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

Course Details

Course Title:	Electronic Circuit Design	**Module:**	04
Instructor:	Engineer Mujtaba Ehsan	**Total Marks:**	20

Student Details

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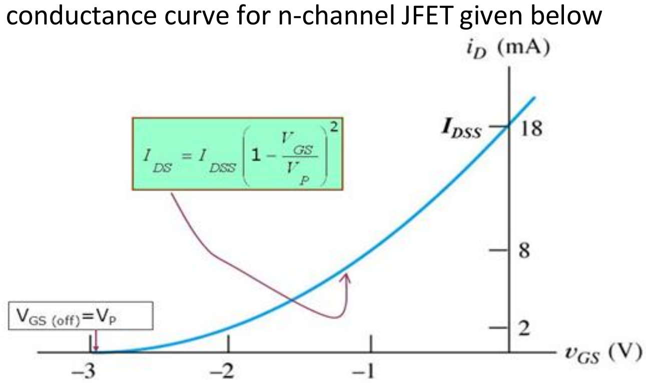
Q1.		**Explain** the trans conductance curve for n-channel JFET given below 	Marks 04 CLO 1
Q2.		**State** the characteristics of a practical operational amplifier.	Marks 04 CLO 1
Q3.		**Calculate** output voltage for summing amplifier if $V_1 = 0.2V$, $V_2 = 0.5V$ and $V_3 = 2V$ and $R_1=R_2=R_3=R_f = 6k\Omega$	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

<table>
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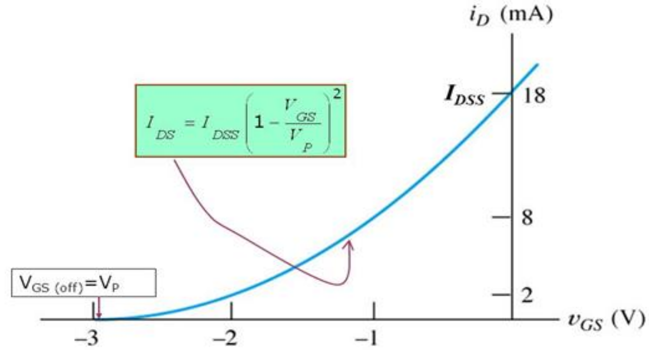

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</table>

ANSWER:

as you can see from the graph, as the value of Vgs changes then the drain current Id will change. So now let us find out the relationship between the input voltage Vgs and the output drain current Id. So, if we plot this relationship, then it is known as the transfer characteristic. So basically, this transfer characteristic is the plot which defines the relationship between the input and the output quantity of the device. And it could be either voltage or current. So, for the JFET, if we keep this voltage Vds constant, and for the different values of Vgs, if we plot this current Id then we will get the transfer characteristic of this JFET. Now for the BJT if you know the relationship between the output collector current and the input base current is linear. And it can be given by the expression Ic is equal to beta times Ib. But for the JFET, the relationship between this input voltage vgs and the drain current Id is non-linear. And it can be given by this expression, that is drain current Id is equal to Idss times, 1 minus vgs divided by Vp, whole square. And if you want to find this relation graphically then it can be found from the output characteristic or the drain curves of the JFET. So, to find this transfer characteristics, first of all let us represent this drain current Id and the voltage vgs on the different axis. Now on the right side of this curve we have a drain curves for the different values of vgs. So, from the right side, first of all let us extend the saturation drain current for the voltage vgs is equal to zero and at the same time let us draw a vertical line for the value of vgs is equal to zero. And the intersection of these two lines will give the value of drain current ID for vgs is equal to zero volt. And we can do the same thing for the different value of Vgs. So for Vgs is equal to minus 1, if we extend this line to the left and if we draw a vertical line for Vgs is equal to minus 1 volt, then we will get an intersection point which represents the value of drain current for Vgs is equal to minus 1 volt. And if we do the same thing for the different drain curves then we will get a values of drain currents for the different values of Vgs. And if we connect these intersection points then we will get a transfer curve which represents the relationship between the current ID and the Vgs. And as it is evident from the graph, the relationship between this current ID and the vgs is non-linear. And like we had seen, mathematically the relationship can be expressed by this expression. That is drain current ID is equal to Idss times 1 minus Vgs divided by Vp, whole square. where Idss is the maximum value of the drain current and the Vp is the pinch off voltage of this JFET. So, in this expression if we put Vgs is equal to zero then we will get this drain current Id is equal to Idss. so, whenever this vgs is equal to zero at that time the value of drain current is maximum. And the value of that drain current will be equal to Idss. Similarly, in this expression, whenever we put this Vgs is equal to Vp, at that time this drain current Id will be equal to zero. so whenever this Vgs is equal to Vp, at that time the drain current is zero.

