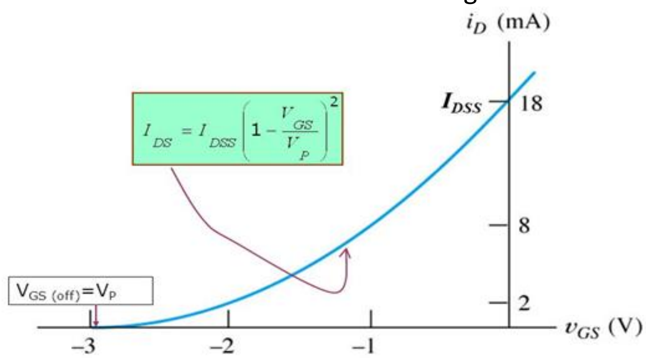
Department of Electrical Engineering
Sessional Assignment
Date: 04/05/2020

Course Details

Course Title: Electronic Circuit Design **Module:** 04
Instructor: ____________ **Total Marks:** 20

Student Details

Name: ____________ **Student ID:** ____________

Q1.		**Explain** the trans conductance curve for n-channel JFET given below 	Marks 04 CLO 1
Q2.		**State** the characteristics of a practical operational amplifier.	Marks 04 CLO 1
Q3.		**Calculate** output voltage for summing amplifier if $V_1 = 0.2V$, $V_2 = 0.5V$ and $V_3 = 2V$ and $R_1=R_2=R_3=R_f = 6k\Omega$	Marks 05 CLO 2
Q4.	(a)	You are working on an audio circuit in the lab. Which class of power amplifier will you not consider for your work? **Justify** your answer with reason.	Marks 04 CLO 2
	(b)	**Outline** the differences between an amplifier and a rectifier.	Marks 03 CLO 2

Department of Electrical Engineering

Course Title: Electronic Circuit Design

Module: 4th semester

Student Detail

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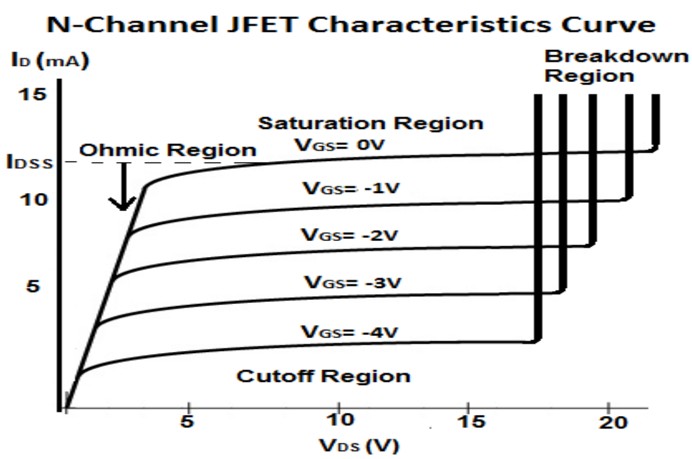
QNO 1: Explain the trans conductance curve for n-channel JFET given below

Ans=The forward transconductance (transfer conductance), The transconductance curve of a JFET transistor is the graph of the drain current, I_D verses the gate-source voltage, V_{GS}. The ratio of change in drain current, ΔI_D, to the change in gate-source voltage, ΔV_{GS}, is the transconductance, gm. The unit of transconductance is the Siemen (S). It is the reciprocal of resistance (Ω). The transconductance curve, as for all semiconductor devices, is nonlinear, for most of the curve, meaning changes to V_{GS} do not directly increase or decrease drain current, I_D. Below are the transconductance curves of N-Channel JFET Transistors.



The **Regions** that make up a transconductance curve are the following:

Cutoff Region- This is the region where the JFET transistor is off, meaning no drain current, I D flows from drain to source.
Ohmic Region- This is the region where the JFET transistor begins to show some resistance to the drain current, Id that is beginning to flow from drain to source. This is the only region in the curve where the response is linear.
Saturation Region- This is the region where the JFET transistor is fully operation and maximum current, for the voltage, VGS, that is supplied is flowing. During this region, the JFET is On and active.
Breakdown Region- This is the region where the voltage, VDD that is supplied to the drain of the transistor exceeds the necessary maximum. At this point, the JFET loses its ability to resist current because too much voltage is applied across its drain-source terminals. The transistor breaks down and current flows from drain to source.
The transfer characteristic for a JFET can be determined experimentally, keeping drain-source voltage, VDS constant and determining drain current, ID for various values of gate-source voltage, VGS. The

circuit diagram is shown in fig. The curve is plotted between gate-source voltage, VGS and drain current, ID, It is similar to the transconductance characteristic of a vacuum tube or a transistor. It is observed that

(i) Drain current decreases with the increase in negative gate-source bias

(ii) Drain current, ID = IDSS when VGS = 0

(iii) Drain current, ID = 0 when VGS = VD

The transfer characteristic follows equation.The transfer characteristic can also be derived from the drain characteristic by noting values of drain current, I_D corresponding to various values of gate-source voltage, V_{GS} for a constant drain-source voltage and plotting them. It may be noted that a P-channel JFET operates in the same way and have the similar characteristics as an N-channel JFET except that channel carriers are holes instead of electrons and the polarities of V_{GS} and V_{DS} are reversed

