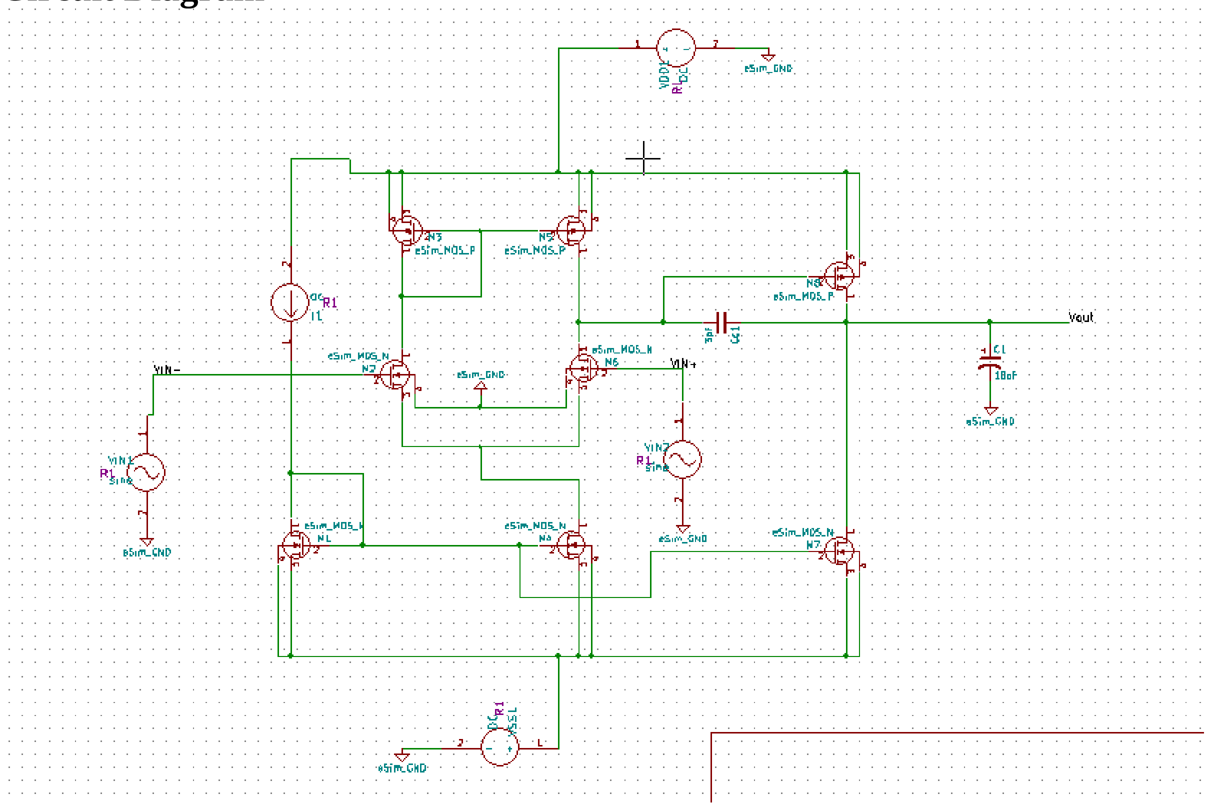
Two Stage Operational Transconductance Amplifier

Yash Kiran Ekhande

Theory: A **two-stage operational transconductance amplifier (OTA)** is a high-gain analog amplifier widely used in signal processing applications. It consists of two main stages: a differential amplifier (first stage) and a gain stage (second stage). The first stage converts the differential input voltage into a proportional current while offering high input impedance and rejecting common-mode signals, thus providing good initial gain and ensuring high accuracy. The second stage boosts the overall gain and drives the load with a high output swing, making the OTA suitable for various applications.

