Subject – Basic Electronics (BEC – 22225)

(IMP Questions with Answers)

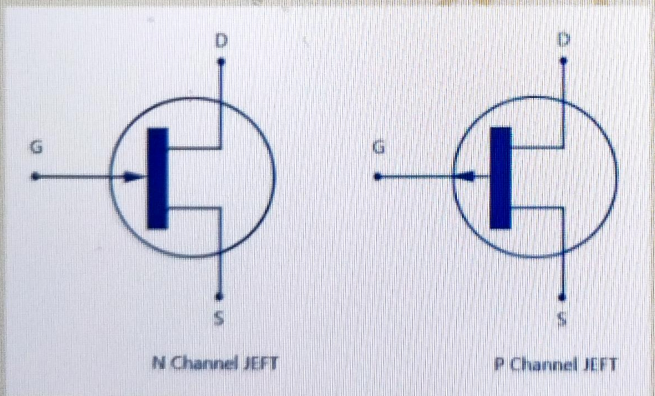
(FY Diploma – Semester 2 – Computer Engineering Group – I Scheme – MSBTE)

Chapter 4 – Field Effect Transistor

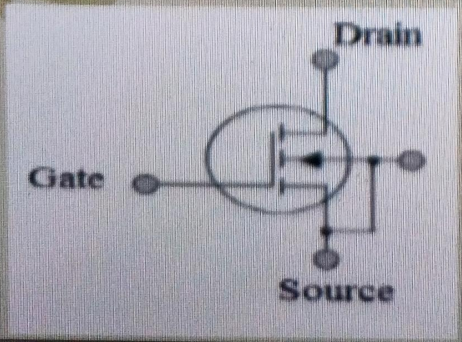
(Weightage – 11 Marks)

2 Marks Questions

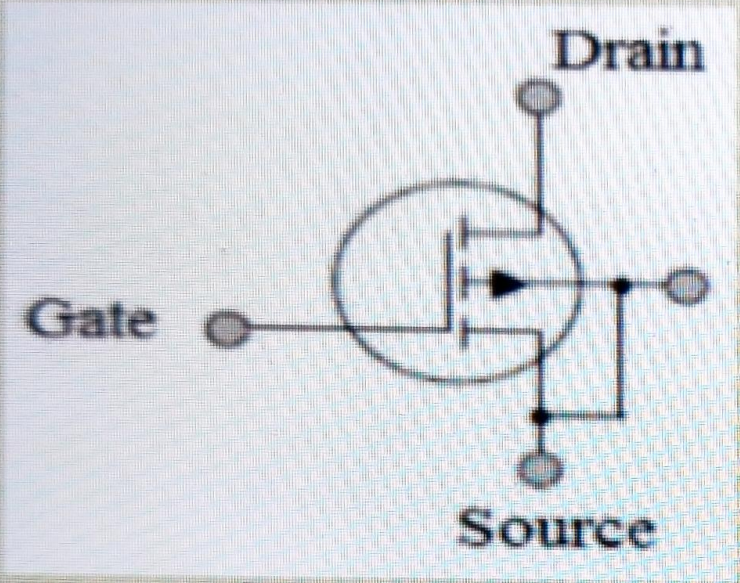
1. **Define amplification factor and trans-conductance of JFET.**
   Answer:
   Amplification factor: Amplification factor (μ) of a JFET is the ratio of change in drain voltage to gate voltage keeping constant drain current.
   $\mu = \frac{\Delta V_{DS}}{\Delta V_{GS}}$ keeping I_D constant
   Transconductance: The transconductance g_m is the change in the drain current for a given change in gate to source voltage with constant drain to source voltage.
   $g_m = \frac{\Delta I_D}{\Delta V_{GS}}$ keeping V_{DS} constant
2. **Draw the symbol of n-channel and p-channel JFET.**
   Answer:



3. **Draw the symbol of N-channel and P-channel enhancement type MOSFET.**
   Answer:
   Symbol of N- Channel Enhancement MOSFET:



Symbol of P- Channel Enhancement MOSFET:



4. **State advantages of MOSFET.**

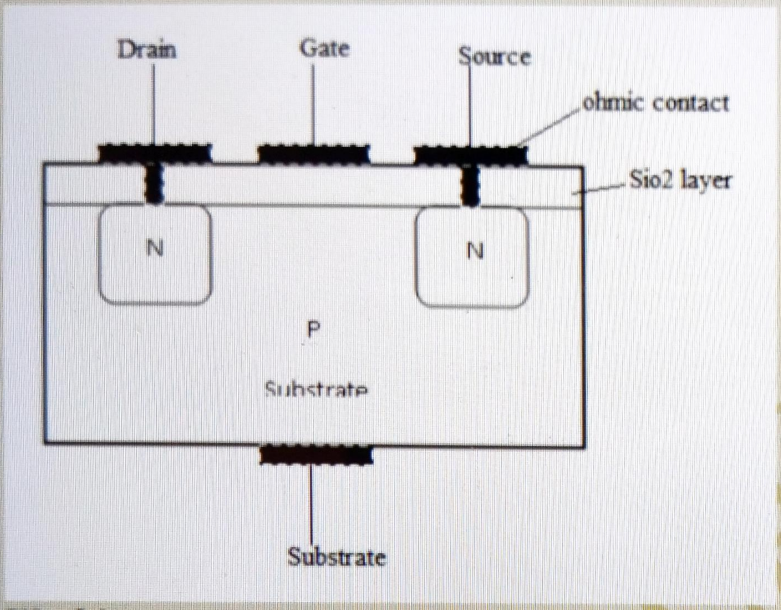
Answer:

1) High switching speed.
2) They operate at lower power.
3) They are easy to manufacture.
4) They are portable

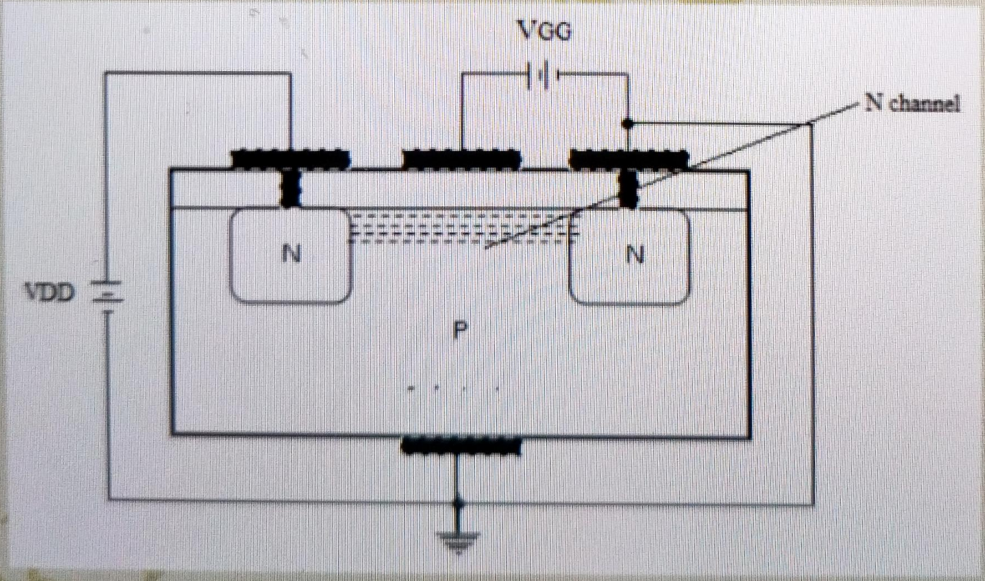
5. Sketch N-Channel MOSFET and describe it's working.

Answer:

Sketch of N-Channel MOSFET:



Working:



1) In fig. both V_{GS} (VGG) & V_{DS} (VDD) have been set at positive with respect to the source.
2) The positive potential at the gate will attract the electrons from the P substrate & accumulated in the region near to the surface of Sio_2 layer.
3) The Sio_2 layer & its insulating qualities will prevent the negative carrier (i.e. electron) from being absorbed at the gate.

4) As V_{GS} increase by increasing VGG the concentration of electron near the Sio_2 surface increases & there is formation of channel & the current starts following through the circuit for further applied voltage.
5) For V_{GS} = OV & negative value of V_{GS}, the absence of n channel will result zero current.
6) As positive value of V_{GS}, less than V_{GSth} drain current is zero.
7) If $V_{GS} > V_{GSth}$ current starts increasing.

