



2 Stage Operational Amplifier

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List of Figures

- 1 **2-Stage Operational Amplifier**
- 2 **Applications of a 2-Stage Operational Amplifier**
- 3 **Comparison of Operational Amplifiers**
- 4 **Working Principle**
- 5 **Design Requirements**
- 6 **Simulation and Analysis**
 - 6.1 AC Analysis
 - 6.2 DC Analysis
 - 6.3 Transient Analysis
- 7 **Conclusion**

List of Figures

- 2-Stage Operational Amplifier
- Block Diagram of a 2-Stage Operational Amplifier
- 2-Stage Operational Amplifier Schematic
- AC Analysis Results
- DC Analysis Results
- Transient Analysis Results

List of Tables

1	Comparison of Operational Amplifier	5
2	Design Requirements	6

1 2-Stage Operational Amplifier

A 2-Stage Operational Amplifier (Op-Amp) is a high-gain electronic voltage amplifier with a differential input and a single-ended output. It is widely used in analog circuits for signal conditioning, filtering, and mathematical operations. The 2-stage design typically consists of a differential input stage followed by a gain stage, providing high gain and good stability.

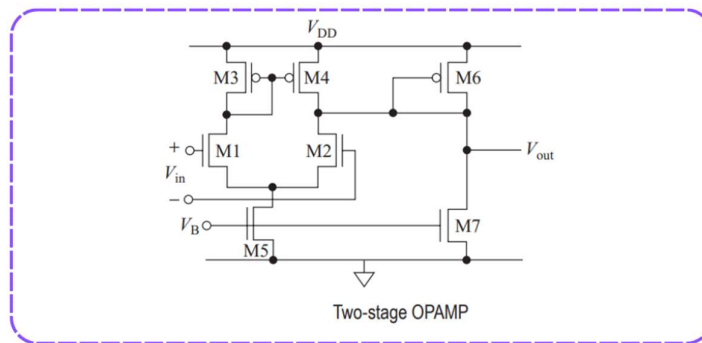


Figure 1: 2 Stage OP-AMP

2 Applications of a 2 stage op-amp

1. **Signal Conditioning:** Used to amplify weak signals from sensors.
2. **Active Filters:** Used in low-pass, high-pass, and band-pass filters.
3. **Analog-to-Digital Converters (ADCs):** Used as a buffer or amplifier in ADC circuits.
4. **Oscillators:** Used in waveform generation circuits.
5. **Voltage Regulators:** Used in feedback loops for voltage regulation.
6. **Instrumentation Amplifiers:** Used in precision measurement systems.

3 Comparison

Type	Gain	Bandwidth	Power Consumption	Use Case
Single-Stage Op-Amp	Low	High	Low	General-purpose applications
2-Stage Op-Amp	High	Moderate	Moderate	High-gain applications
3-Stage Op-Amp	Very High	Low	High	Precision applications
Folded Cascode Op-Amp	High	High	Moderate	High-speed applications

4 Working Principle

A **2-Stage Operational Amplifier** consists of two main stages:

1. Differential Input Stage:

- The first stage is a differential amplifier that amplifies the difference between the two input signals.
- It provides high input impedance and common-mode rejection.

2. Gain Stage:

- The second stage is a common-source or common-emitter amplifier that provides additional gain.
- It converts the differential signal into a single-ended output.

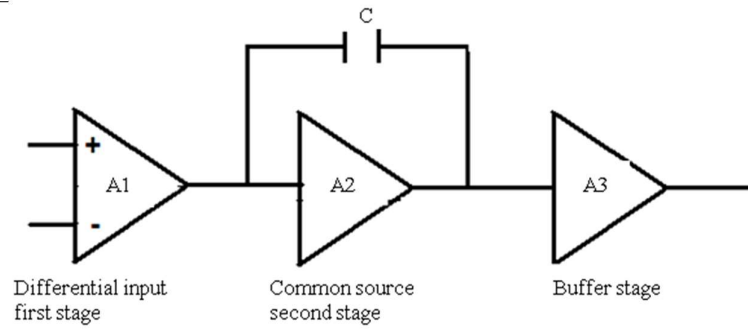


Figure 2: Block Diagram of a op-amp

The output of the 2-stage op-amp is fed back to the input through a compensation network to ensure stability and prevent oscillations.

