Experiment No. - 08

Characteristics of Metal Oxide Semiconductor FET (MOSFET)

Object :-

To study of drain current of MOSFET by changing in gate source Voltage of enhancement type MOSFET.

Apparatus required :-

MOSFET (BFW10), Bread board, Regulated Power Supply Ammeters (0-35 mA), Voltmeter (0-4V), Connecting wires.

Theory :-

There are two types of MOSFET:

1) Enhancement type MOSFET
2) Depletion type MOSFET.

1) Enhancement type MOSFET :-

Construction :-

An N channel MOSFET is shown in figure (A). There are two highly doped (N+) regions (one source and the other drain) on a lightly doped P type.

A layer of insulating silicon di-oxide is placed over it. Now over the insulating SiO_2 layear a gate is formed.

There different terminals for source, gate and drain are taken out as shown in figure. The insulating layer between gate and channels provides a very high Input impendance.

When a positive Voltage is applied at the gate. It induces negative charge in insulating layer and correspondingly negative charge in semiconductor.

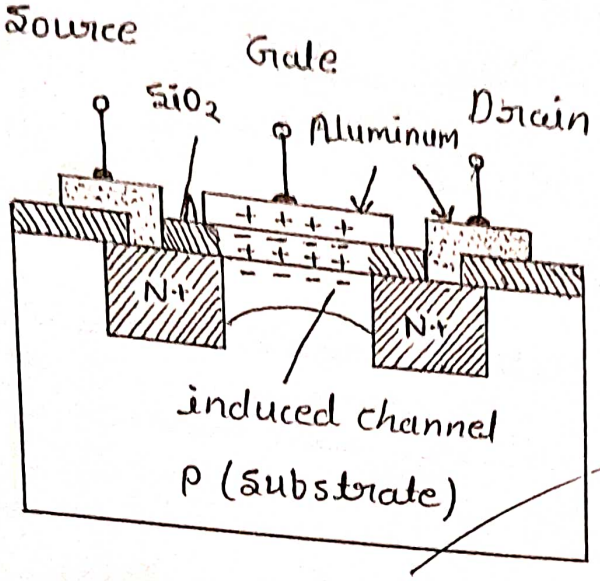
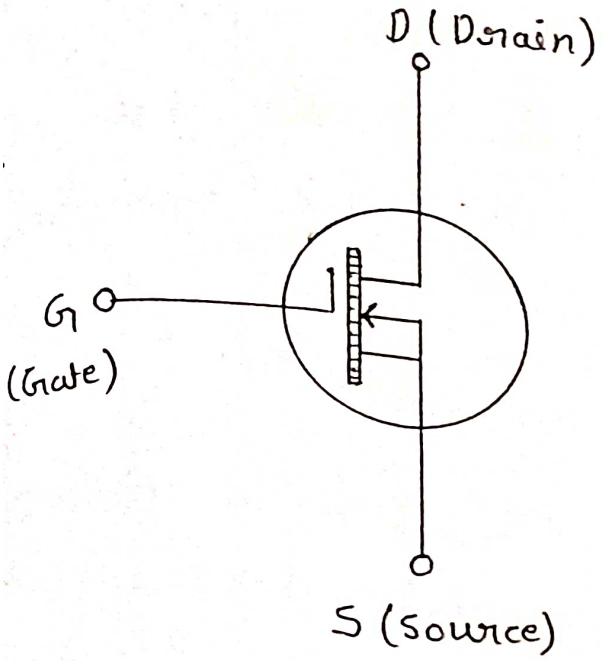