Circuit Diagram

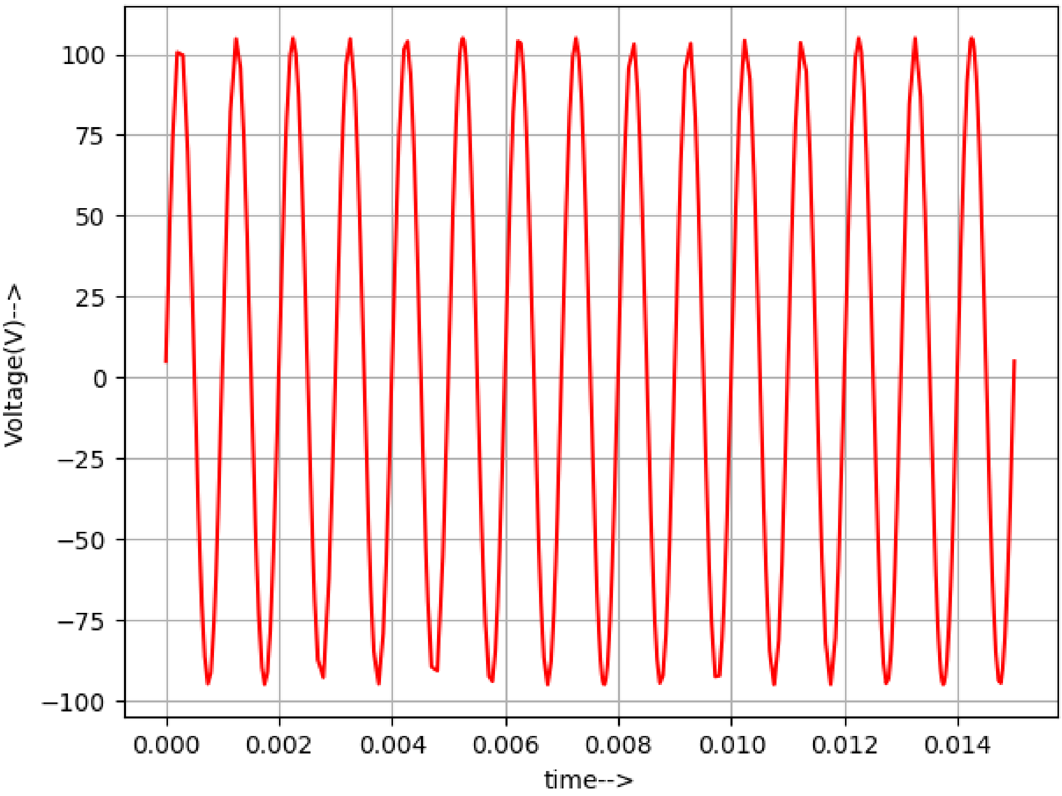


2 stage OTA

Simulation

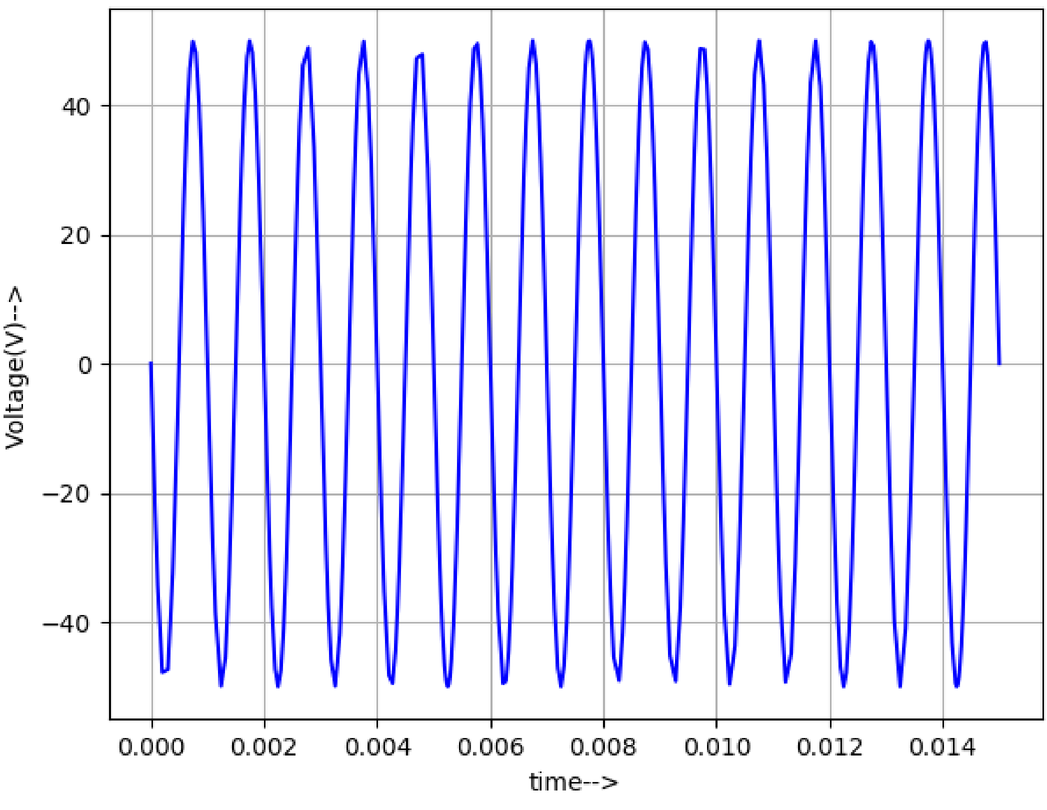
Transient analysis

INPUTS and Differential Inputs