So, by putting these two values we will get the two extreme points of this curve. So now let's take the value of Vgs in between these two extreme points. So let's say for some JFET, the value of Idss is equal to 12 milli ampere. And for the JFET, the value of pinch-off voltage Vp is equal to minus 4 volt. And let's say we want to find the value of drain current whenever this Vgs is equal to minus 2 volt. So, if we put all these values then the drain current Id will be equal to 12 milli ampere times, 1 minus -2 divided by minus 4, whole square. And if we simplify it then the value of Id will be equal to 3 milli ampere. So, whenever the Vgs is equal to minus 2 volt at that time the value of drain current ID is equal to 3 milli ampere. And in this way, by putting the value of this Vgs between the zero and the pinch off voltage Vp, we can find the value of drain current for the given JFET. And similarly, for the given JFET, if we know the value of this drain current ID then we can find the value of Vgs. So, if we just rewrite this expression in terms of the Vgs, then it can be represented like this. so here let's say we want to find the value of Vgs for the drain current ID is equal to 6 milliampere. So, from the given expression we can say that Vgs is equal to minus 4 times 1 minus under root 6 divided by 12. That is equal to minus four times one minus under root 1 by 2. And if we simplify it then the value of Vgs will be equal to -1.17 volt. So in this way if we know the value of the drain current Id then we can find the corresponding value of this Vgs using this expression. Now so far we have only discussed about the transfer characteristic of the n-channel JFET. So now similarly let us see the transfer characteristic for the p-channel JFET. so in case of the p-channel JFET, as the value of Vgs and Vp both are positive, so the transfer curve will be the mirror image of the n-channel JFET curve. So if we see the transfer curve for the p-channel JFET, then it will look like this. And in this curve if we know the value of Vgs, then by drawing the vertical line we can find the intersection point on the curve. And thereby we can find the corresponding value of the drain current. Now here as the voltage Vgs and Vp both are positive so we can apply the same mathematical expression that we have used for the n-channel JFET. And using this we can find the value of the drain current Id.

Q2.		**State** the characteristics of a practical operational amplifier.

ANSWER:

Practical Op Amp Characteristics:

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 upto 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.

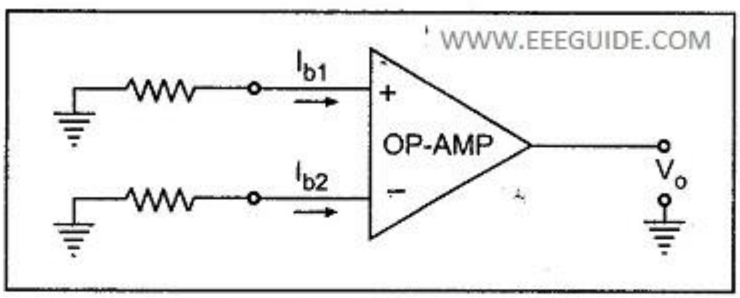


Fig. 2.9 Input bias currents

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 $I_{b/}$ and I_{b2} and dividing the sum by 2.

Mathematically it is expressed

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

g) **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.

Q3.		**Calculate** output voltage for summing amplifier if $V_1 = 0.2V$, $V_2 = 0.5V$ and $V_3 = 2V$ and $R_1=R_2=R_3=R_f = 6k\Omega$

ANSWER:

Given:

V_1=0.2V

V_2=0.5V

V_3=2V

R_1=R_2=R_3 =Rf= 6k Ohms

Required:

Vout=?