JFET Universal Transfer Characteristic

You have learned that a range of VGS values from zero to VGS(off) controls the amount of drain current. For an n-channel JFET, VGS(off) is negative, and for a p-channel JFET, VGS(off) is positive. Because VGS does control ID, the relationship between these two quantities is very important. FIG. 12 is a general transfer characteristic curve that illustrates graphically the relationship between VGS and ID. This curve is also known as a transconductance curve. Notice that the bottom end of the curve is at a point on the VGS axis equal to VGS(off), and the top end of the curve is at a point on the ID axis equal to IDSS. This curve shows that:

$$I_D = 0 \quad \text{when } V_{GS} = V_{GS(off)}$$

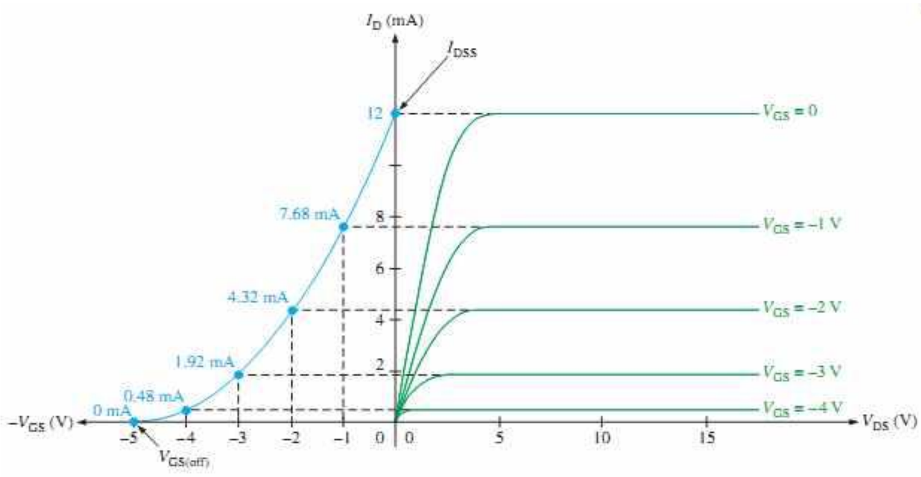
$$I_D = \frac{I_{DSS}}{4} \quad \text{when } V_{GS} = 0.5V_{GS(off)}$$

$$I_D = \frac{I_{DSS}}{2} \quad \text{when } V_{GS} = 0.3V_{GS(off)}$$

and

$$I_D = I_{DSS} \quad \text{when } V_{GS} = 0$$

The transfer characteristic curve can also be developed from the drain characteristic curves by plotting values of ID for the values of VGS taken from the family of drain curves at pinch-off, as illustrated in FIG. 13 for a specific set of curves. Each point on the transfer characteristic curve corresponds to specific values of VGS and ID on the drain curves. For example, when Also, for this specific JFET, and IDSS = 12 mA. VGS(off) =-5V VGS =-2V, ID = 4.32 mA.



QNO 2: State the characteristics of a practical operational amplifier.

Characteristic of Practical Op-amp

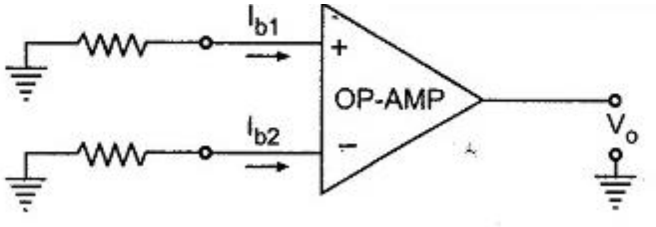
The Practical Op Amp Characteristics can be approximated closely enough, for many practical op-amps But basically the Practical Op Amp Characteristics are little bit different than the ideal op-amp characteristics.

The various characteristics of a practical op-amp can be described as below

1. **Open loop gain :** It is the voltage gain of the op-amp when no feedback is Practically it is several thousands.
2. **Input impedance : It** is finite and typically greater than 1 M 0. But using FETs for the input stage, it can be increased up to several hundred M
3. **Output impedance :** It is typically few hundred ohms. With the help of negative feedback, it can be reduced to a very small value like 1 or 2 ohms.
4. **Bandwidth :** The bandwidth of practical op-amp in open loop configuration is very small. By application of negative feedback, it can be increased to a desired value.
5. **Input offset voltage :** Whenever both the input terminals of the op-amp are grounded, ideally, the output voltage should be zero. However, in this condition, the practical op-amp shows a small non zero output voltage. To make this output voltage zero, a small voltage in millivolts is required to be applied to one of the input Such a voltage makes the output exactly zero. This d.c. voltage, which makes the output voltage zero, when the other terminal is grounded is called **input offset voltage** denoted as V_{ios}. How much voltage, to which terminal and with what polarity, to be applied, is specified by the manufacturer in the datasheet. The input offset voltage depends on the temperature.
6. **Input bias current :** For ideal op-amp, no current flows into the input The practical op-amps do have some input currents which are very small, of the order of 10^{-6} A to 10^{-14} A.