fig :- (a) An N channel MOSFET

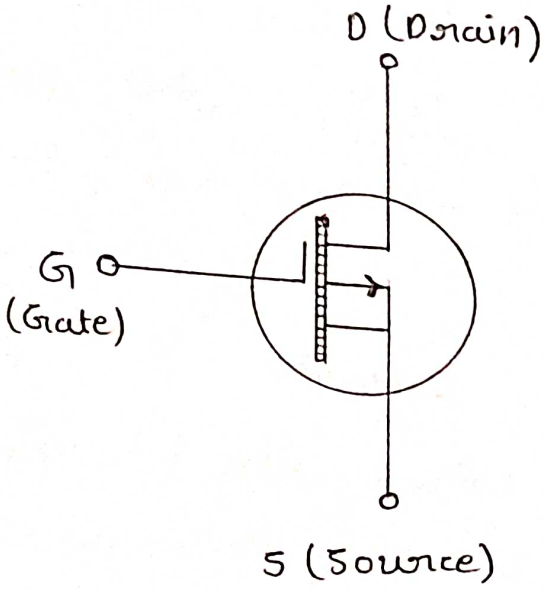
The negative charge region in semiconductors increases as the positive voltage at the gate increases.

This negative charge in semiconductor helps in conducting between source and drain. In this way the drain current is enhanced by the positive gate voltage.

Symbols :-

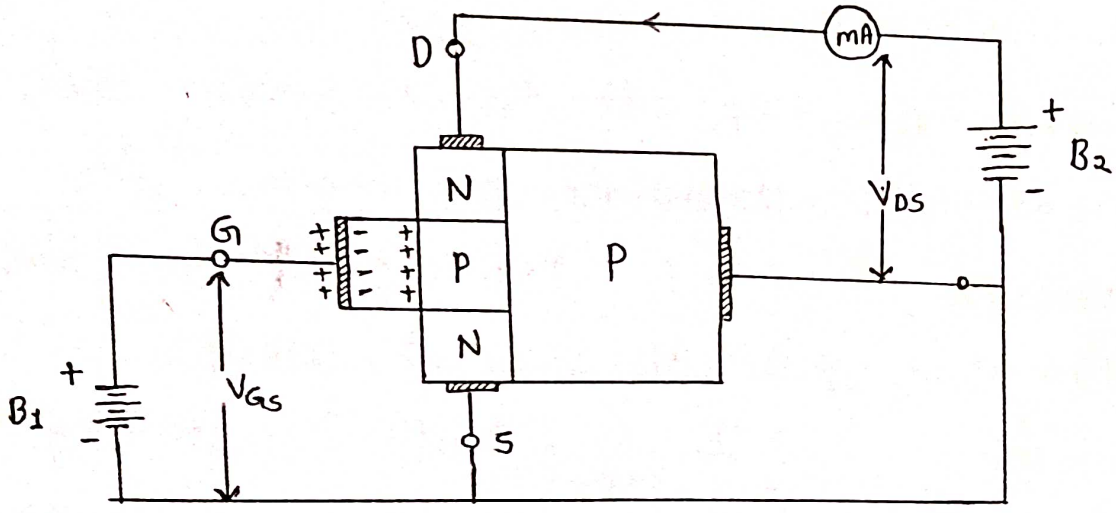


(a) N - channel



(b) P - channel.

Operation :-



Initially, when the gate G is at zero potential no drain current flow through the channel because the drain - channel junction is reverse bias by means of the battery B_2.

Now when a positive potential is applied at the gate by means of the battery B_1, the matal plate G of the capacitor has a +ve, charge which induces -ve charge on the channel. Thus a conduction channel is form between source and drain, as a result drain current I_D begins to flow.

As the +ve potential at the gate increases, then the conduction channel increases and so the drain current I_D also increases on the other hand, if the gate G is at -ve potential, then no drain current flows.

Characteristics of enhancement type MOSFET

The drain characteristics and transfer characteristics of N-Channel enhancement type MOSFET.

It may be noted, that the drain current for V_{GS} greater than is very zero is very small and as V_{GS} is made more positive the current increases slowly at first and then at a much more rapid rate. The gate source voltage at which the channel is formed to let through the flow of drain current of predefined value (say 10 μA) is called the gate-source threshold value.