6. A JFET has a drain current of 5 mA. If IDSS = 10mA and VGS(OFF) = -6V. Find the value of
(i) VGS (ii) VP
Answer:

Given:

$I_D = 5mA$

$I_{DSS} = 10mA$

$V_{GS(OFF)} = -6V$

$V_{GS} = ?$

$V_P = ?$

$$I_D = I_{DSS} \cdot \left(1 - \frac{V_{GS}}{V_{GS\,(OFF)}}\right)^2$$

$$V_{GS} = \left(1 - \frac{\sqrt{I_D}}{\sqrt{I_{DSS}}}\right) X\ V_{GS\ OFF}$$

$$V_{GS} = \left(1 - \frac{\sqrt{5mA}}{\sqrt{10mA}}\right) X - 6$$

$$\boxed{V_{GS} = -1.756V}$$

$$V_P = V_{GS(OFF)}$$

$$\therefore \quad \boxed{V_P = -6V}$$

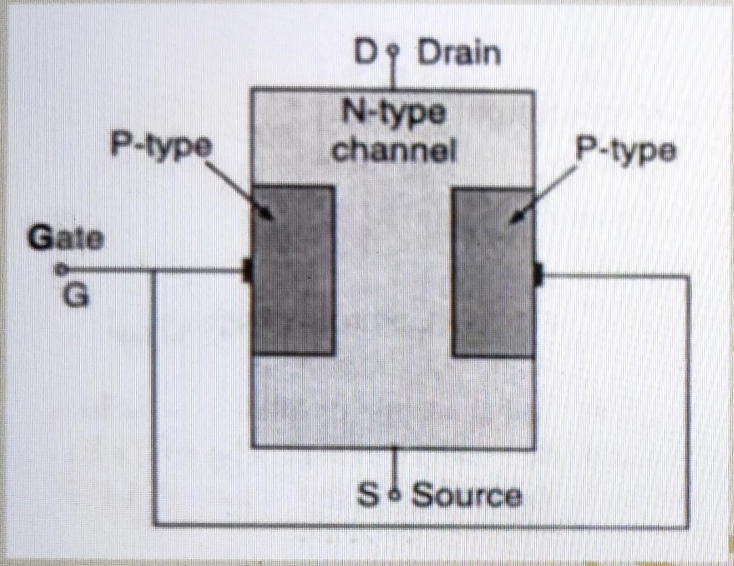
7. Sketch the construction of n-channel JFET and explain its working principle.

OR

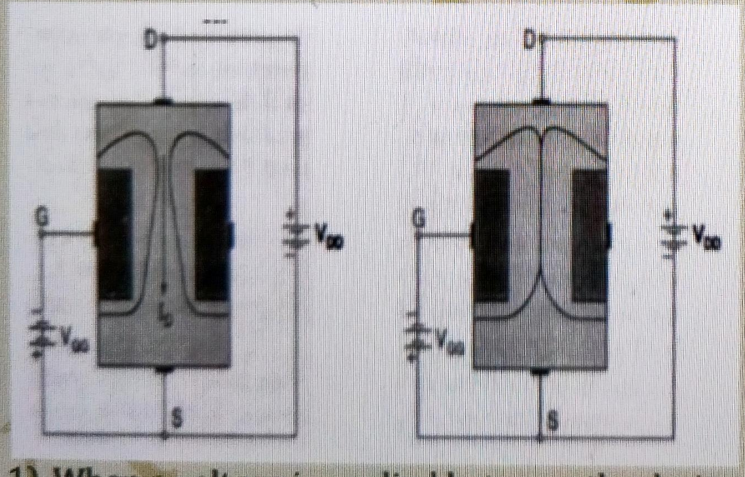
With the help of N-channel JFET describe the effect of input voltage VGS on output current ID.

Answer:

Construction of N-channel JFET:



Working of N channel FET:

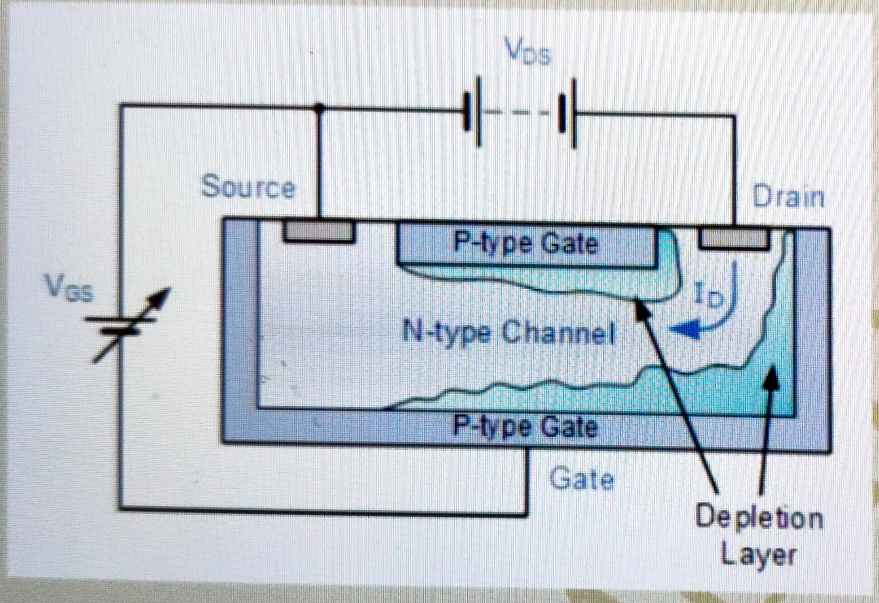


1) When a voltage is applied between the drain and source with a DC supply (VDD), the electrons flows from source to drain through narrow channel existing between the depletion regions.
2) This constitutes drain current, ID.
3) The value of drain current is maximum when the external voltage applied between gate and source 0V.
4) When the gate to source voltage (applied by VGG) becomes negative,, the reverse bias voltage across gate source junction is increased.

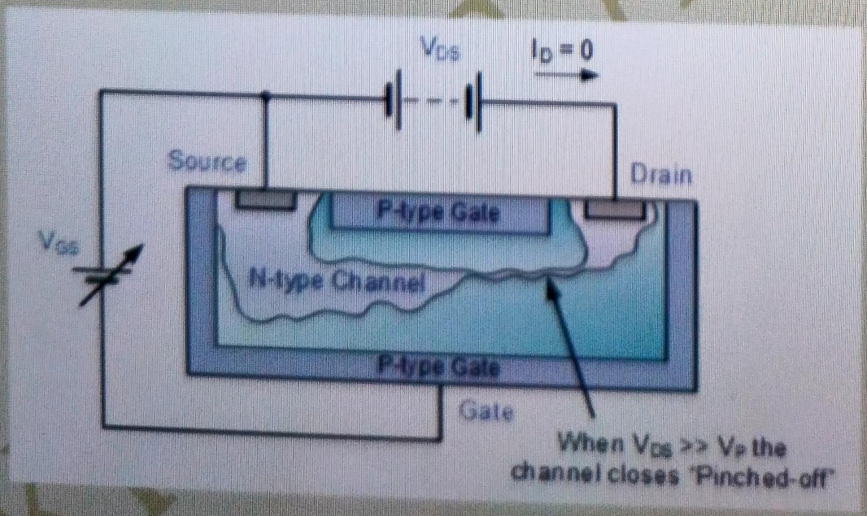
5) The depletion region is widened. This reduces the width of the channel and thus controls the flow of current.
6) The gate source voltage reaches a point where the channel gets completely blocked and the drain current becomes zero is called pinch- off voltage.

8. Draw suitable diagrams showing depletion regions before & after pinch-off for N channel JFET.

Depletion regions before pinch-off:



Depletion regions after pinch-off:



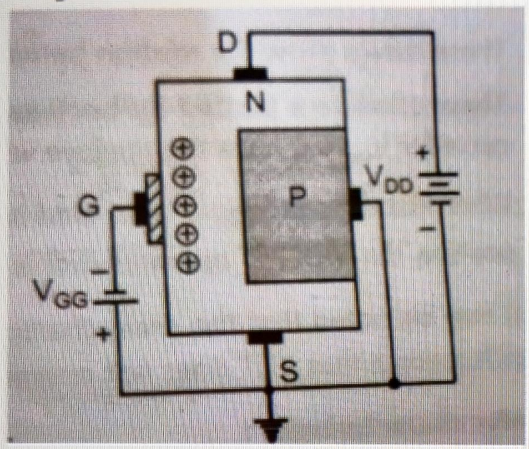
9. Explain working principle of N-channel depletion type MOSFET with construction diagram. Compare depletion type MOSFET & enhancement type MOSFET.

