KS16001 LABORATORY 1

LAB 9: JUNCTION FIELD EFFECT TRANSISTOR

Objective:
To study transfer and output characteristics of an n-channel Junction field effect Transistor (JFET) in Common-source configuration.

Learning Outcomes:
Able to analyze the characteristics of an n-channel Junction field effect Transistor (JFET) in Common-source configuration.

Instrument/Component:
Variable Voltage Supply
Digital Multimeter
N Channel JFET (2N3370/NTE 312/any)

THEORY: Construction & Characteristics of JFET
JFET(Junction Field Effect Transistor) is a three terminal device (drain, source, gate) similar to BJT. The difference between them is that the JFET is a voltage controlled device, whereas BJT is a current controlled device.

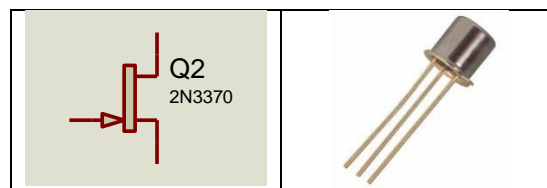Figure 9.1 shows the 2N3370 N Channel JFET symbol and real device.

Figure 9.1

Drain Characteristics:
For JFET, the relationship between an output parameter, I_D, and an input parameter, V_{GS}, is more complex. In the saturation region, there exists a square-law transfer relationship.

Transconductance Characteristics:
In the transfer characteristics of a two port network, the input parameter is changed and its effect on the output parameter is observed. Similarly JFET can be treated as a two-port nonlinear network. The transfer characteristics wherein the input parameter is the voltage across gate and source, and the output parameter is the drain current are called the transconductance characteristics. The transfer gain is nothing but conductance, hence the name.

Task 1: Measuring I_D versus V_DS (Output Characteristics)

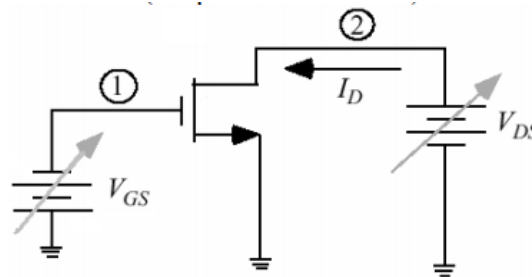1. Build the circuit as in Figure 9.2. Use the 2N3370 transistor.

Figure 9.2

2. Set a particular value of voltage for V_GS (i.e. 0V). Vary the voltage across drain (V_DS) from 0 to 8V and measure the corresponding drain current (I_D). Repeat the procedure for different values of V_GS (as in Table 9.1). Record the readings in Table 9.1.

Table 9.1

V_GS (V)	V_DS (V)										
	0	0.5	1.0	1.5	2.0	3.0	4.0	5.0	6.0	7.0	8.0
0.0	0	0.72m	0.26	0.74	1.22	2.21	3.20	4.19	5.19	6.18	7.18
-0.5	0	0.31m	1.03m	0.26	0.74	1.72	2.70	3.70	4.69	5.68	6.68
-1.0	0	0.01m	0.33m	1.05m	0.26	1.22	2.21	3.20	4.19	5.19	6.18
-1.5	0	0	0.01m	0.33m	1.06m	0.74	1.72	2.70	3.70	4.69	5.68
-2.0	0	0	0	0.01m	0.33m	0.26	1.22	2.21	3.20	4.19	5.19

