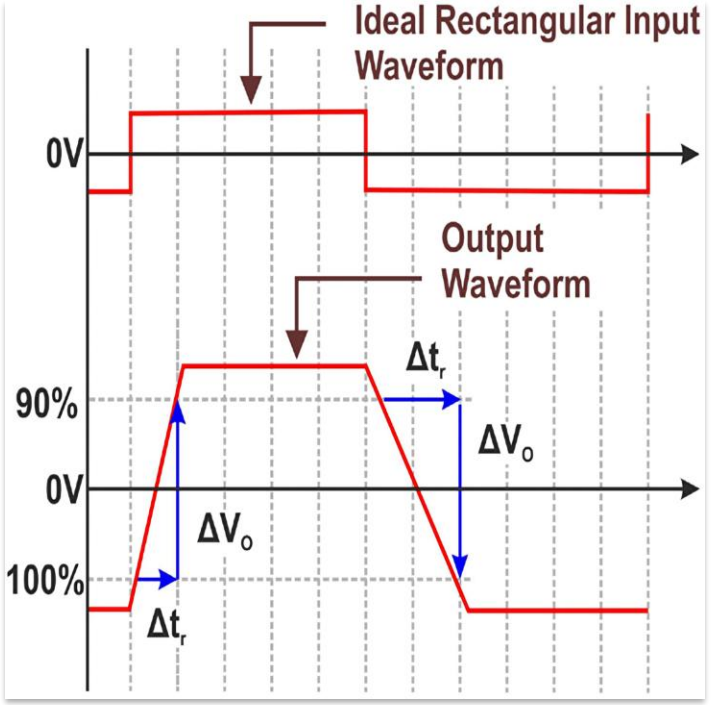
SR = ΔV/Δt (V/μs)

Stage 3: Ideate

Brainstorming approaches to analyze slew rate limitations

Approaches

- Measure **slew rate** using step input signals
- Analyze **waveform distortion** for different frequencies
- Calculate **maximum frequency** for given slew rate
- Use **simulation tools** to verify slew rate effects

