INTERNATIONAL INSTITUTE OF INFORMATION TECHNOLOGY

HYDERABAD

EC2.103.M21 Analog Electronic Circuits

Two Stage Op-Amp

Team 46

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Initial Report

Introduction:

Two stage op-amp can provide high gain and high output swing. It is an excellent example to illustrate many important design concepts that are also directly applicable to other designs. The two-stage refers to the number of gain stages in the OpAmp.

The output buffer is normally present only when resistive loads need to be driven. If the load is purely capacitive, it is not needed.

Circuit:

Reference Circuits:

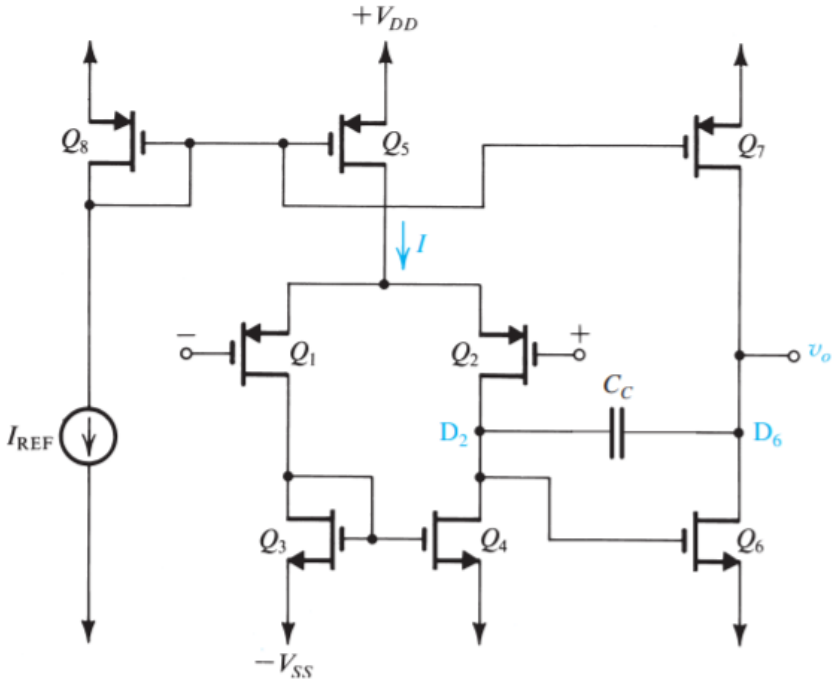
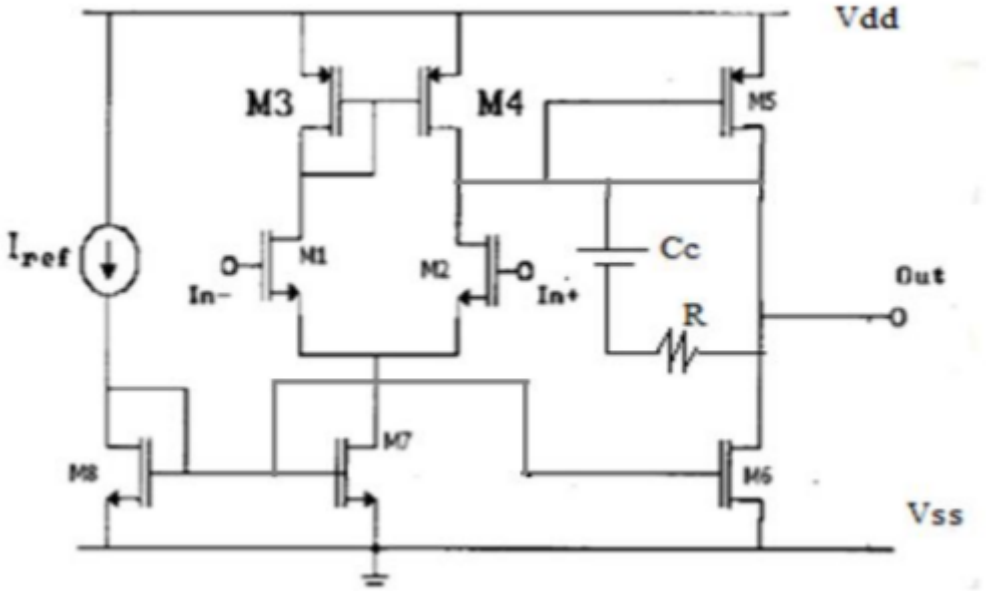
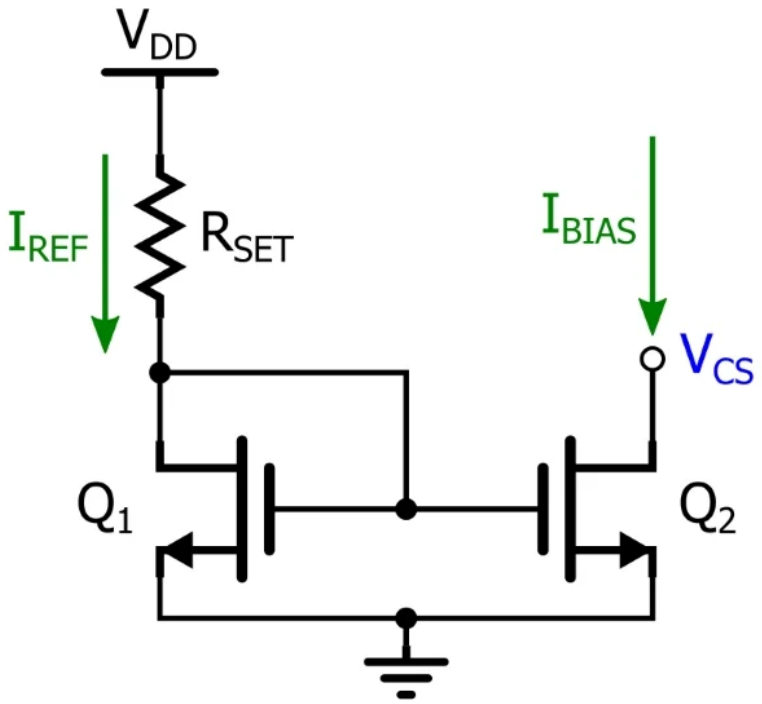


