EI-27003: Electronics Devices and Circuits
Lecture - 7

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LECTURE - 7

Year: 2020-21

Unit – 4 : MOS Transistor

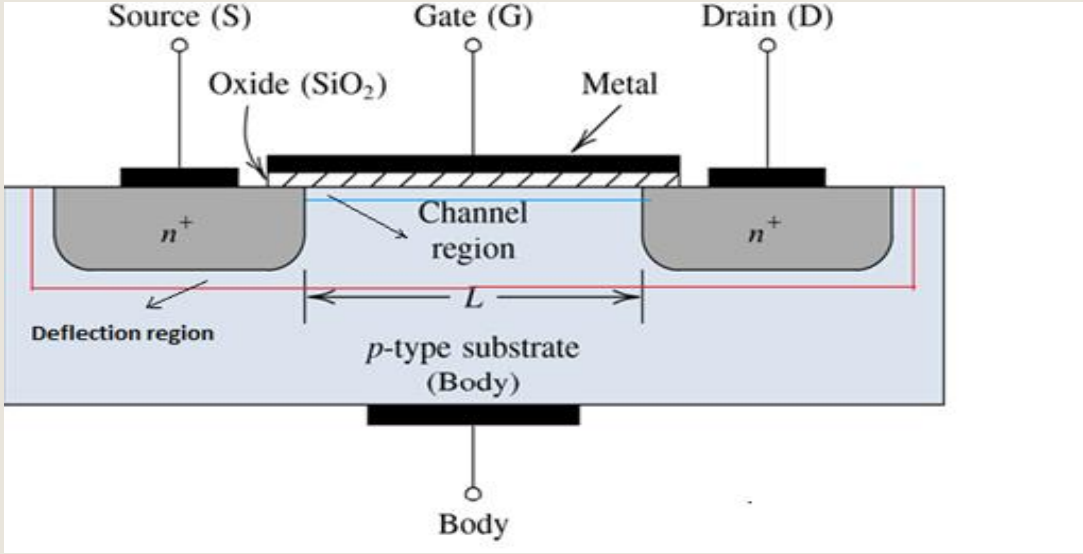
- Today's class:

1. Construction
2. Types and symbols
3. Operation-1

Construction:

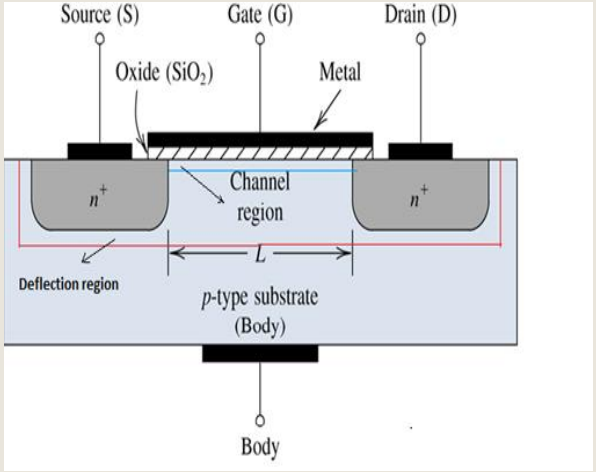
MOS Transistor also called as MOSFET stands for:

Metal **O**xide **S**emiconductor **F**ield **E**ffect **T**ransistor



MOS Construction

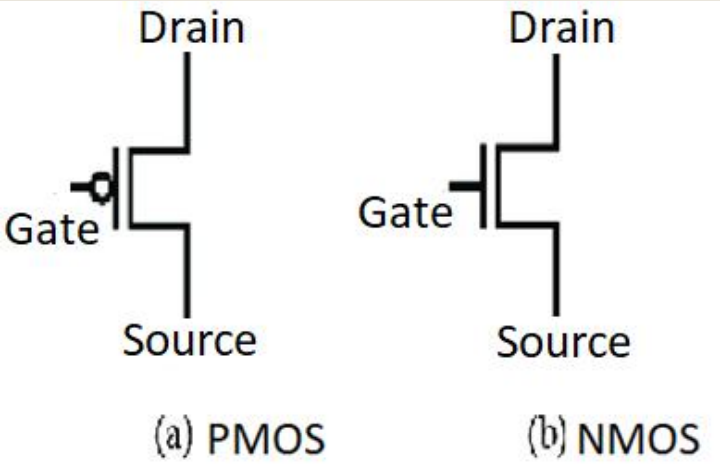
- MOS consists of p-type substrate/body
- In it two n-type semiconductor layers are alloyed as shown in fig.