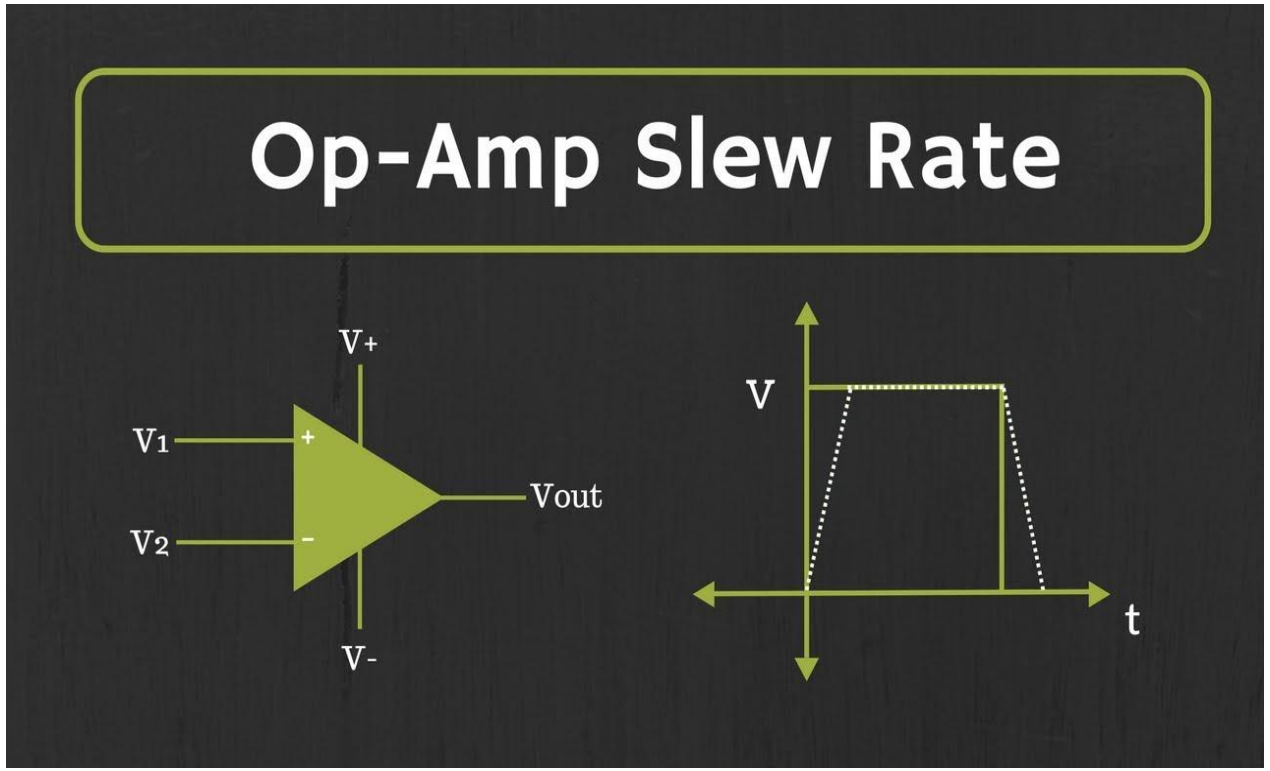


Stage 4: Prototype

Creating a slew rate model of an op-amp

The Model

1. Start with **ideal op-amp symbol**
2. Add **slew rate limitation** element
3. Include **voltage change rate** formula: SR = ΔV/Δt
4. Model helps **predict signal distortion** for fast signals

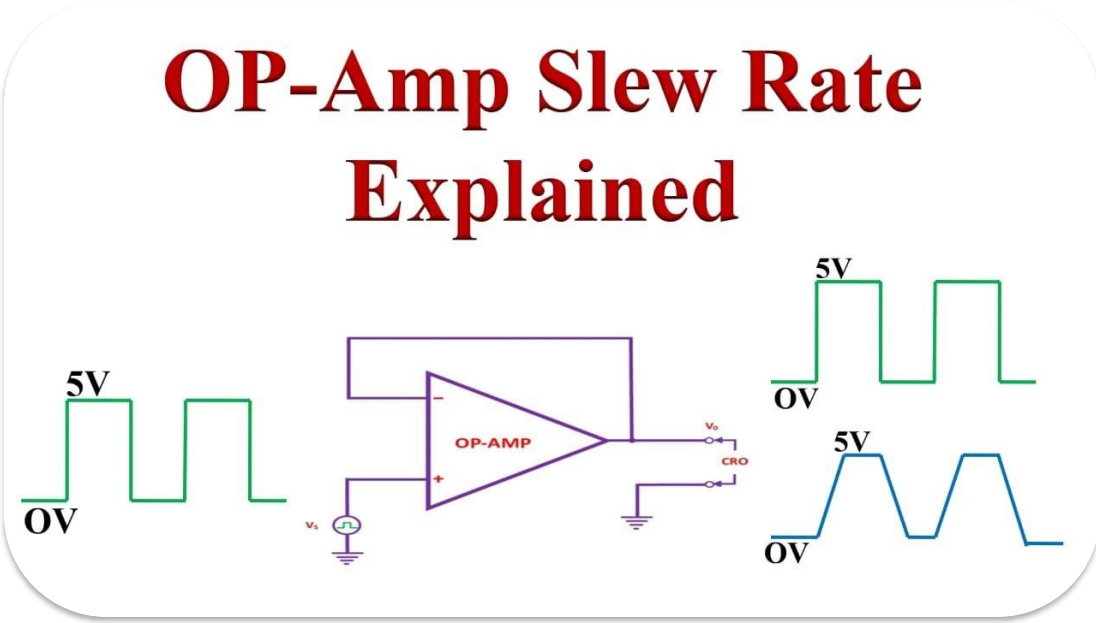


Stage 5: Test

Testing and evaluating slew rate calculations

Testing Method

1. Apply **step input** to op-amp circuit
2. Measure **output voltage** with oscilloscope
3. Calculate **slew rate** from waveform
4. Compare with **datasheet specifications**



Activity: THINK-PAIR-SHARE

Analyzing slew rate limitations

THINK (2 min)

An op-amp has a **slew rate** of 1 V/μs. What is the maximum frequency for a 5V peak-to-peak sine wave output?

PAIR (3 min)

Discuss your calculation and method with a partner

SHARE (5 min)

