Department of Electrical Engineering
Sessional Assignment
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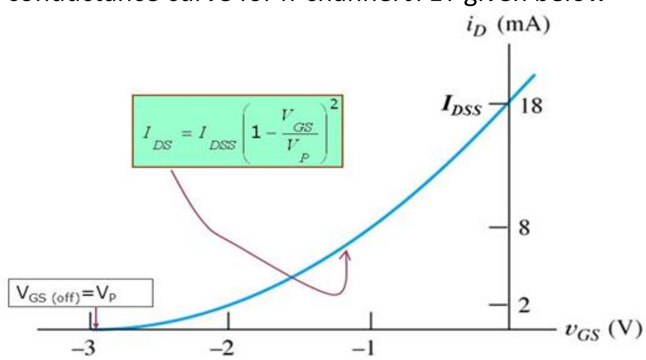
Course Details

Course Title:	Electronic Circuit Design	**Module:**	04
Instructor:	**Engr. Mujtaba Ihsan Sir**	**Total Marks:**	20

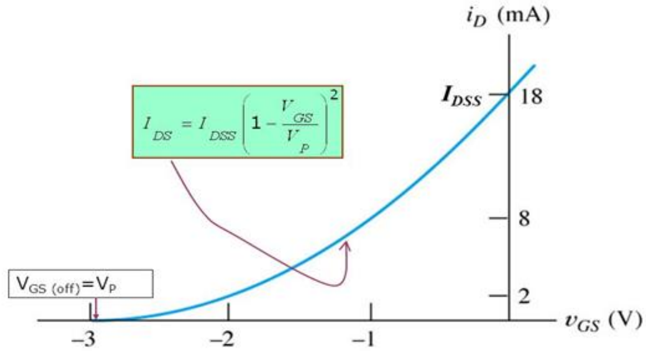
Student Details

Name:	**FAWAD AHMAD**	**Student ID:**	**13204**

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 $R_1=R_2=R_3=R_f$ = 6kΩ	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

ANSWER SHEET

Q1.		**Explain** the trans conductance curve for n-channel JFET given below	Marks 04 CLO 1



ANSWER:

Trans conductance Curve of a JFET:

The trans conductance curve of a JFET transistor is the graph of the drain current, ID verses the gate-source voltage, VGS.

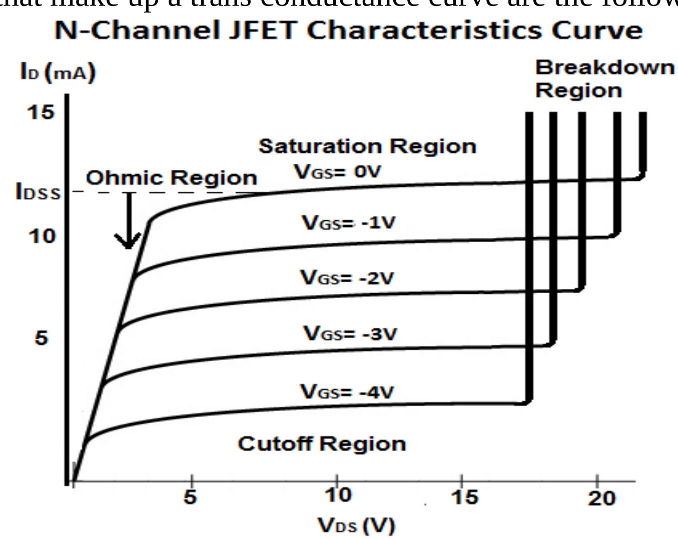
The ratio of change in drain current, ΔID, to the change in gate-source voltage, ΔVGS, is the trans conductance, gm.

The unit of trans conductance is the siemen (S). It is the reciprocal of resistance (Ω).

The trans conductance curve, as for all semiconductor devices, is nonlinear, for most of the curve, meaning changes to VGS do not directly increase or decrease drain current, ID.

Below are the trans conductance curves of N-Channel JFET transistors and P-Channel JFET Transistors.

The Regions that make up a trans conductance 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.	
Q2.		**State the characteristics of a practical operational amplifier.** **ANSWER:** **Practical Op Amp Characteristics:** 1) It has both voltage and current limitations 2) High voltage gain 3) High input impedance 4) Very Low output impedance 5) Generation of unwanted signals (noise). 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	Marks 04 CLO 1

Open loop gain: It is the voltage gain of the op-amp when no feedback is Practically it is several thousands.

