Practical No.24: Determine the drain and transfer characteristics of FET.

I Practical Significance:

The field-effect transistor (FET) is a transistor that uses an electric field at the gate to control the electrical behaviour of the FET. JFETs are known as unipolar transistors since they involve single-carrier-type operation. Field effect transistors have a very high input impedance at low frequencies. In this Practical students will plot Drain and Gate Transfer characteristics of JFET. FET are used in high frequency applications.

II Industry/Employer Expected Outcome(s):

FET switch and FET amplifier are employed in high frequency circuits in electronic industries. The employee should be able to select suitable type of transistor and configuration for given applications.

III Course Level Learning Outcome(s):

Use BJT & FET in various electronic circuits.

IV Laboratory Learning Outcome(s):

Use FET (BFW10) to plot drain and transfer characteristics.

V Relevant Affective Domain related outcome(s):

1. Handle equipment and component carefully.

VI Relevant Theoretical Background (With diagrams if required):

Junction Field Effect Transistors are a type of FETs (high input impedance devices) which have three terminals namely Source (S), Gate (G) and Drain (D). These devices are also called voltage controlled devices as the voltage applied at the gate terminal determines the amount of current flowing in-between the drain and the source terminals.

N-channel JFET

N-channel JFET has its major portion made of n-type semiconductor. The mutually- opposite two faces of this bulk material form the source and the drain terminals. There are two relatively-small p-regions embedded into this substrate which are internally joined together to form the gate terminal. Thus, here, the source and the drain terminals are of n-type while the gate is of p-type.

P-channel JFET

P-channel JFET has its major portion made of p-type semiconductor. The mutually- opposite two faces of this bulk material form the source and the drain terminals. There are two relatively-small-regions embedded into this substrate which are internally joined together to form the gate terminal. Thus, here, the source and the drain terminals are of p-type while the gate is of n-type.

IX Precautions to be followed:

1. Care should be taken while handling terminals of components.
2. Select proper range & mode of ammeter and voltmeter.
3. Connect wires tightly while building circuit.
4. Show the connections to concerned teacher and then switch ON the power supply.

X Procedure:

Part I Drain characteristics:

1. Connect the electrical circuit as shown in fig 3.
2. Fix gate to source voltage (V_{GS}) at OV.
3. Increase drain to source power supply and note down drain to source voltage (V_{DS}) and drain current (I_D).
4. Increase gate to source dc power supply so that voltmeter connected to gate and source terminal show 1V.
5. Now repeat above procedure and note down drain to source voltage and drain current by increasing drain power supply.
6. Take readings for 3 to 4 gate voltage values and tabulate it.
7. Plot a graph of V_{DS} verses I_D for various values of V_{GS}.

Part II Transfer characteristics:

1. Connect the electrical circuit as shown in fig 3.
2. Set drain to source voltage to 1V, vary gate to source voltage in steps and note down corresponding drain current (I_D)
3. Repeat the procedure for different set values of drain voltage and keep the record of gate to source voltage and drain current.
4. Plot a graph of gate to source voltage verses drain current for different set values of drain to source voltage.
5. A graph will be in second quadrant as gate to source voltage is negative.

XI Required Resources/apparatus/equipment with specifications:

S. No	Instruments/Components	Suggested broad specification	Quantity
1	Power supply	0-30 V 1 Amp	1
2	Voltmeter	0-20 V	1
3	Ammeter	(0-50 mA, 0-500 μA)	1
4	JFET	BFW 10.	1

XII Actual procedure followed:

1. Connect the electrical circuit as shown in fig.
2. fix gate to source voltage (V_{GS}) at Vo
3. Increase drain to source power supply and note down drain to source voltage & drain current (V_{DS} & I_D).

XIII Observations and Calculations:

Table 1: Drain Characteristics

S. No.	V_{GS}=.....V		V_{GS}=.....V		V_{GS}=.....V	
	V_{DS} (V)	I_D(mA)	V_{DS} (V)	I_D(mA)	V_{DS} (V)	I_D(mA)
1						
2						
3						
4						
5						
6						

Table 2: Transfer Characteristics

S. No.	V_{DS} =0V		V_{DS} =.....V		V_{DS} =.....V	
	V_{GS} (V)	I_D(mA)	V_{GS} (V)	I_D(mA)	V_{GS} (V)	I_D(mA)
1						
2						
3						
4						

Calculations:

Drain dynamic Resistance:

$$rd = \frac{\Delta V_{DS}}{\Delta I_D}$$

Mutual Conductance:

$$gm = \frac{\Delta ID}{\Delta VGS}$$

Amplification Factor:

$$\mu = \frac{\Delta V_{DS}}{\Delta V_{GS}}$$

XIV Results:

1. Drain dynamic resistance (r_D) =.....
2. Mutual conductance (gm) =.....
3. Amplification factor (μ) =.....

XV Interpretation of Results:

we have studied in this practical to determine the drain & transfer characteristics of FET.

XVI Conclusions & Recommendations:

In this practical we will plot drain & Gate Transfer characteristics of JFET. FET are used in high frequency applications.

XVII Practical Related Questions:

1. Write the Part number and manufacturer of given JFET.
2. State the advantages of FET over BJT.
3. List the applications of JFET.

[Space for Answers]

Q 1. 2N3819 (Fairchild), 2N3820, J201, BF245A (NXP semiconductor)

Q 2. 1. High Input Impedence 2. low Power Consumption
3. High speed 4. low Noise
5. high current gain 6. lower leakage Current

Q.3.: Amplifiers, Switches, Voltage Regulators, Audio Equipment, Instrumentation, Analog to Digital Converters, Oscillators, Filters.

XVIII References/ suggestions for further reading ; includes websites:

1. http://www.electronics-tutorials.ws/transistor/tran_5.html
2. http://www.circuitstoday.com/characteristics-of-jfets
3. www.nptel.ac.in/courses/117107095/lecturers/lecture_36/lecture36_page1.htm

XIX Suggested Assessment Scheme:

	Performance Indicators	Weightage
	Process Related : 15 Marks	**60 %**
1	Handling of the components	10%
2	Identification of components	20%
3	Measuring value using suitable instrument	20%
4	Working in teams	10%
	Product Related: 10 Marks	**40%**
5	Calculated theoretical values of given component	10%
6	Interpretation of result	05%
7	Conclusions	05%
8	Practical related questions	15%
9	Submitting the journal in time	05%
	Total (25 Marks)	**100 %**