EI-27003: Electronics Devices and Circuits
Lecture - 9

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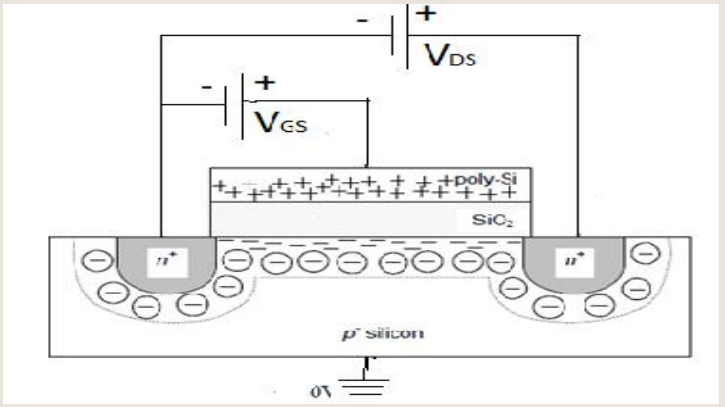
LECTURE - 9

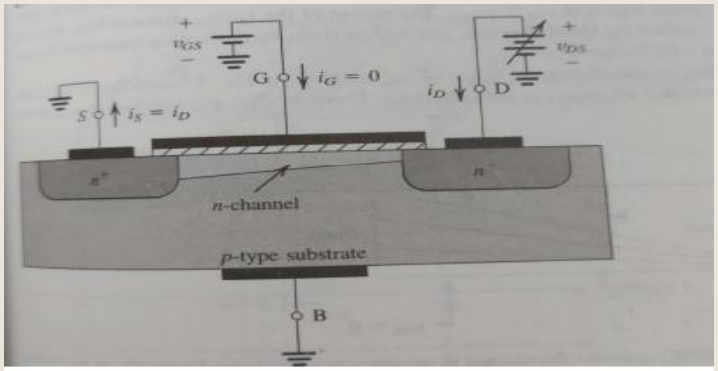
Year: 2020-21

MOS Operation-3

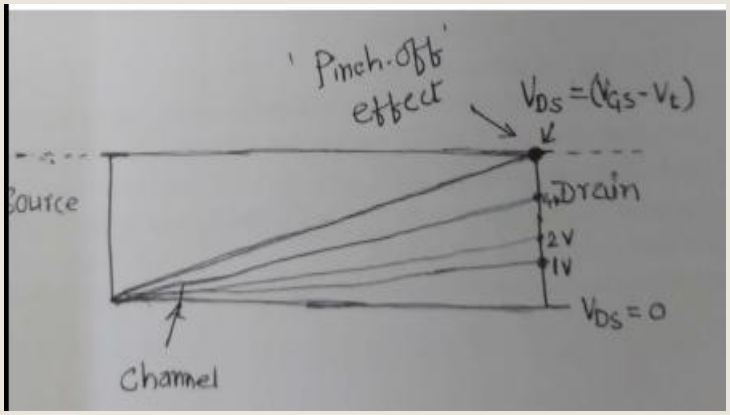
- Till now we have seen:
- In NMOS if $V_{GS}>V_t$, Channel forms but NO Current flows till V_{DS} is applied (Fig.1).



- Now $(V_{GS} - V_t)>0$, and V_{DS} is slowly increased the current I_D flows from, drain to source. It will also increase as VDS increases.
  The channel in this case is tapered. (Fig.2)



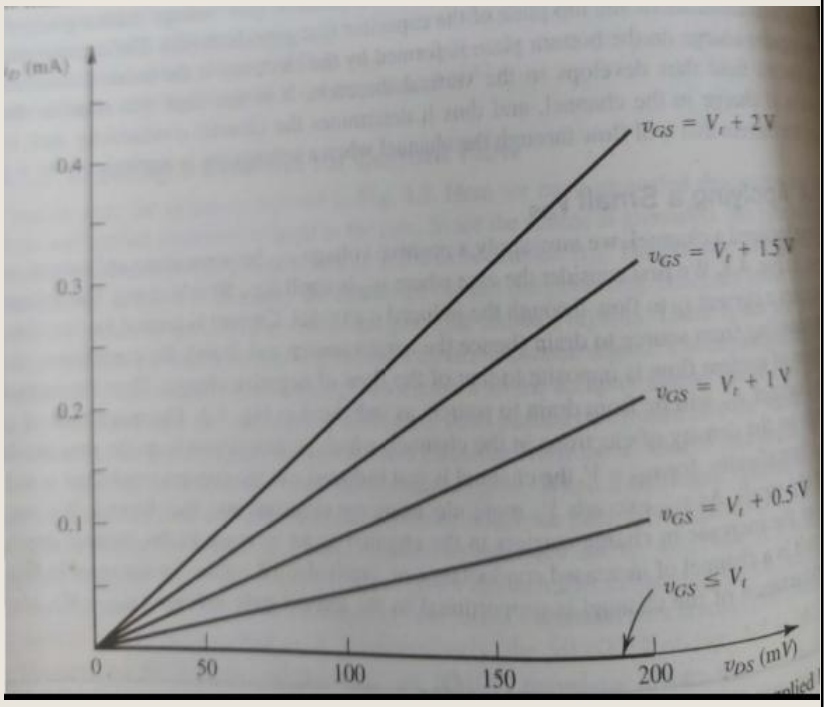
- The depth of channel at drain side reduces if we goes on increasing V_{DS}. (Fig.3)



- At $V_{DS}=(V_{GS}-V_t)$, the channel gets pinch-off.