The gate source threshold value is denoted by V_{GST} or simply V_T as shown. The current $I_{D(ON)}$ represents the maximum permissible current on the drain characteristics.

2) Depletion type MOSFET :-

Construction :-

An N-channel depletion MOSFET with its symbol is shown in figure. The difference between depletion MOSFET and enhancement MOSFET is that depletion MOSFET an N-type layer is also introduced between Source and drain.

When a negative voltage is applied at the gate, positive charges are induced in the channel. We know that the electron are the majority carriers in N-type material but the positive charges reduce the conductivity of channel by forming a depletion layer.

In this way the drain current can be reduced by applying negative voltage at the gate.

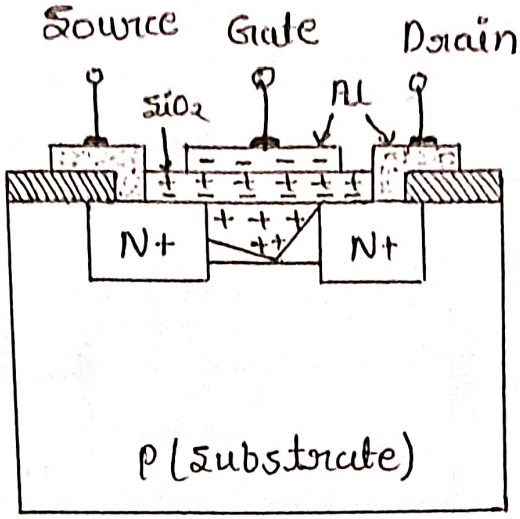
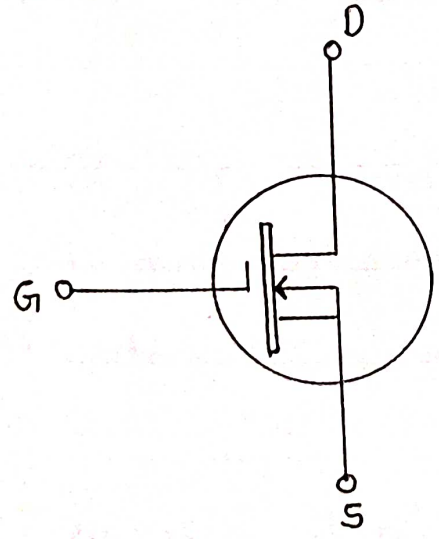


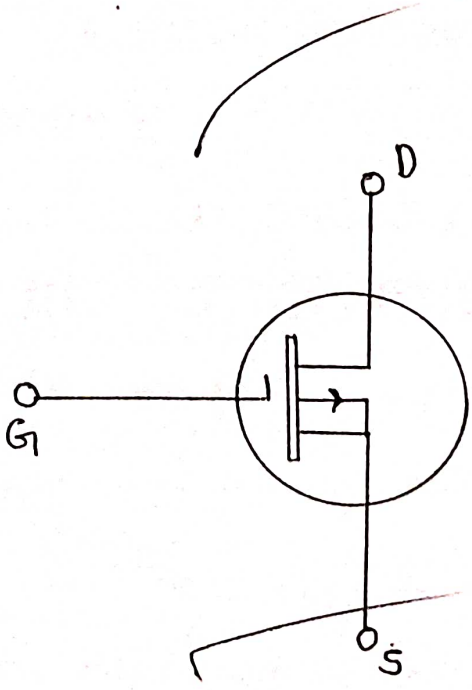
Fig. :- (a) Depletion type MOSFET

However, depletion of MOSFET can be used in enhancement mode applying positive grid voltage.