Solution:

Formula: Vout= -(Rf/R) * (V1+ V2)

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

= -2.7V Answer

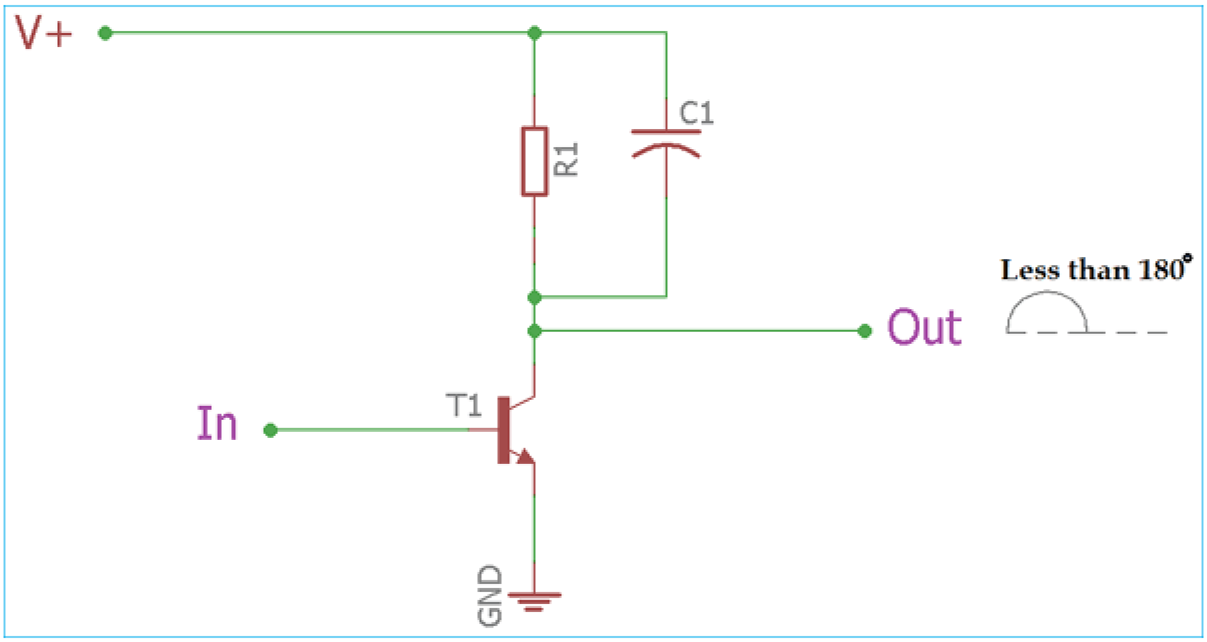
Q4.	(a)	You are working on an audio circuit in the lab. Which class of power amplifier will you not consider for your work? **Justify** your answer with reason.

ANSWER:

The correct answer is class 'C' amplifier.

As 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.

Apart from the Class A, B, and AB amplifier, there is another amplifier Class C. It's a traditional amplifier which works differently than the other amplifiers classes. Class C amplifier is tuned amplifier which works in two different operating modes, tuned or untuned. The efficiency of Class C amplifier is much more than the A, B, and AB. Maximum 80% efficiency can be achieved in radio frequency related operations



Class C amplifier uses less than 180-degree conduction angle. During the untuned mode, the tuner section is omitted from the amplifier configuration. In this operation, Class C amplifier also gives huge distortion across the output.

When the circuit is exposed to a tuned load, the circuit clamps the output bias level with the average output voltage equal to the supply voltage. The tuned operation is called as clamper. During this operation, the signal gets its proper shape and the center frequency became less distorted.

In typical uses, Class C amplifier gives 60-70% efficiency.

(b)	**Outline** the differences between an amplifier and a rectifier.