Figure 9.40 Two-stage CMOS op-amp configuration.

The above image is taken from Sedra Smith. Thus consists of input via 2 pmos. Then it uses the current mirror.



This circuit uses nmos as input and the current mirror is implemented using nmos and a constant current source.

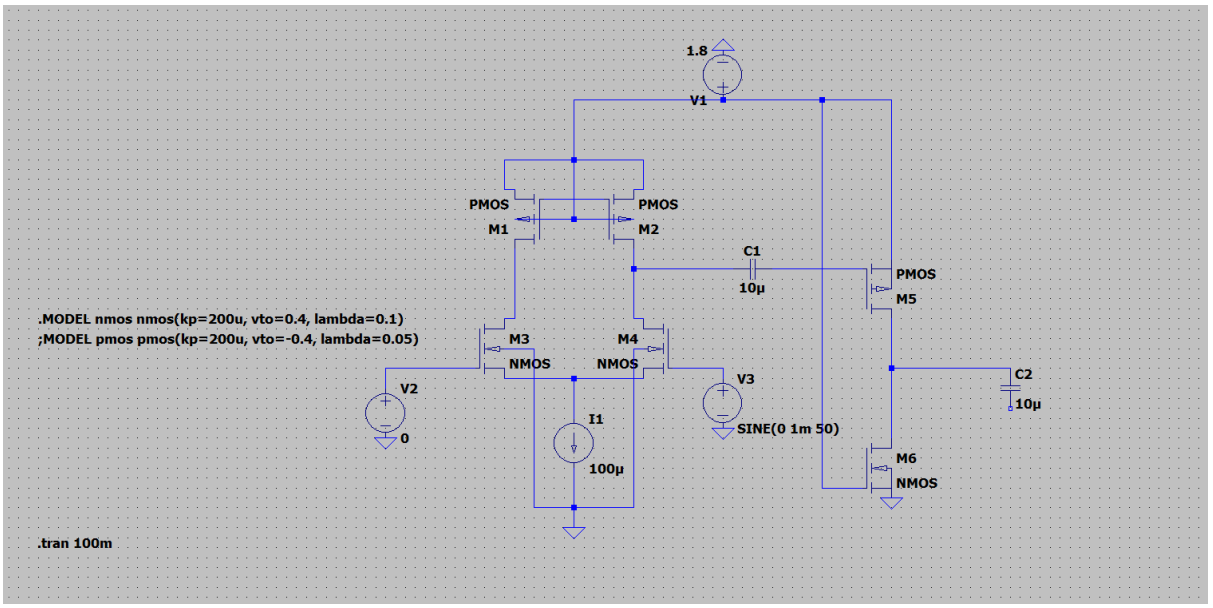


Then we used a constant current source instead of a current mirror in the fully differential amplifier for the ease of use.

The 2-stage op-amp uses a fully differential op-amps whose output is connected to a Common source amplifier. The name of the two stage op-amp comes from the fact that there are 2 gains. Initially from the fully differential amplifier and then another gain from the CS amplifier.