Symbols :-

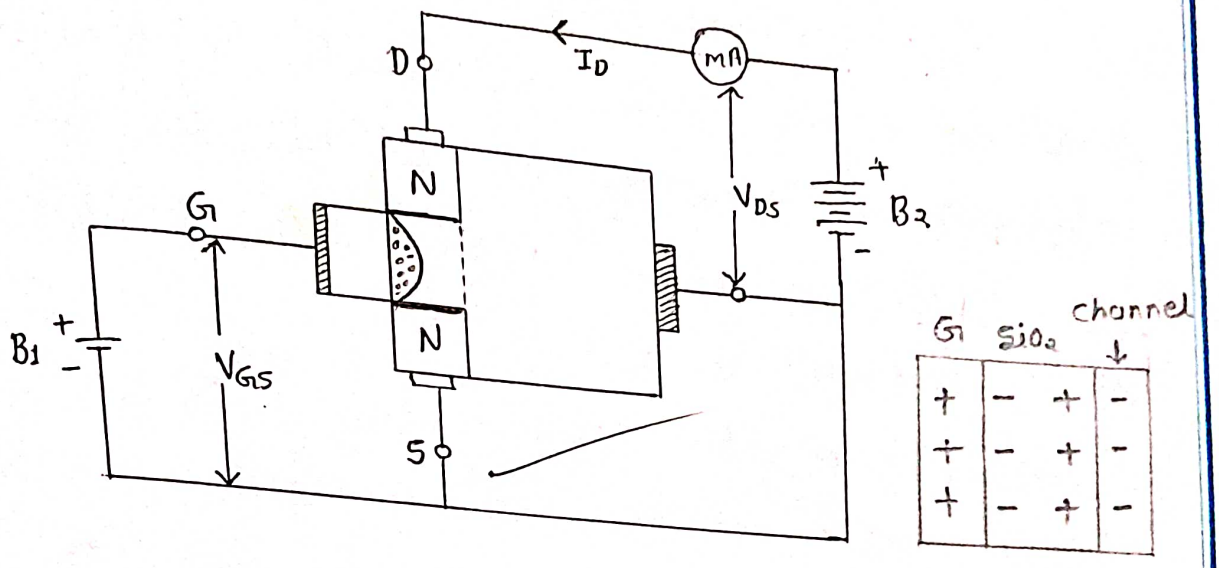


(a) N - Channel



(b) P - Channel

Operation :-



The difference between, depelation MOSFET & enhancement MOSFET is that in depelation MOSFET on N-type layer is also introduced between the source and drain.

In MOSFET, the gate & the channel acts like a condenser with gate and channel as plates and the insulating SiO_2 as dielectric.

When a -Ve Voltage is applied the gate. (then electrons are) +Ve charge are indiced in the channel.

we know that, the electrons are the majority carriers in N-type material, but the +ve charges reduces the conductivity of by forming a depletion layer. this way, the drain current I_D can be reduced by applying a -ve voltage the gate.

When a +ve voltage is applied at the gate, then electrons are indiced in the channel, as a result conductivity of the channel increases and also the drain current I_D increases.

Characteristics :-

The drain characteristic and transfer characteristic for an N-channel MOSFET which can be operated in both depletion mode and enhancement mode corresponding to negative and positive gate voltage respectively. So more appropriately, MOSFET may be designated as dual mode MOSFET.

It is obvious from, that for $V_{GS} = 0$, the drain current is not zero but has appreciable value.

The figure shows the gate source cut off voltage $V_{GS(off)}$ at which the drain current I_D reduces to some specified negligible value at a recommended drain voltage V_{DS}. This voltage $V_{GS(off)}$ corresponds to a pinch off voltage V_p of a JFET.