5 Design Requirements

Component	Component Value	Quantity
Transistor (NMOS)	0.18 μ m	4
Transistor (PMOS)	0.18 μ m	4
Resistor	10k Ω	2
Capacitor	1pF	1
Current Source	50 μ A	1

Table 2: Design Requirements

6 Working of the Circuit

AC Analysis

- Objective: To determine the frequency response of the 2-stage op-amp.
- Procedure:
- Apply a small AC signal at the input.
- Sweep the frequency from 1Hz to 1GHz.
- Measure the gain and phase margin

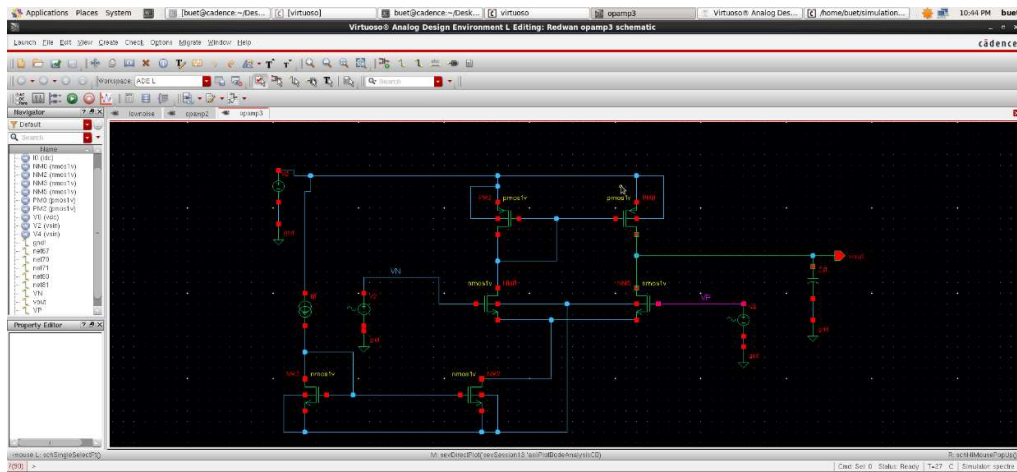
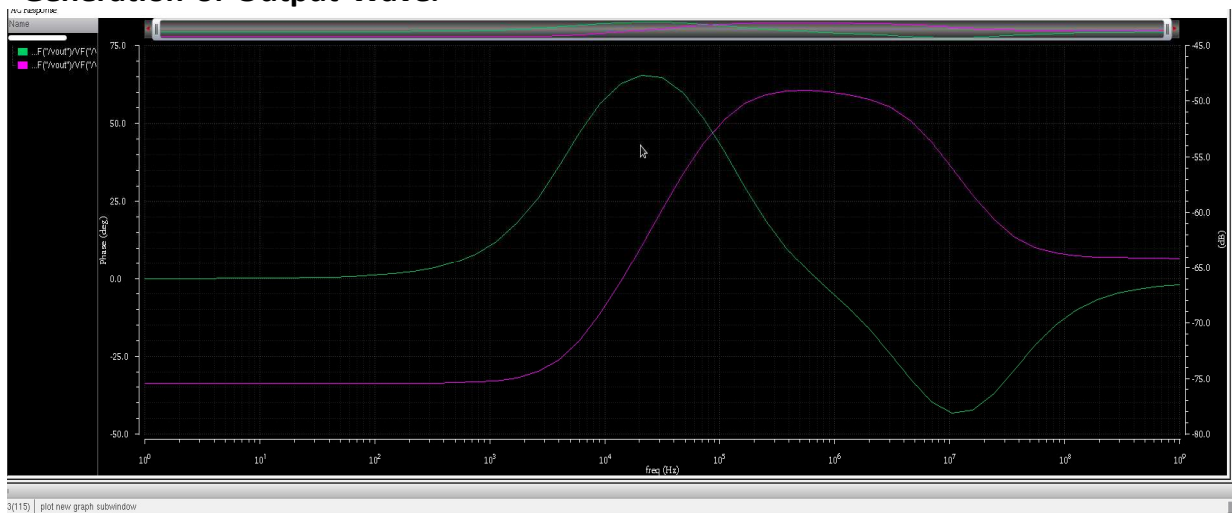