Most of the op-amps use differential amplifier as the input stage. The two transistors of the differential amplifier must be biased correctly. But practically, it is not possible to get exact matching of the two transistors. Thus, the input terminals which are the base terminals of the two transistors, do conduct the small d.c. current. These small base currents of the two transistors are nothing but bias currents denoted as I_{bi} and 42•

So input bias current can be defined as the current flowing into each of the two input terminals when they are biased to the same voltage level i.e. when the op-amp is balanced.



The two input currents, when op-amp is balanced, are shown in the Fig.

The two bias currents are never same hence the manufacturers specify the average input bias current Ib, which is found by adding the magnitudes of $l_{b/}$ and I_{b2} and dividing the sum by 2.

Mathematically it is expressed

$$I_b = \frac{|I_{b1}| + |I_{b2}|}{2}$$

Input offset current : The difference in magnitudes of I_{bi} and I_{b2} is called as input offset current and is denoted as I_Q Thus,

$$I_{ios} = | I_{b1} - I_{b2}$$

The magnitude of this current is very small, of the order of 20 to 60 nA. It is measured under the condition that input voltage to op-amp is zero.

If we supply equal d.c. currents to the two inputs, output voltage of op-amp must be zero. But practically, there exists some voltage at the output. To make it zero, the two input currents are made to differ by small amount. This difference is nothing but the input offset current.

QNO 3:Calculate output voltage for summing amplifier if V_1 = 0.2V, V_2 = 0.5V and V_3 = 2V and R_1=R_2=R_3=R_f = 6kΩ

Given:

V_1=0.2V

V_2=0.5V

V_3=2V

R_1=R_2=R_3 =Rf= 6k Ohms

Required:

V_{out}=?

Solution:

Formula: V_{out}= -(Rf/R) * (V_1+ V_2+V_3)

=-(6k/6k)* (0.2+0.5+2)

= -2.7V Answer

QNO4(a): You are working on an audio circuit in the lab. Which class of power amplifier will you not consider for your work?
Justify your answer with reason.

For Class A

And class A is always ON .it is used for “signal" level circuits (where power requirements are small) because they maintain low distortion. They are very inefficient and are rarely used for high power designs. Class A 75% (or more) of the supplied power is dissipated by DC

For Class B

Peak efficiency of the class B output stage is 78.5 %, much higher than class A. Class B amplifiers are used in low cost designs or designs where sound quality is not that important. Class B amplifiers are significantly more efficient than class A amplifiers. Before the advent of IC amplifiers, class B amplifiers were common in clock radio circuits, pocket transistor radios, or other applications where quality of sound is not that critical.

For Class C

Class C amplifiers are never used for audio circuits. They are commonly used in RF circuits. Class C amplifiers operate the output transistor in a state that results in tremendous distortion (it would be totally unsuitable for audio reproduction). So the class C isn’t able for audio circuits

QNO 4(b):Outline the differences between an amplifier and a rectifier.

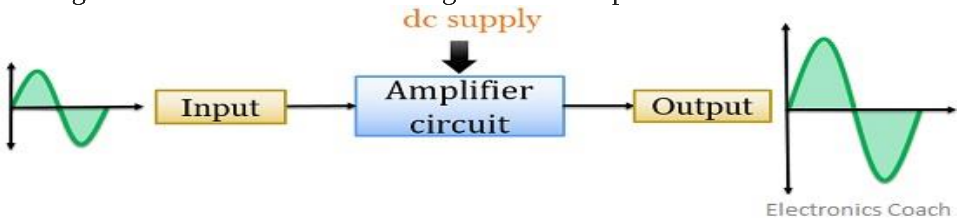
- **Rectifier :** A Rectifier is an electrical device that is made of one or more than one diodes that converts the alternating current (AC) into direct current (DC). It is used for rectification where the process below shows that how it convert AC into DC. Rectification is the process of conversion of the alternating current (which periodically changes direction) into direct current (flow in a single direction). The rectifiers are mainly classified into two types:
- Half wave rectifier
- Full wave rectifier

Amplifiers : An electronic device that is used to **boost the power level of an input signal** is known as an **amplifier.** Amplifiers are basically used in wireless communication systems that include an analogue signal. It has the ability to provide an amplified or increased form of an applied input signal. It is noteworthy that **BJT**, **JFET** or **MOSFET** can be used as an amplifier. However, for amplification, the device must be in the appropriate region. In other words, proper biasing must be provided to the transistor in order to have an amplified signal at the output. It is a two-port network and holds the following major properties:

- Gain of amplifier
- Input impedance
- Output impedance

Block diagram of amplifier

The figure below shows the block diagram of an amplifier:



Here, as we can see the transmitted signal is fed to the amplifier as input. The circuitry involved inside the amplifier raises the amplitude of the signal up to the desired level and then further transmits it to the receiver.

The amplifier can be single stage or multistage depending upon the need of the circuit. Sometimes optical signals are also needed to be amplified so in that case optical amplifiers are used.