3. Plot the graph I_D versus V_DS. Label the graph completely.
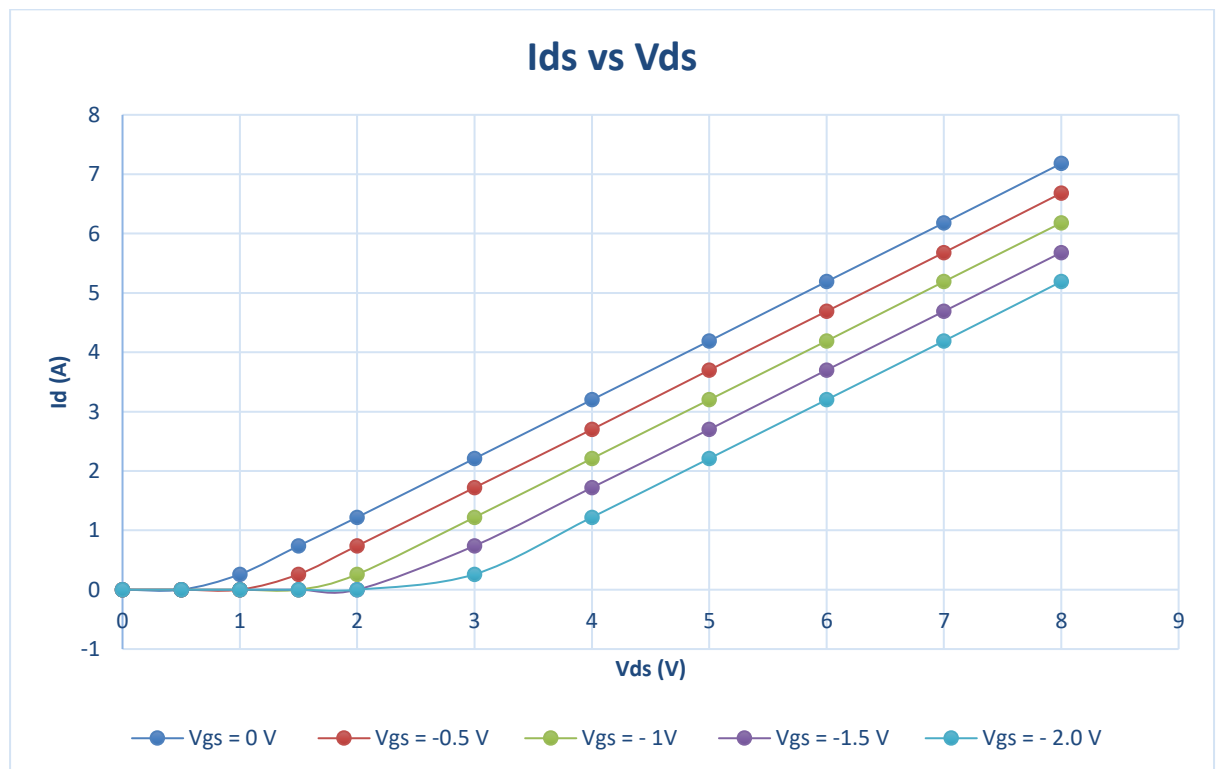
Task 2: Measuring I_D versus V_{GS} (Transconductance Characteristics)

1. Using the same circuit, set a particular value of voltage for V_{DS}, i.e. 5V. Start with a gate voltage V_{GS} of 0 V, and measure the corresponding drain current (I_D). Then decrease V_{GS} in steps of 0.25 V until V_{GS} is -3V. At each step record the drain current (I_D) in Table 9.2.

<div align="center">

Table 9.2

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V_{DS} (V)	V_{GS} (V)												
	0	-0.25	-0.50	-0.75	-1.00	-1.25	-1.50	-1.75	-2.00	-2.25	-2.50	-2.75	-3.00
5	4.19	3.94	3.70	3.45	3.20	2.95	2.70	2.46	2.21	1.96	1.72	1.47	1.22

