CMOS (Operational and Other) Amplifiers: Then and Now

ABSTRACT
The early design of MOS operational amplifiers followed the three-stage architecture of the classical BJT 741 Operational Amplifier, which was intended for general purpose applications. With the emergence of MOS switched-capacitor filters in the late 1970s, it was realized that power-consuming output stages (for driving load and/or compensation capacitances) were not needed. Concurrently, a deeper understanding of frequency compensation led to what is now the classical CMOS two-stage OTA, which has been a key enabler for analog/mixed-signal and RF integrated systems for nearly four decades.

In recent years as technology feature sizes continue to scale exponentially according to Moore’s Law, several alternative amplifying techniques have emerged to challenge the dominance of the CMOS two-stage OTA. These new techniques aim to maintain voltage high-gains with ultra-low-power dissipation at ever shrinking sub-1V supply voltages.

This talk will lay the historical foundation that underpins several new amplifier design techniques that include ring amplifiers, pseudo-pseudo amplifiers, load-pole cancelled amplifiers, etc. Many of these amplifier techniques are in the early stages of development similar to what was happening 40 years ago. Thus, a major goal of this talk is to describe the basic operating principles and indicate areas where the design community can contribute to better solutions. The ultimate goal is to determine the best possible replacement for the classical CMOS two-stage OTA.