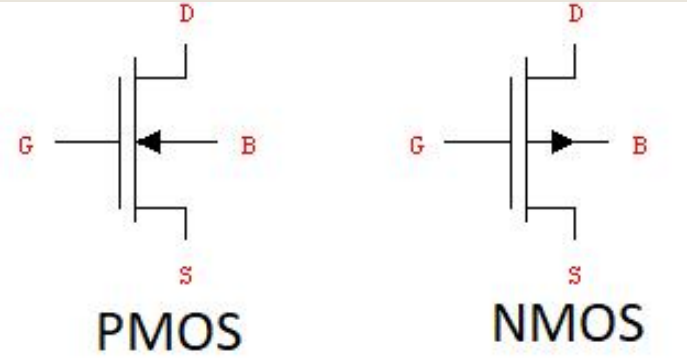
- Over the substrate and between two n-type layers, a layer of Oxide(SiO_2) is deposited as shown in fig.
- A thin layer of Metal is deposited over this SiO_2 layer.
- Contacts are taken out from this metal layer and from two n-layers as well as from substrate/body.
- These contacts are Source (S), Drain (D), Gate (G) and Body (B) as shown in fig.
- Such type of MOS transistor is called as n-channel MOS or simply nMOS.

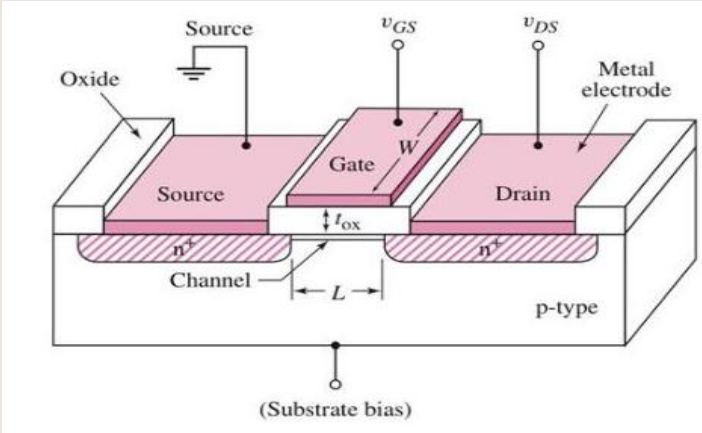
MOS Transistor – Symbols & 3D view

- Symbols:

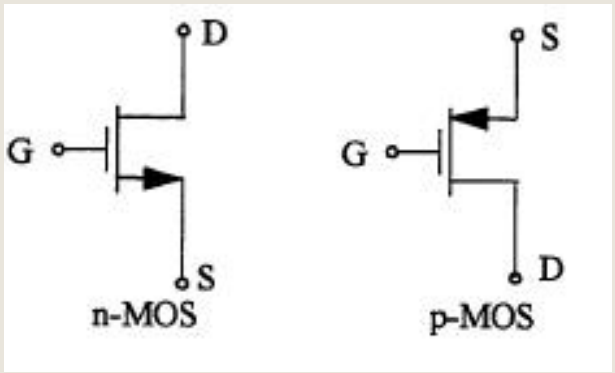


OR





Now instead of metal polysilicon is used at gate.