Theoretical Calculation:

Our circuit:



Large signal analysis:

For M1, V_{th}= 0.4V, $\mu_p C_{ox}$ = 200µ, λ = 0.1

For M2, V_{th}= 0.4V, $\mu_p C_{ox}$ = 200µ, λ = 0.1

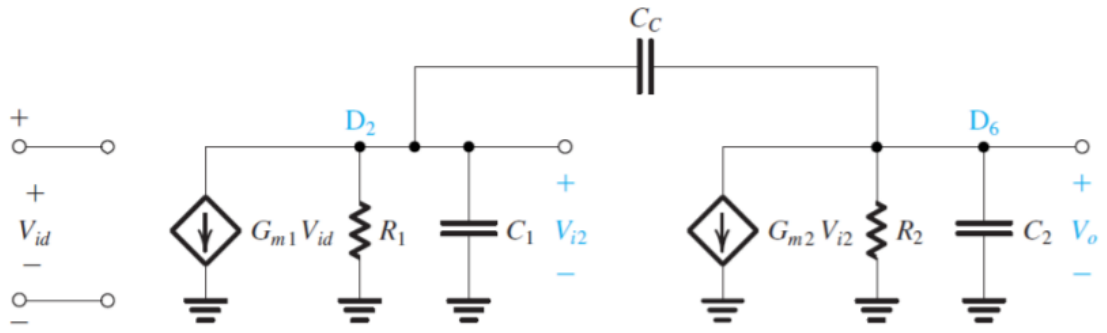
For M3, V_{th}= -0.4V, $\mu_n C_{ox}$ = 200µ, λ = 0.05

For M4, V_{th}= -0.4V, $\mu_n C_{ox}$ = 200µ, λ = 0.05

First stage Gain = A1 = $-gm_1(ro2||ro4)$

Second stage Gain = A2 = $-gm_6(ro6||ro7)$

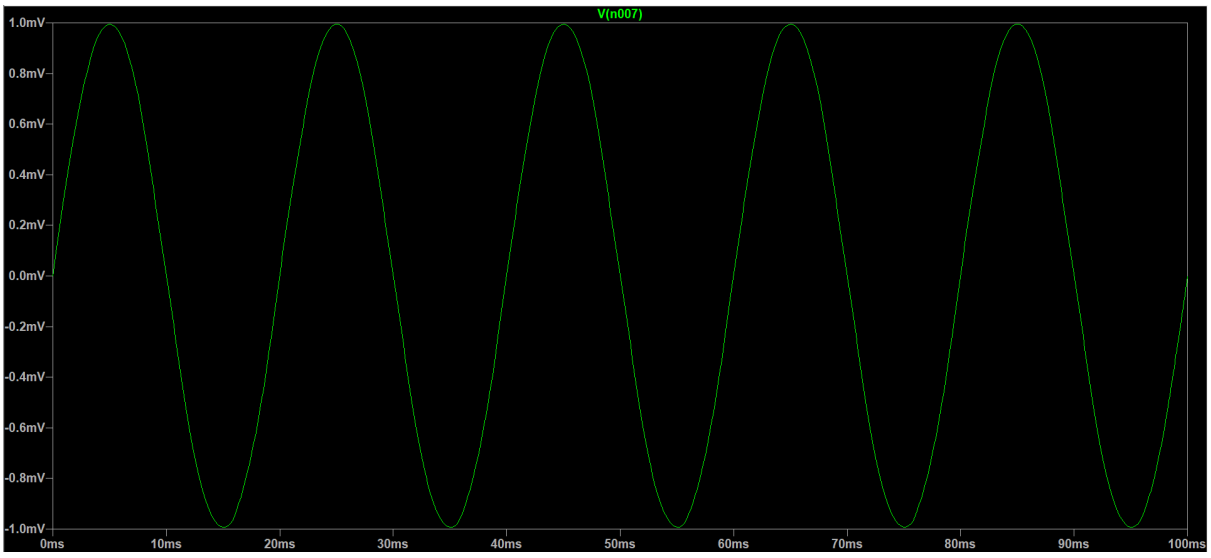
Small signal model of two-stage op amp:



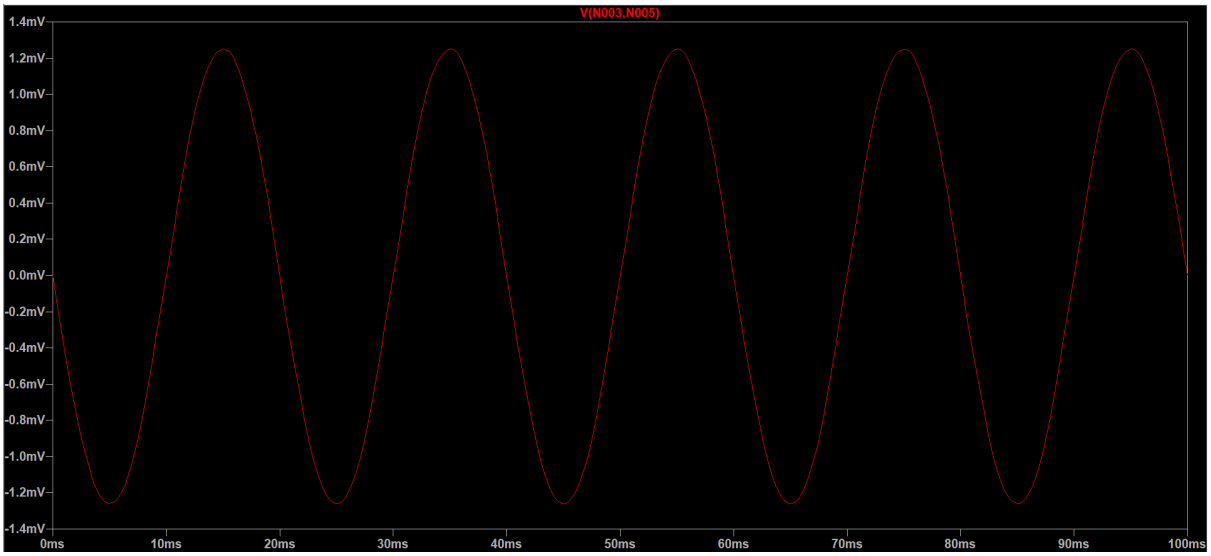
DC gain = 118.903mV

Simulations:

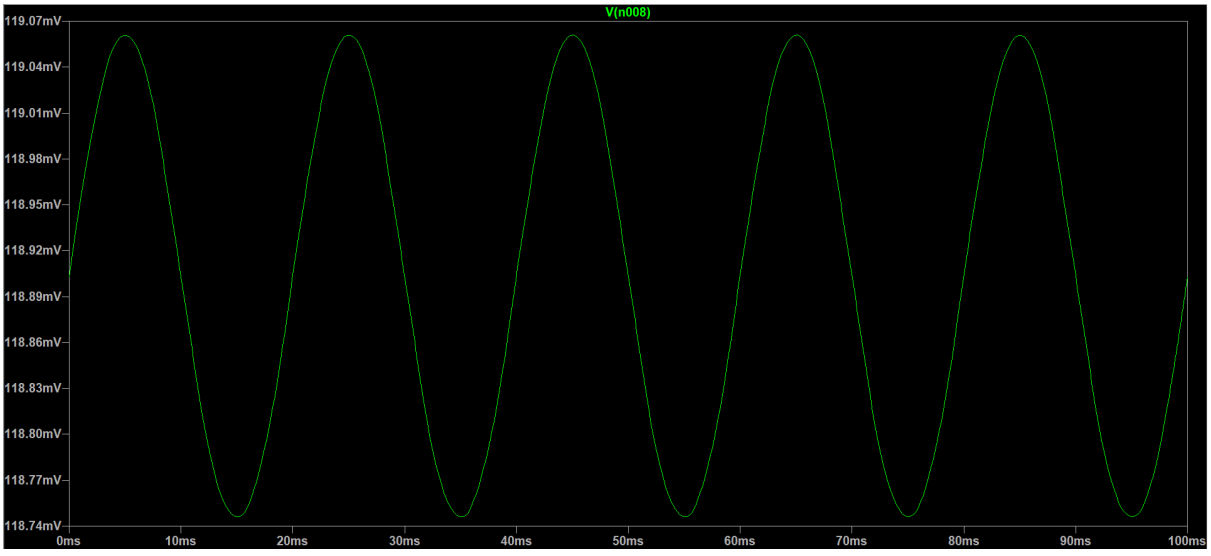
Input:



Output from fully differential amplifier:



Output from two stage op-amp:



Comparison:

The difference between the reference circuit and our circuits is that we have replaced the current mirror made using nmos by a constant current source. A constant-current source circuit can generate a current relatively stable against variations of power supply voltage.

The reference circuit uses a pmos input, but we used an nmos input by inverting the circuit.

Applications:

1. Two stage op-amps have good gain, high output swing, low noise and good bandwidth over folded cascode. And it needs compensation, low PSRR value compared to folded cascode.
2. They can be used as voltage amplifiers