Figure 3: Op-amp Schematic

Generation of Output Wave:



DC Analysis

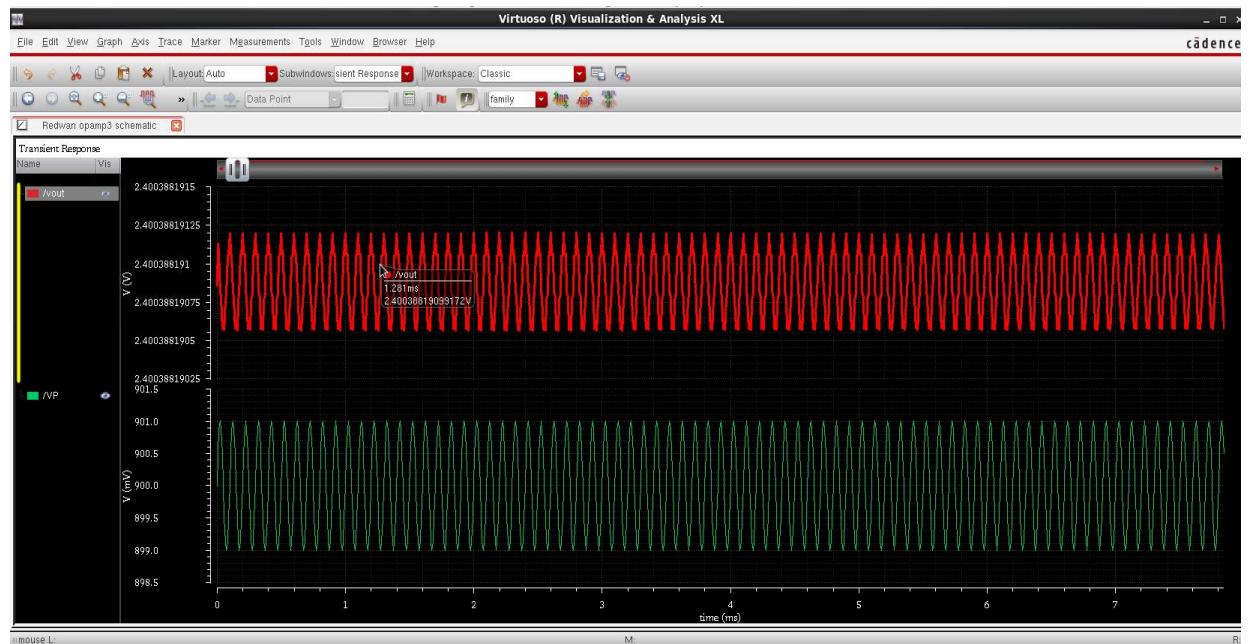
- Objective: To determine the DC operating point of the 2-stage op-amp.
- Procedure:
- Apply a DC voltage at the input.
- Measure the output voltage and current.

Generation of Output Wave

Transient Analysis

- Objective: To observe the time-domain response of the 2-stage op-amp.
- Procedure:
- Apply a step input signal.
- Measure the output response over time.

Generation of Output Wave:



7 Conclusion

The 2-Stage Operational Amplifier is a versatile and widely used component in analog circuit design. By performing AC, DC, and transient analyses in Cadence, we were able to verify the performance of the op-amp, including its gain, bandwidth, and stability. The designed 2-stage op-amp demonstrates high gain and good stability, making it suitable for a wide range of applications in signal conditioning, filtering, and precision measurement systems.