Input impedance: It is finite and typically greater than 1 M 0. But using FETs for the input stage, it can be increased upto several hundred M

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.

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.

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.

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.

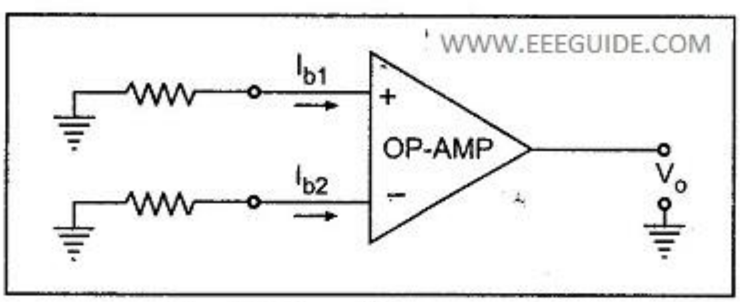


Fig. 2.9 Input bias currents

The two input currents, when op-amp is balanced, are shown in the Fig. 2.9.

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

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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 = 6kΩ.**

Marks 05

CLO 2

ANSWER:

Derivation of Vout Formula:

According to KVL:

IT= I1 + I2……………………….eq.1

According to Ohm's Law output voltage will be:

Vout= - IT Rf…………………..eq.2

Reason: (for negative sign): Summing amplifier is an inverting amplifier.

Putting values of eq.1 in eq.2

Vout=-(I1+I2) x Rf…………...eq.3

According to Ohm's Law V=IR

V1=I1 R1

Therefore

I1=V1/R1

I2=V2/R2

I3=V3/R3

Put these values in eq.3

Vout= - [V1/R1+V2/R2+V3/R3] RF………..eq.4

If the three resistors are equal i.e. R1=R2=R3=Rf=R

Vout= - [V1/R+V2/R+V3/R] R

Vout= - [V1+V2+V3]……………eq.5

$$Vout = -[V1+V2+V3 \ldots\ldots\ldots Vn]$$

<u>Given data:</u>

$V_1 = 0.2V$, $V_2 = 0.5V$ and $V_3 = 2V$ and $R_1=R_2=R_3=R_f = 6k\Omega$.

So putting the value in eq.

$$Vout = -[V1/R+V2/R+V3/R]\,R$$

$$Vout = -[0.2V/6\,\Omega + 0.5V/6\,\Omega + 2V/6\,\Omega]6\Omega$$

$$Vout = -[0.0333+0.0833+0.333]6\Omega$$

$$Vout = -[0.4496]6\Omega$$

Vout= -2.6976V

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

ANSWER:

- 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).
- However, the RF circuits where Class C amplifiers are used, employ filtering so that the final signal is completely acceptable.
- Class C amplifiers are quite efficient.

<u>Reason:</u>

<u>Class-C:</u>

		Output device(s) conduct for less than 180 degrees (100 to 150 degrees typical) - Radio Frequencies only - cannot be used for audio! This is the sound heard when one of the output devices goes open circuit in an audio amp! See Figure 1, showing the time the output device conducts.	
	(b)	**Outline the differences between an amplifier and a rectifier.** **ANSWER:** **Rectifier** A **rectifier** is an electrical device that converts alternating current (AC), which periodically reverses direction, to direct current (DC), which flows in only one direction. **USES:** Rectifiers have many uses, but are often found serving as components of DC power supplies and high-voltage direct current power transmission systems. Rectification may serve in roles other than to generate direct current for use as a source of power. As noted, detectors of radio signals serve as rectifiers. In gas heating systems flame rectification is used to detect presence of a flame. **Amplifier:** An **amplifier**, **electronic amplifier** or (informally) **amp** is an electronic device that can increase the power of a signal (a time-varying voltage or current). It is a two-port electronic circuit that uses electric power from a power supply to increase the amplitude of a signal applied to its input terminals, producing a proportionally greater amplitude signal at its output. The amount of amplification provided by an amplifier is measured by its gain: the ratio of output voltage, current, or power to input. An amplifier is a circuit that has a power gain greater than one.	Marks 03 CLO 2