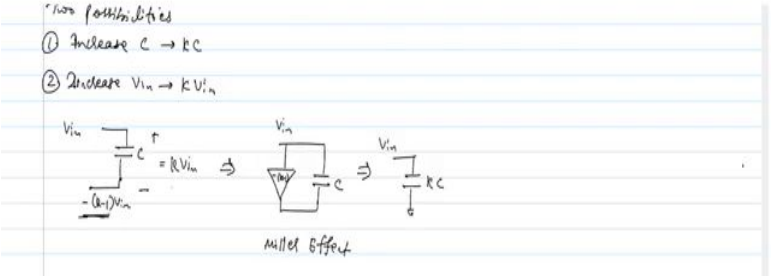
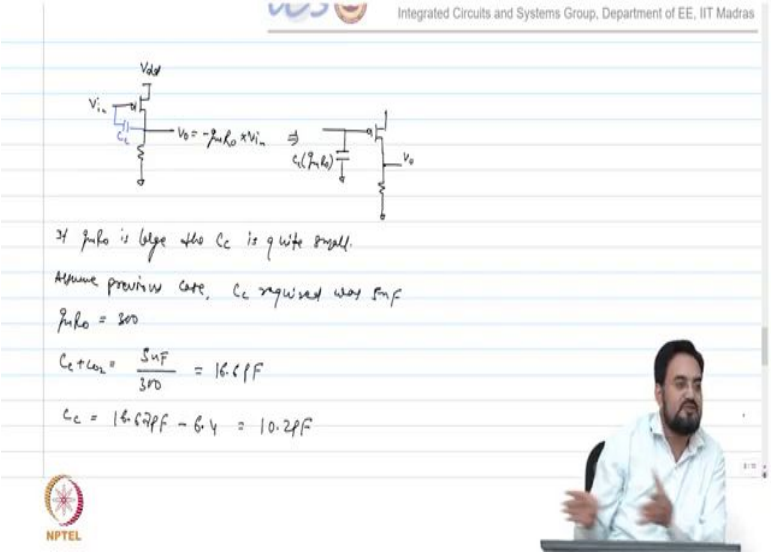
Power Management Integrated Circuits
Dr. Qadeer Ahmad Khan
Department of Electrical Engineering
Indian Institute of Technology, Madras

Lecture - 20
Dominant Pole Compensation using Miller Effect,
RHP Zero due to Miller Capacitor

- Miller compensation: a capacitor is placed in feedback around an inverting amplifier.
- The capacitance (looking in at the input of the inverting amplifier) is Miller multiplied by 1 + gain (of the amplifier). This is known as the Miller effect.

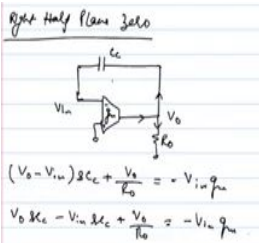


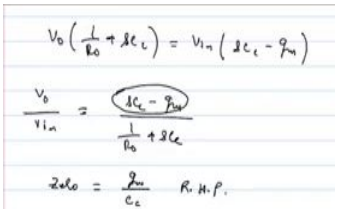
- A common-source amplifier (which is inverting and has a gain of $-g_m R_{out}$) with a capacitor in feedback can be used for Miller compensation.



- The advantage of Miller compensation is that the capacitance required (for a given location of the dominant pole) is much smaller; it is smaller by a factor of 1 + gain.
- The Miller multiplication factor is a function of the output-stage gain, which depends on the load current. One must make sure that the minimum required phase margin is satisfied over the entire range of variation of the load current. The lowest value of the dominant pole frequency occurs at light load.

- Dominant pole compensation requires that there be only a single (dominant) pole below the unity loop gain frequency, to ensure sufficient phase margin. All the other (non-dominant) poles must lie beyond the unity loop gain frequency.
- Miller compensation has the added advantage of pole-splitting, i.e. in addition to the dominant pole moving to a lower frequency, the non-dominant pole moves to a higher frequency, which further reduces the value of the compensation capacitance required.
- Miller compensation introduces a right-half-plane zero, which degrades the phase margin. It occurs at g_m / C_c in respect of the figure shown below.





- One way to mitigate the effect of the RHP zero is to use a nulling resistor in series with the Miller capacitor, as shown in the figure below. If the nulling resistance $R_c > 1/g_m$, then the RHP zero turns into an LHP zero at a frequency $1 / ((R_c - 1/g_m)*C_c)$.