V_{DS} Versus I_D Characteristics

- Thus from previous discussion, in NMOS if $V_{GS}>V_t$ and V_{DS} is slowly increases, then drain current I_D also increases linearly till $V_{DS}=V_{GS}-V_t$ is reached.



- So as shown in fig, for condition

  $V_{DS}<(V_{GS}-V_t)$,

- The MOS is said to be in linear or triode Region.

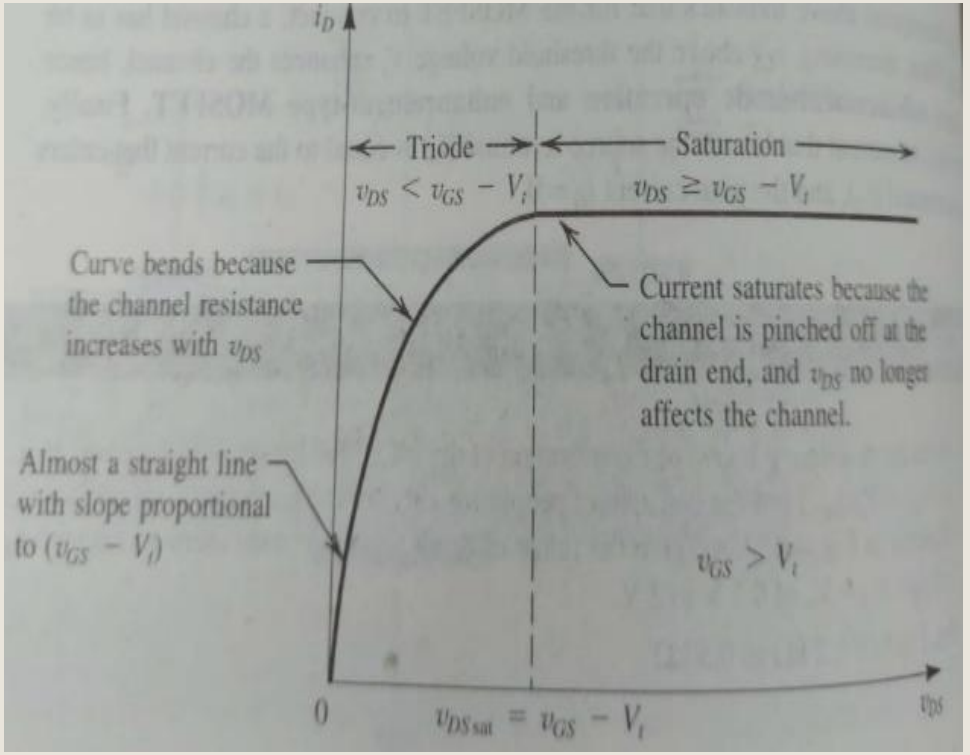
- At $V_{DS}=(V_{GS}-V_t)$, channel gets pinched off and MOS is said to be just at edge of Saturation

NMOS in Deep Saturation

- If V_{DS} is further increased i.e.

  $V_{DS} >> (V_{GS} - V_t)$

  then since the channel is pinched off, only constant drain current I_D will flow and NMOS is said to be in saturation.
- There is no effect of increasing V_{DS} on the drain current I_D.



Summary: In NMOS ($V_{GS}>V_{t)}$

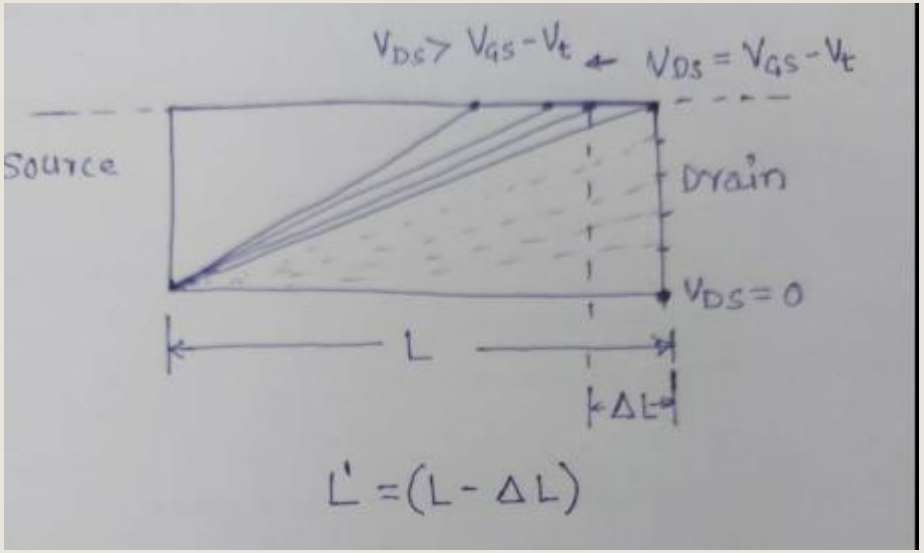
if $V_{DS}<(V_{GS}-V_t)$ ---- NMOS in linear or triode region

if $V_{DS}=(V_{GS}-V_t)$ ---- NMOS is pinched-off or Just on verge of sat.

if $V_{DS}>(V_{GS} - V_t)$ ---- NMOS is in Saturation region.

Channel Length Modulation

- If we further increase VDS, beyond (V_{GS}-V_t), as shown in fig.
- Then the length of channel reduces ΔL as shown in fig.
- This ΔL is proportional to V_{DS}.
- i.e. if we increase or decrease the VDS beyond (VGS-Vt), the channel length increases or decreases respectively.



This effect is called as Channel Length modulation effect

Its Quiz Time

https://forms.gle/hQGdVbhuYpLxn3rq6