Observation Table :-

Transfer characteristics

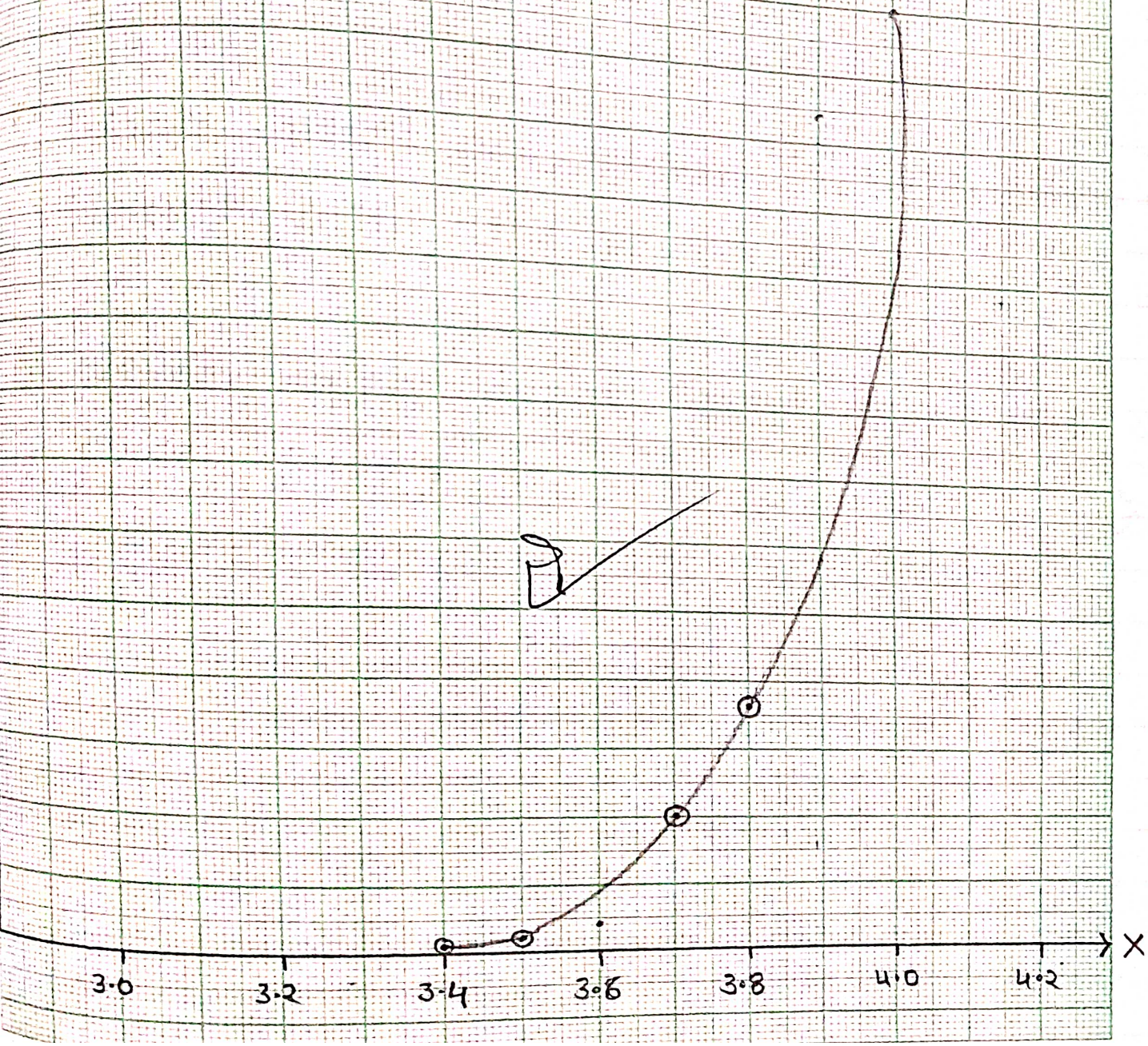
S.No.	V_{GS} (Volt)	I_D (mA)
1.	3.4	0.2
2.	3.5	0.5
3.	3.6	1
4.	3.7	5
5.	3.8	9
6.	3.9	31
7.	4.0	35

Date of Preparation :

Date of Submission :

On x-axis 20 Small div. = 0.2

y-axis 20 Small div. = 5



Precautions :-

1) The Connection should be tight otherwise fluctuation in voltage and current will happen.

2) Never insert or remove MOSFET from a circuit with the power ON.

3) Never apply input signal when the dc power supply is off.

Seen/checked by

24/1/2023