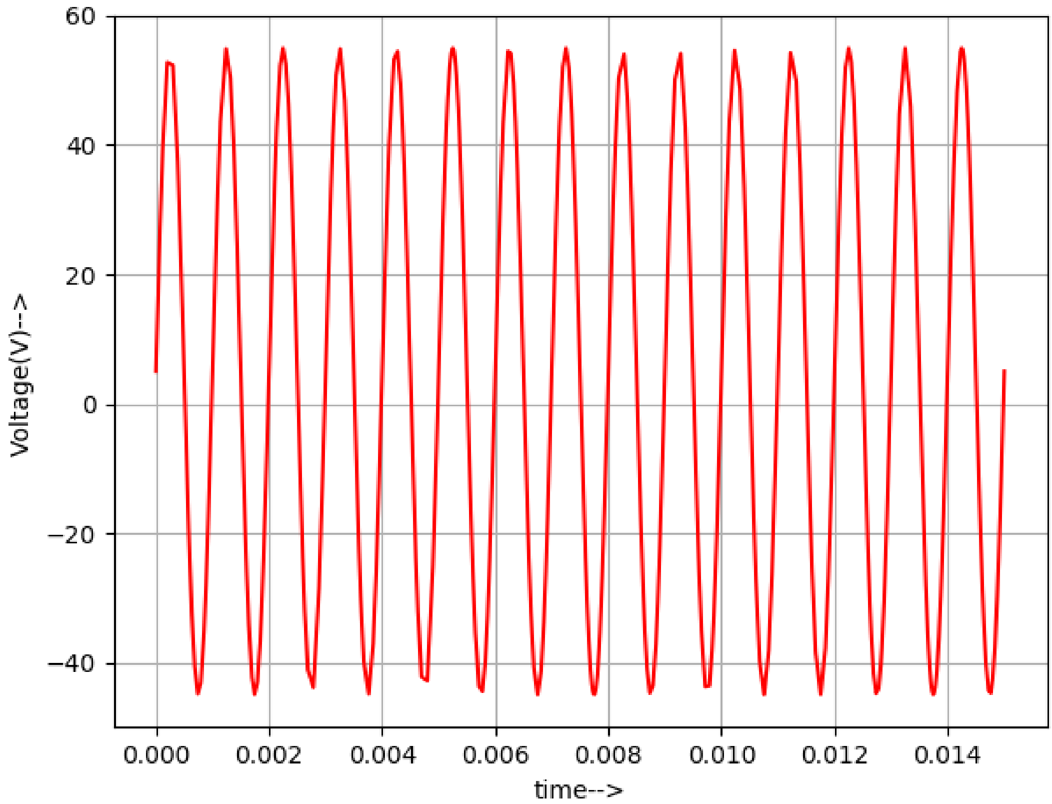
100
75
50
25
0
−25
−50
−75
−100
Voltage(V)-->
0.000
0.002
0.004
0.006
0.008
0.010
0.012
0.014
time-->

(VIN+) - (VIN-)

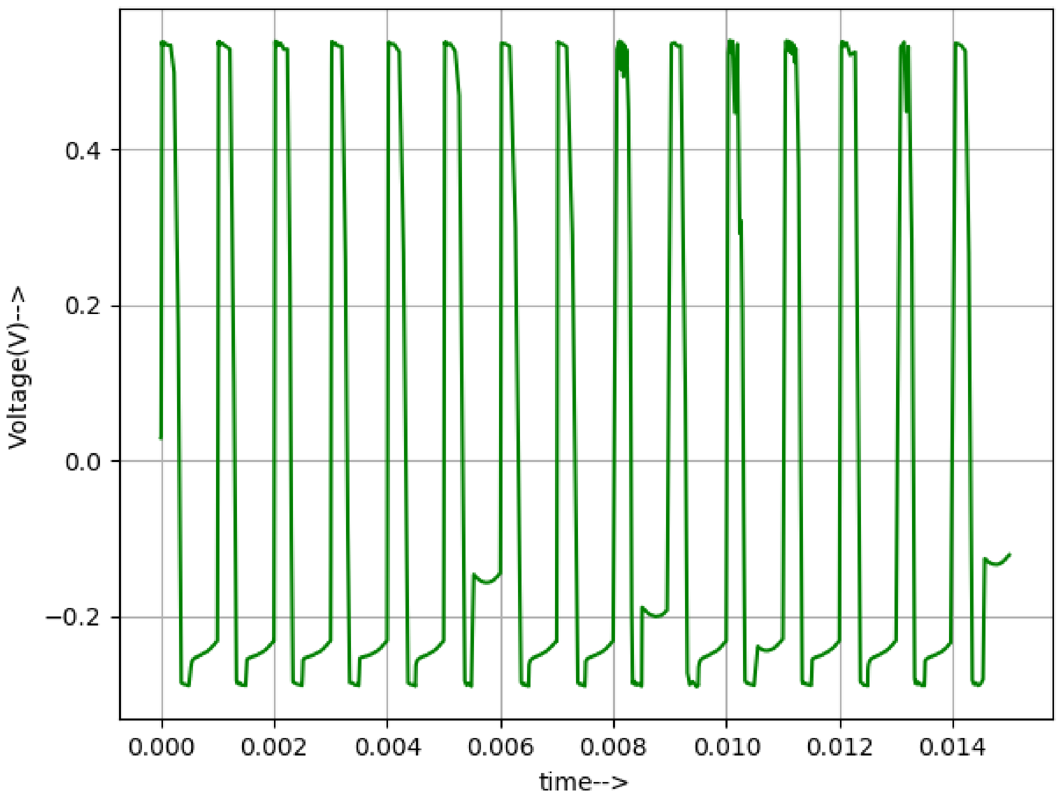


40
20
0
−20
−40
Voltage(V)-->
0.000
0.002
0.004
0.006
0.008
0.010
0.012
0.014
time-->

VIN-


60
40
20
0
−20
−40
Voltage(V)-->
0.000
0.002
0.004
0.006
0.008
0.010
0.012
0.014
time-->

VIN+


0.4
0.2
0.0
−0.2
Voltage(V)-->
0.000
0.002
0.004
0.006
0.008
0.010
0.012
0.014
time-->

VOUT

Transient Analysis

The **transient analysis of a 2-stage Operational Transconductance Amplifier (OTA)** provides insights into its dynamic response to time-varying input signals. The waveform obtained suggests a **periodic switching behavior**, which may indicate oscillations, slewing limitations, or instability in the circuit. In a 2-stage OTA, the **first stage** provides high gain and differential amplification, while the **second stage** enhances output swing and drives the load. The transient response is influenced by factors such as **compensation techniques (Miller capacitance), biasing conditions, and feedback mechanisms**. The observed irregularities in the waveform could result from **insufficient phase margin, improper pole-zero placement, or parasitic effects**.

Working

The two-stage operational transconductance amplifier (OTA) is a widely used analog circuit that amplifies input signals with high precision and stability. It operates through two main stages to achieve high gain and dynamic performance

The first stage is a differential amplifier, which converts the input differential voltage into a proportional current. This stage provides high input impedance, ensuring minimal loading of the source, and rejects common-mode signals to maintain signal accuracy. It establishes the initial amplification and ensures precise signal processing by suppressing noise and unwanted disturbances.

The second stage is a gain stage, often implemented as a common-source amplifier, which amplifies the current output from the first stage into a large voltage signal. It enhances the overall voltage gain and provides sufficient output swing to meet application requirements while driving the load effectively.

To ensure stability during dynamic operations, a Miller compensation capacitor is used. This capacitor introduces a dominant pole in the frequency response, which suppresses high-frequency oscillations, improves the phase margin, and stabilizes the circuit. This compensation mechanism enables the OTA to handle high-speed transitions in input signals while maintaining accuracy and stability.

References

I. S. Dhanjal, “Two-Stage Operational Transconductance Amplifier,” Lecture Notes, (KJSCE,SVU), (Mumbai, Maharashtra)

Jambek, Asral & Ismail, R.C. & Baharudin, Siti. (2014). Design and Analysis of a Two-Stage OTA for Sensor Interface Circuit. ISCAIE 2014 - 2014 IEEE Symposium on Computer Applications and Industrial Electronics. 10.1109/ISCAIE.2014.7010215.