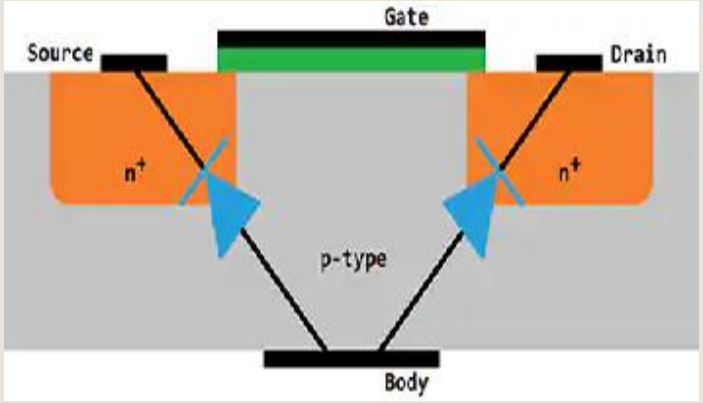


Operation – 1 (NMOS)

- Some important points:

- Body of NMOS is always connected to ground/most negative.
- In NMOS drain (D) is connected to +ve terminal of battery and source (S) is connected to ground. (V_{DS})
- In NMOS Gate (G) is connected to +ve terminal of battery w.r.t. source (S) (V_{GS})

- Operation with No gate voltage



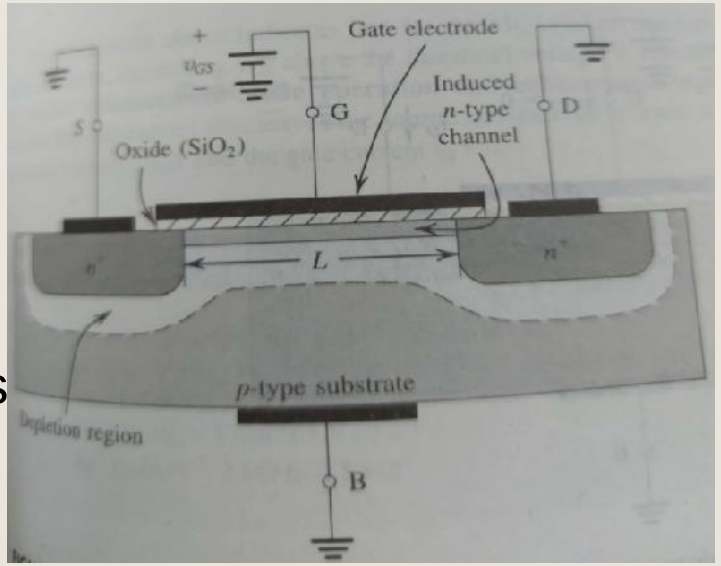
With NO bias voltage applied to Gate(V_{GS}=0), two back to back diodes exist in series between drain and source.

One is n+ drain and p-type substrate and other is n+ source and p-type substrate.

These back to back diodes prevent current conduction from drain to source when voltage V_{DS} is applied.

Operation – 1 (NMOS)

- Creating channel for current flow.



- Consider fig shown.
- Here source and drain are grounded and +ve voltage is applied to the gate (V_{GS}).
- The +ve voltage on gate causes the free holes to be repelled from region of substrate under the gate. These holes are pushed downward into substrate, leaving behind a carrier depletion region.
- Also, the +ve gate voltage attracts electrons from the n+ source and drain regions just below oxide layer. When sufficient number of electrons accumulate near the surface of substrate under gate, an n region is in effect created, connecting source and drain regions.
- Now if voltage is applied between drain and source (V_{DS}) , current flows through this induced n region called as n-channel.
- Note that n-channel is formed in p-substrate i.e. inverting substrate from p type to n type, this channel is called as inversion layer.

Operation – 1 (NMOS)

- Threshold Voltage: The value of V_{GS} at which a sufficient number of mobile electrons accumulate in the channel region to form a conducting channel is called as threshold voltage and is denoted as V_t

- V_t for n channel MOS is positive and is controlled during device fabrication and is typically in range of 0.5v to 1v.

Time for Quiz

https://forms.gle/JpQTS2qpQDbKvamE7