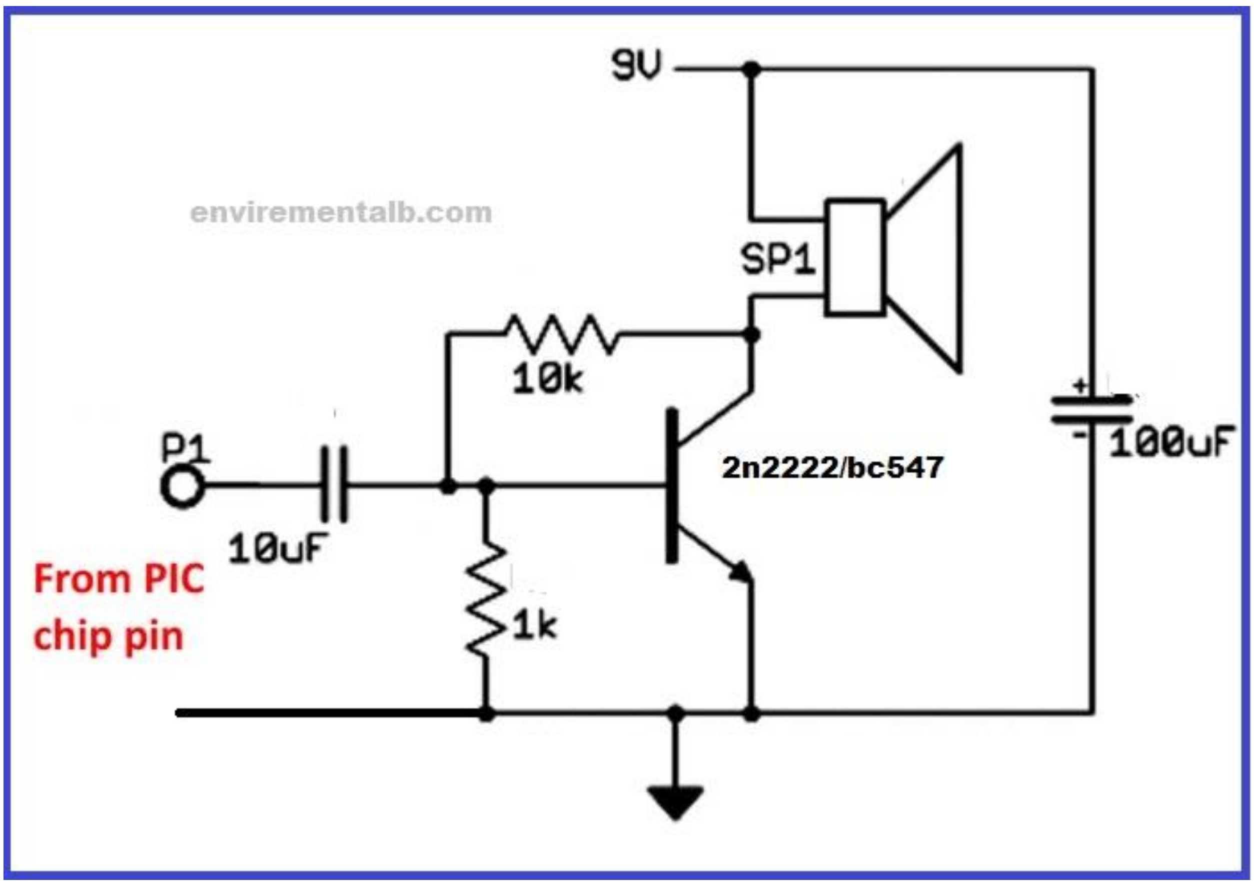
ANSWER:

Following is the main differences between an amplifier and rectifier;

AMPLIFIER:

An amplifier is a type of circuit which can increase the power of a weak signal. It is a device which increases the strength / voltage of the signal (By strength, it is generally the power of the signal). There are many types of amplifiers like voltage, power, current etc. (Refer to Sedra and Smith for more.). In practice (there may be exceptions) voltages of the order of milli volts or microvolts is amplified (to 1V or near 1V). In general, they work on the principle of cross-conductance / voltage dependent current source / current dependent voltage source etc. To be simple, voltage/current flowing through one pair of terminals must affect voltage/current flowing through other pair.

CIRCUIT DIAGRAME:



RECTIFIER:

A rectifier is a type of circuit which can convert an AC signal to DC by the use of a single diode. It is a device which converts a AC signal to DC. Although at class 12 level one might be knowing about half wave rectifier and full wave rectifier using transformers, diodes and capacitors, there are other types also which uses thyristors and whole full semester course on this topic. Rectifiers are generally used to convert AC voltages of 100V or greater (generally) to DC voltages.

This can be explained in a simple fashion as making the average of the signal non zero. In plane AC , the average voltage is zero but consider a rectified AC, the average is non-zero.

CIRCUIT DIAGRAME: