AVLSI – Experiment - 7

Aim : A] Analysis of Two–stage op amp with single ended output.

B] Analysis of single ended Differential/Telescopic Cascode Operational

Amplifier.

Apparatus : PC loaded with ORCAD.

Theory:

**A] Two–stage op amp with single ended output :** Single/One stage op amp allow the small signal current produced by the input pair to flow directly through the output impedance. The gain of such topologies is limited to the product of input pair transconductance and the output impedance. Applying cascade in such circuits increases the gain while limiting the output swings. For some applications, the gain and/or the output swings provided by cascade op amps are not adequate. In such cases two stage op amps are best suited.

In two stage op amps the first stage provides a high gain while second stage provides large swings. It isolates the gain and swing requirements as shown in fig. (a). Each stage can incorporate various amplifier topologies, but the second stage is typically configured as a simple common source stage that allows maximum output swings.

In this experiment we have implemented two stage op amps with single ended output. Here first is differential stage whose differential current is converted to a single ended voltage.

Two stage op amp topology exhibits high gain, highest o/p swing, low speed, medium power dissipation and low noise over other op amp topologies.

**B] Single ended Differential/** **Telescopic Cascode Operational Amplifier :**  The **cascode** is a two-stage [amplifier](http://en.wikipedia.org/wiki/Amplifier) composed of a [transconductance](http://en.wikipedia.org/wiki/Transconductance) amplifier followed by a [current buffer](http://en.wikipedia.org/wiki/Buffer_amplifier). In a cascode amplifier, two NMOS transistors are connected together. One is on top of the other as shown in fig.(a).

Compared to a single amplifier stage, this combination have the following characteristics: higher input-output isolation, higher [input impedance](http://en.wikipedia.org/wiki/Input_impedance), high [output impedance](http://en.wikipedia.org/wiki/Output_impedance), higher [gain](http://en.wikipedia.org/wiki/Gain) or higher [bandwidth](http://en.wikipedia.org/wiki/Bandwidth_(signal_processing)).

In modern circuits, the cascode is often constructed from two [transistors](http://en.wikipedia.org/wiki/Transistor) ([BJTs](http://en.wikipedia.org/wiki/Bipolar_Junction_Transistor) or [FETs](http://en.wikipedia.org/wiki/Field-effect_transistor)), with one operating as a [common emitter](http://en.wikipedia.org/wiki/Common_emitter) or [common source](http://en.wikipedia.org/wiki/Common_source) and the other as a [common base](http://en.wikipedia.org/wiki/Common_base) or [common gate](http://en.wikipedia.org/wiki/Common_gate). The cascode improves input-output isolation (or reverse transmission) as there is no direct coupling from the output to input. This eliminates the [Miller effect](http://en.wikipedia.org/wiki/Miller_effect) and thus contributes to a much higher bandwidth.

The use of a cascode is a common technique for improving [analog circuit](http://en.wikipedia.org/wiki/Analog_circuit) performance. Fig.(b) shows differential cascode op amp with single ended output. This configuration is also called as Telescopic cascode op amp. The o/p swing of these op amps is relatively limited.

**Procedure: Design Simulation**

1. Draw the circuit using P- spice software.

2. For Telescopic Cascode Operational Amplifierapply

VDD = 12V, Vin = 2V peak-to-peak /1KHz, V1=10V

3. Run the simulation and observe the output waveforms.

4. For Two–stage op amp apply

VDD = 2.5V, Vin = 0.5V peak-to-peak /1KHz, Idc=30uA

3. Run the simulation and observe the output waveforms.

**Conclusion:**

**Attach the printouts of both the circuit diagram and waveform respectively.**