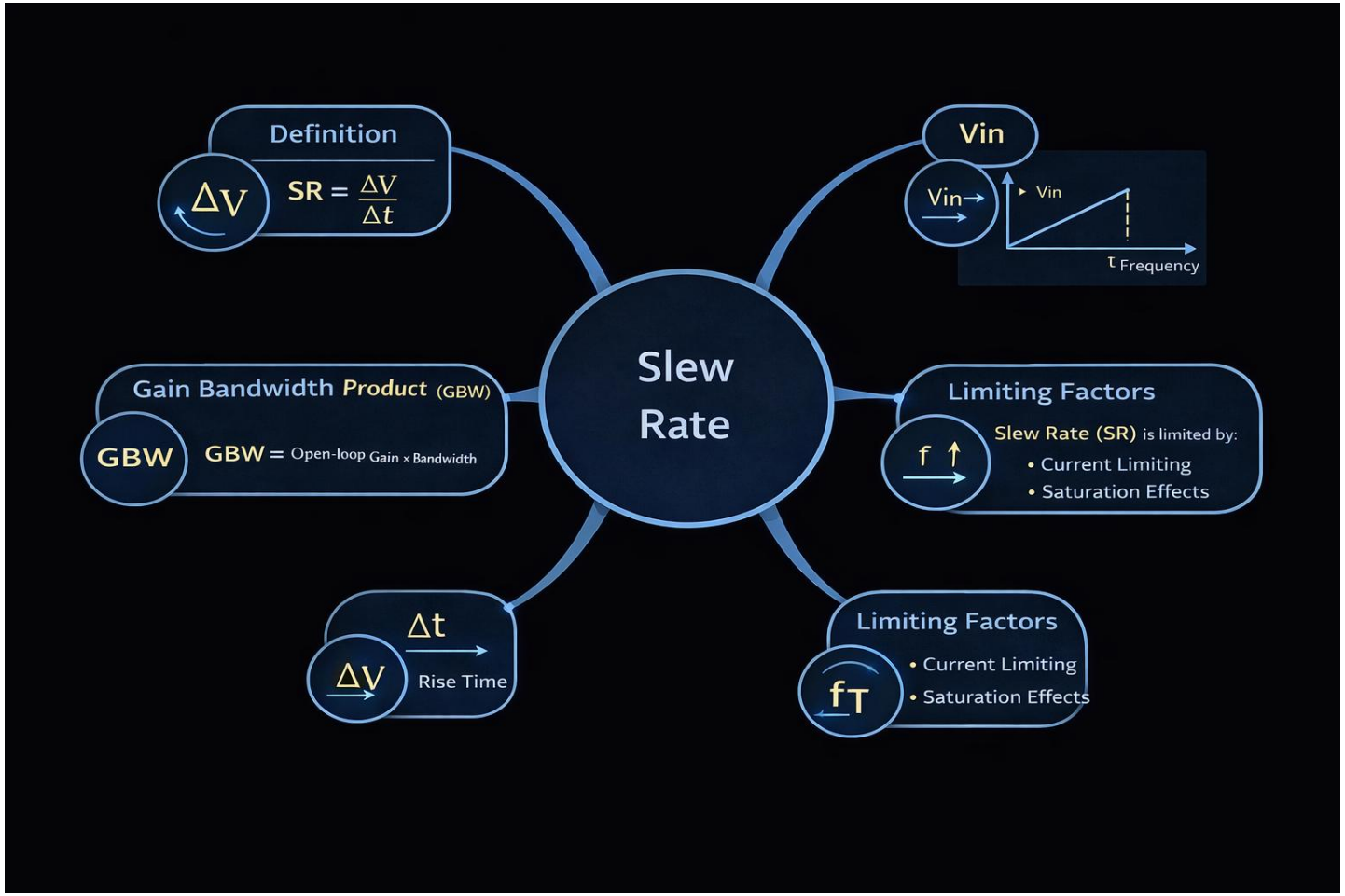
Be ready to share your answer and formula you used

Individual Thinking

Partner Discussion

Group Sharing

Mind Map


Slew Rate
Definition
ΔV
SR = ΔV / Δt
Vin
Vin
Vin
τ Frequency
Gain Bandwidth Product (GBW)
GBW
GBW = Open-loop Gain × Bandwidth
Limiting Factors
f
Slew Rate (SR) is limited by:
• Current Limiting
• Saturation Effects
Δt
ΔV
Rise Time
Limiting Factors
fT
• Current Limiting
• Saturation Effects

Assessment

Exam-Oriented Questions

1. Define **slew rate** and explain its significance in op-amp circuits.

2. Explain the relationship between **slew rate** and **full power bandwidth** in op-amp circuits.

3. Draw a **slew rate limitation** diagram for a 5V peak sine wave with a slew rate of 1 V/µs.

4. Calculate the **maximum frequency** for a 10V peak sine wave with a slew rate of 2 V/µs.

References

Textbooks

D.Roy Choudhry, Shail Jain, **"Linear Integrated Circuits"**, New Age International, 5th edition, 2018. (Unit I, Section 1.5)

Sergio Franco, **"Design with Operational Amplifiers and Analog Integrated Circuits"**, 4th Edition, Tata Mc Graw-Hill, 2014. (Chapter 3)

Online Resource

Texas Instruments, **"Op-amp Slew Rate and Full Power Bandwidth"**, [Link to TI E2E or technical document]

Textbooks

Online Resources

Thank You