## Experiment No: 5

## JFET Characteristics

**Aim:**

1. To study Drain Characteristics and Transfer Characteristics of a Junction Field Effect Transistor (JFET).
2. To measure drain resistance, trans-conductance and amplification factor.

**Components:**

| Name | Quantity |
|---|---|
| JFET BFW 11 | 1 |
| Resistor 100KΩ,1KΩ | 2 |

**Equipment:**

| Name | Range | Quantity |
|---|---|---|
| Bread Board | | 1 |
| Regulated power supply | 0-30V | 1 |
| Digital Ammeter | 0-200mA | 1 |
| Digital Voltmeter | 0-20V | 2 |
| Connecting Wires | | |

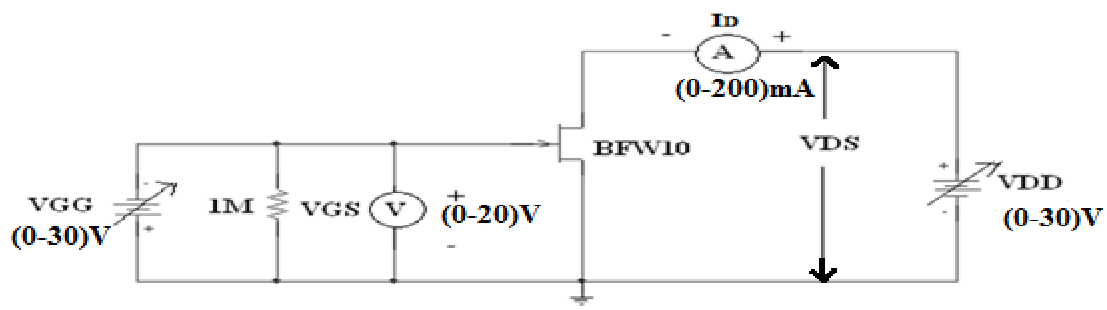
**Specifications: For FET BFW11:**

Gate Source Voltage $V_{GS}$ = -30V

Forward Gain Current $I_{GF}$ = 10mA

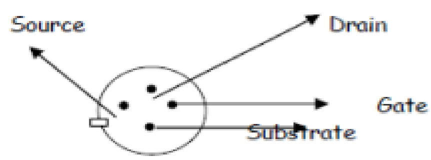
Maximum Power Dissipation $P_D$ = 300mW

## Circuit Diagram:




**Fig(1).Characteristics of FET**

## Pin assignment of FET:




## Theory:

The basic circuit diagram for studying drain and transfer characteristics is shown in the circuit diagram.

1. Drain characteristics are obtained between the drain to source voltage ($V_{DS}$) and drain current ($I_D$) taking gate to source voltage ($V_{GS}$) as the constant.
2. Transfer characteristics are obtained between the gate to source voltage ($V_{GS}$) and drain current ($I_D$) taking drain to source voltage (VDS) as the constant.

## Procedure:

## Drain Characteristics:

1. Connect the circuit as shown in the circuit diagram.
2. Keep $V_{GS}$ = 0V by varying $V_{GG}$.

3. Varying $V_{DD}$ gradually, note down drain current $I_D$ and drain to source voltage ($V_{DS}$).
4. Step size is not fixed because of non linear curve and vary the X-axis variable (i.e. if output variation is more, decrease input step size and vice versa).
5. Repeat above procedure (step 3) for $V_{GS}$ = -1V and -2V.

**Transfer Characteristics:**

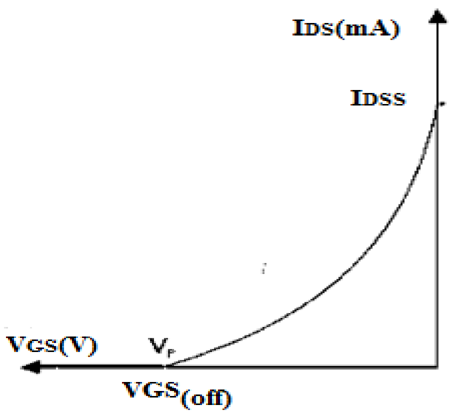
1. Connect the circuit as shown in the circuit diagram.
2. Keep $V_{DS}$ = 4V by varying $V_{DD}$.
3. Varying $V_{GG}$ gradually, note down both drain current $I_D$ and gate-source voltage ($V_{GS}$).
4. Step size is not fixed because of non linear curve and vary the X-axis variable (i.e. if output variation is more, decrease input step size and vice versa).
5. Repeat above procedure (step 3) for $V_{DS}$ = 6V.

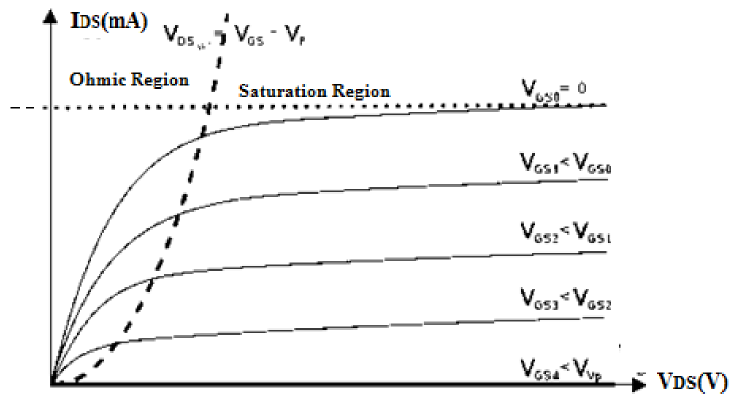
**Observations:**

| $V_{GS}$ = 0V | | $V_{GS}$ = -1V | | $V_{GS}$ = -2V | |
|---|---|---|---|---|---|
| $V_{DS}$(V) | $I_D$(mA) | $V_{DS}$(V) | $I_D$(mA) | $V_{DS}$(V) | $I_D$(mA) |
| | | | | | |
| | | | | | |
| | | | | | |

| Transfer Characteristics | | | |
|---|---|---|---|
| $V_{DS}$ = 2v/4V | | $V_{DS}$ = 4v/6V | |
| $V_{GS}$(V) | $I_D$(mA) | $V_{GS}$(V) | $I_D$(mA) |
| | | | |
| | | | |
| | | | |
| | | | |

## Graph:




**Transfer Characteristics** **Drain Characteristics**

1. Plot the drain characteristics by taking $V_{DS}$ on X-axis and $I_D$ on Y-axis at a constant $V_{GS}$.
2. Plot the transfer characteristics by taking $V_{GS}$ on X-axis and taking $I_D$ on Y-axis at constant $V_{DS}$.

## Calculations from Graph:

1. **Drain Resistance ($r_d$):** It is given by the relation of small change in drain to source voltage ($\Delta V_{DS}$) to the corresponding change in Drain Current ($\Delta I_D$) for a constant gate to source voltage ($\Delta V_{GS}$), when the JFET is operating in pinch-off region.
2. **Trans Conductance (gm):** Ratio of small change in drain current ($\Delta I_D$) to the corresponding change in gate to source voltage ($\Delta V_{GS}$) for a constant $V_{DS}$.

gm $= \frac{\Delta I_D}{\Delta V_{GS}}$ at constant $V_{DS}$ (from transfer characteristics).

The value of **gm** is expressed in mho's (℧) or Siemens (**s**).

3. **Amplification factor (μ):** It is given by the ratio of small change in drain to source voltage ($\Delta V_{DS}$) to the corresponding change in gate to source voltage ($\Delta V_{GS}$) for a constant drain current ($I_D$).

$$\mu = \left(\frac{\Delta V_{DS}}{\Delta I_D}\right) * \left(\frac{\Delta I_D}{\Delta V_{GS}}\right) = \frac{\Delta V_{DS}}{\Delta V_{GS}} = r_d * gm$$

**Inference:**

1. As the gate to source voltage ($V_{GS}$) is increased above zero, pinch off voltage is increased at a smaller value of drain current as compared to that when $V_{GS} = 0V$.
2. The value of drain to source voltage ($V_{DS}$) is decreased as compared to that when $V_{GS}$ = 0V.

**Precautions:**

1. While performing the experiment do not exceed the ratings of the FET. This may lead to damage the FET.
2. Connect voltmeter and ammeter in correct polarities as shown in the circuit diagram.
3. Do not switch ON the power supply unless you have checked the circuit connections as per the circuit diagram.
4. Make sure while selecting the Source, Drain and Gate terminals of the transistor.

**Result:**

1. Drain Characteristics and Transfer Characteristics of a Field Effect Transistor are studied (FET).

2. Measured drain resistance, transconductance and amplification factor.

**Viva Questions:**

**1. Why FET is called a Unipolar device?**

**Ans:** FETs are unipolar transistors as they involve single-carrier-type operation.

**2. What are the advantages of FET?**

**Ans:** The main advantage of the FET is its high input resistance, on the order of 100 MΩ or more. Thus, it is a voltage-controlled device, and shows a high degree of isolation between input and output. It is a unipolar device, depending only upon majority current flow. It is less noisy. and is thus found in FM tuners and in low-noise amplifiers for VHF and satellite receivers. It is relatively immune to radiation. It exhibits no offset voltage at zero drain current and hence makes an excellent signal chopper. It typically has better thermal stability than a bipolar junction transistor (BJT)

**3. What is transconductance?**

**Ans:** Trasconductance is an expression of the performance of a bipolar transistor or field-effect transistor (FET). In general, the larger the transconductance figure for a device, the greater the gain (amplification) it is capable of delivering, when all other factors are held constant. The symbol for transconductance is gm. The unit is Siemens, the same unit that is used for direct-current (DC) conductance.

**4. What are the disadvantages of FET?**

**Ans:** It has a relatively low gain-bandwidth product compared to a BJT. The MOSFET has a drawback of being very susceptible to overload voltages, thus requiring special handling during installation. The fragile insulating layer of the MOSFET between the gate and channel makes it vulnerable to electrostatic damage during handling. This is not usually a problem after the device has been installed in a properly designed circuit.

**5. Relation between $\mu$, $g_m$ and $r_d$?** **Ans:** $\mu = g_m * r_d$.