2. Plot the graph I_D versus V_{GS}. Calculate the transconductance parameter from the graph assuming your V_{GSQ} value is -1 V. **Transconductance** is the ratio of change in drain current (δI_D) to change in the gate to source voltage (δV_{GS}) i.e the change in drain current divided by the change in gate voltage.
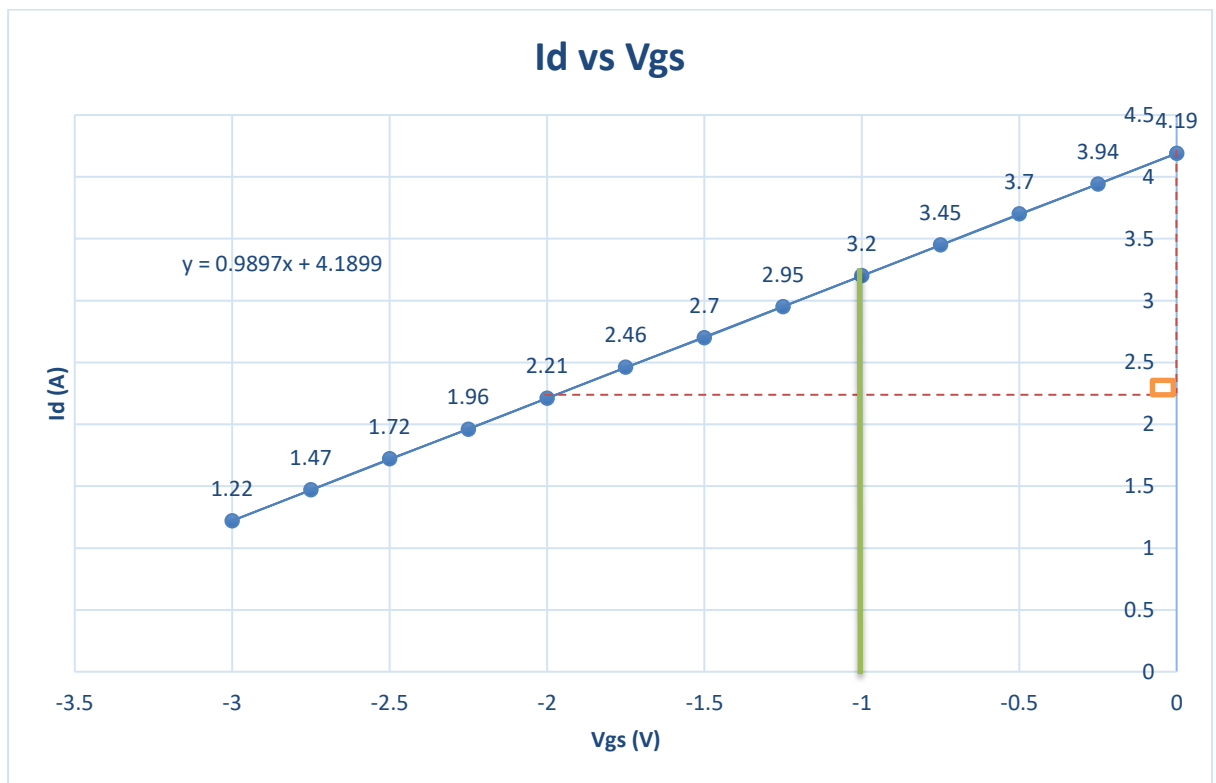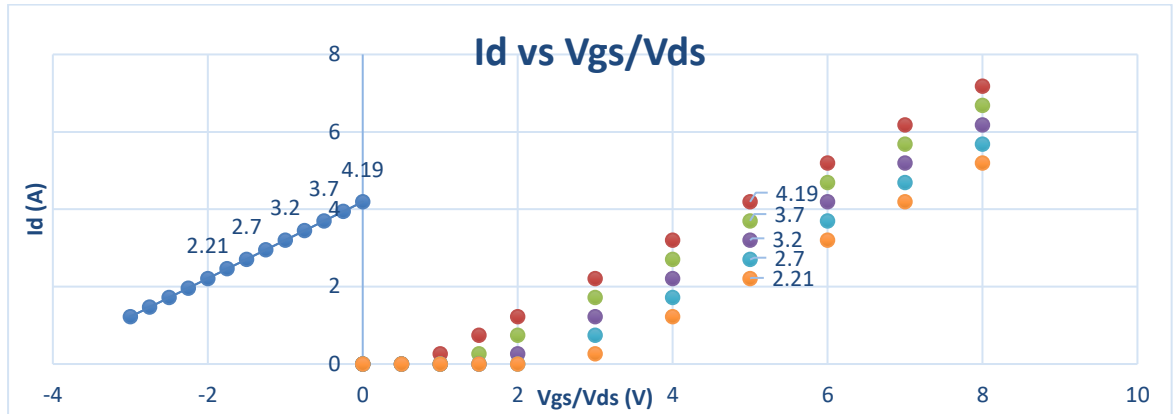

Transconductance, g_m At V_{GSQ} = -1 V,

$$g_m = \frac{\Delta I_D}{\Delta V_{GS}} = \frac{(4.19 - 2.21)\,A}{(0 - (-2))\,V} = \frac{1.98}{2} = 0.99\ S$$

Discussion:

Use all of the data obtained to answer the following questions:

1. Discuss the output (Task 1) and transconductance curves (Task 2) obtained in lab? Are they what you expected?
   Answer:

-If we compare the value $V_{DS} = 5V$ from I_d vs V_{DS} (right) also Graph I_D vs V_{GS} when $V_{DS} = 5V$ (left), the some of value of Id are exactly the same. Hence, it is expected.

2. Are the output characteristics (Task 1) spaced evenly? Should they be?
   Answer:

-From the graph on Task 1, we can see clearly that the graph is spaced evenly on the active region but not on the ohmic region.

-The transfer and I_d vs V_{DS} characteristic curves for the JFET, differ from the corresponding curves for a BJT. The BJT curves can be represented as evenly spaced for uniform steps in base current because of the linear relationship between I_C and I_B .

-The JFET have no current analogous to a base current because the gate currents are zero. Therefore, we are forced to show the family of I_d vs V_{DS} curves, and the relationships are very nonlinear. Hence, it **should not be** and vary sometimes.

3. What are the applications of JFET?
   Answer:

-Used as a switch, chopper, amplifier, buffer, voltage-controlled resistors in operational amplifiers.

-Used **in** the oscillatory circuits because of its low frequency drift, **in** digital circuits, such as computers, LCD and memory circuits because of their small size, **in** communication equipment's, such as FM and TV receivers because of their low modulation distortion, **in** cascade amplifiers and in RF amplifiers.