Answer:

Working principle:

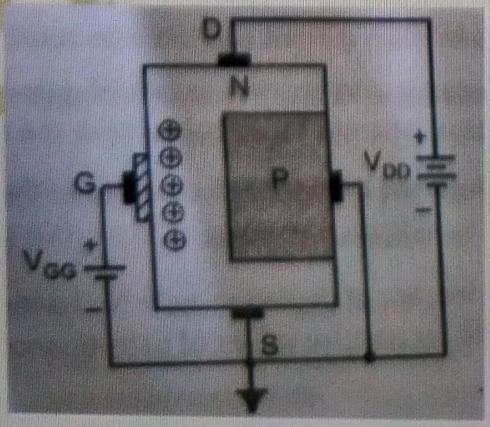
The depletion type MOSFET can be operated in the following two ways:

A) Depletion mode:



1) A depletion type N channel MOSFET with negative gate to source voltage is shown in figure.
2) The negative gate voltage induces positive charges in N type channel through the insulating layer SiO2.
3) Since, conduction of current through the N type channel is by means of majority carriers (i.e. electrons), the free electrons in the vicinity of positive charges are repelled away in the N type channel.
4) This reduces the number of free electrons passing through the N type channel. As a result of this, the N type channel is depleted of free electrons(i.e. majority carriers).
5) Thus, it reduces the drain current flowing through the N type channel as the gate to source voltage is made more negative.
6) As large negative gate to source voltage, the N type channel region near the drain end is totally depleted of free electrons and therefore the drain current reduces to zero

B) Enhancement mode:



1) An enhancement type N channel MOSFET with positive gate to source voltage is shown in figure.
2) The positive gate voltage induces negative charges in N type channel through the insulating layer SiO2.
3) Since, conduction of current through the N type channel is by means of majority carriers(i.e. electrons), the free electrons in the vicinity of positive charges are added together in the N type channel.
4) Thus, the positive gate voltage increases the number of free electrons passing through the N type channel.
5) This increases the drain current flowing through the N type channel as a result, it enhances the conductivity of the N channel.
6) Thus, it increases the drain current flowing through the N type channel as the gate to source voltage become more positive.
7) Because of the fact, the positive gate operation is called an enhancement mode.

Comparison of Depletion type MOSFET & Enhancement type MOSFET:

Sr. No.	Depletion type MOSFET	Enhancement type MOSFET
1	An insulating oxide layer is present between gate and channel.	An insulating oxide layer is present between gate and substrate
2	N or P type channel is present	N or P type channel is not present. At a time of operation, induced channel is created
3	For N channel V_{GS} = negative (for depletion mode) V_{GS} = positive (for enhancement mode)	For N channel V_{GS} = only positive
4	For N-channel, If V_{GS} is more negative, drain current decreases more	For N-channel, If V_{GS} is more positive, drain current increases more.

10. The following readings were obtained experiment from JFET.

V_{GS}	0 V	0 V	-0.2 V
V_{DS}	7 V	15 V	15 V
I_D	10 mA	10.25 mA	9.65mA

Determine:
(i) AC drain resistance
(ii) Transconductance

(iii) Amplification factor

Answer:

(i) AC drain resistance is given as, $r_d = \frac{\Delta V_{DS}}{\Delta I_D}$ at V_{GS} constant

$$\frac{15V-7V}{10.25-10mA} = \frac{8V}{0.25mA} = 32K\Omega$$

(ii) Transconductance gm is given as , $g_m = \frac{\Delta I_D}{\Delta V_{GS}}$, V_{DS} at constant

$$\frac{10.25mA-9.65mA}{0-(-0.2V)} = \frac{0.6mA}{0.2V} = 3m\ Mho$$

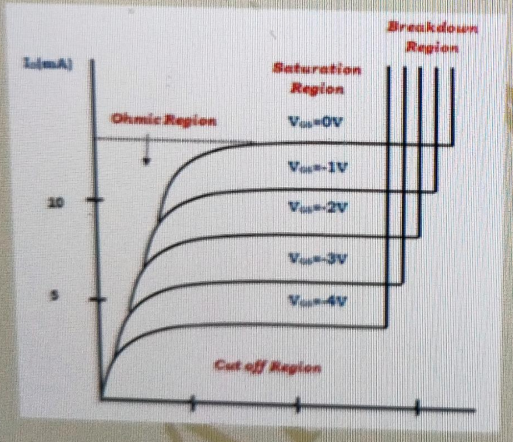
(iii) Amplification factor μ

$$\mu = r_d \times g_m = 32\ K\Omega \times 3m\ Mho = 96$$

11. Draw the drain characteristics and transfer characteristic of JFET.

Answer:

Drain characteristics characteristic of JFET:



Transfer characteristic of JFET: