RELATIONSHIP OF α,β, γ

$$\boxed{\alpha_{dc} = \frac{I_C}{I_E}}$$

$$\gamma = \frac{I_E}{I_B}$$

$$\boxed{\beta_{dc} = \frac{I_C}{I_B}}$$

$$\boxed{\gamma = \beta + 1}$$

$$\boxed{\alpha = \frac{\beta}{\beta + 1}}$$

$$\boxed{\beta = \frac{\alpha}{1 - \alpha}}$$

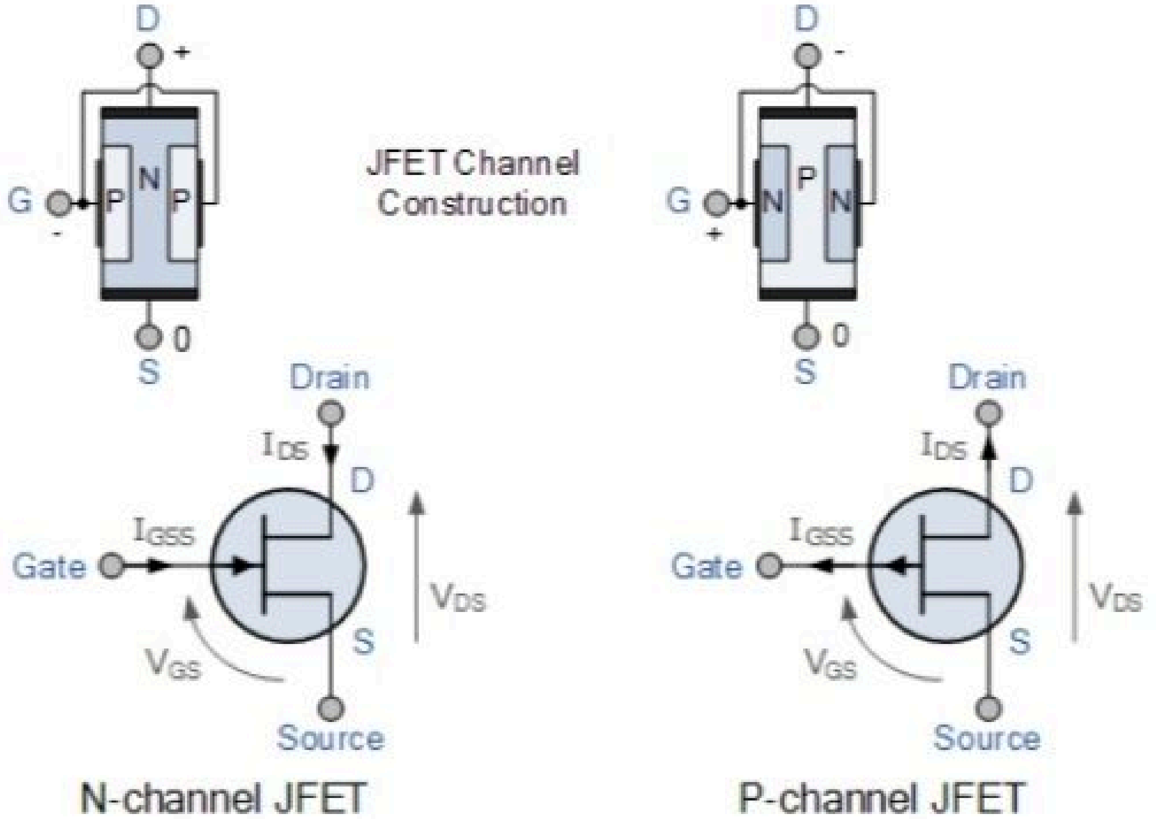
COMPARISON OF CB,CE,CC

Characteristic	Common base (CB)	Common emitter,(CE)	Common collector,(CC)
Input Dynamic Resistance	Very Low(less than 100 ohm)	Low(less than 1K)	Very High(750K)
Output Dynamic Resistance	Very High	High	Low
Current Gain	Less than 1	High	Very High
Voltage gain	Greater than CC but less than CE	Highest	Lowest(less than 1)
Power gain	Medium	Highest	Medium
Leakage current	Very small	Very large	Very large
Relationship between I/p and o/p	In phase	Out of phase(180^0)	In phase
Application	For High freq. applications	For Audio freq. Applications	For impedance Matching Applications

JUNCTION FIELD EFFECT TRANSISTOR (JFET)

BASICS

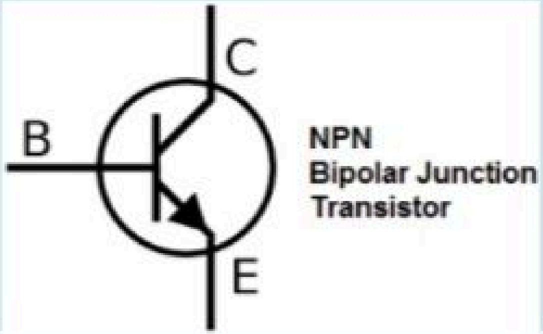
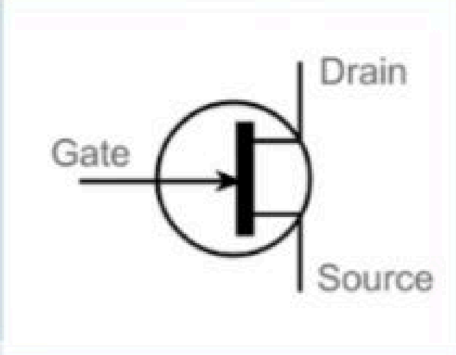
- There are two types of JFET's: n-channel and p-channel.
- The **n-channel** is widely used.
- Three terminals:
  - Drain (D) and Source (S) are connected to n-channel
  - Gate (G) is connected to the p-type material.
- Gate is always **reverse biased**
- Gate current, I_D=0



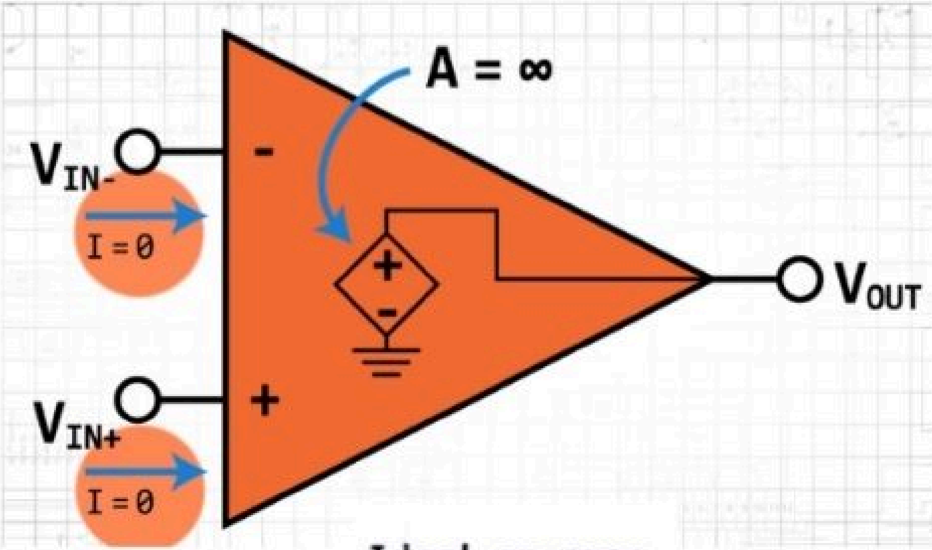
CONSTRUCTION, TYPES & SYMBOLS

(Image source: www.electronics-tutorials.ws)

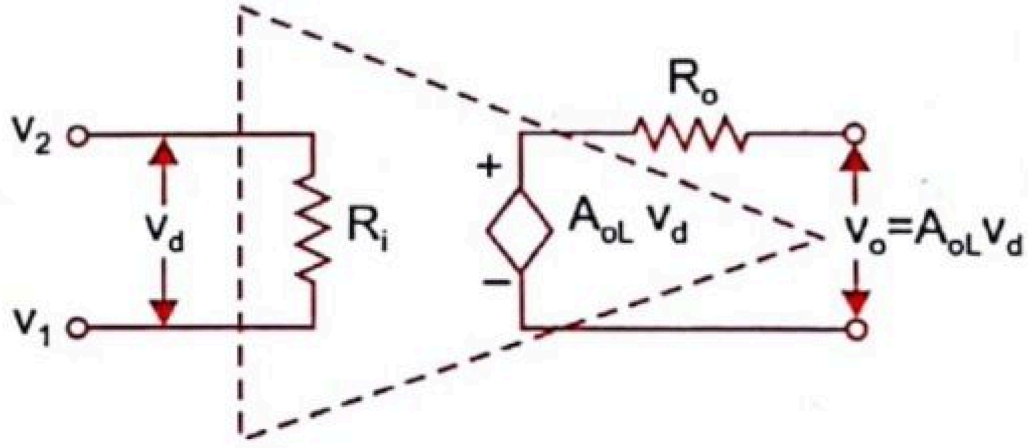
COMPARISON BETWEEN BJT AND JFET

BJT	JFET
	
Bipolar Device	Unipolar Device
Current Controlled Device	Voltage Controlled Device
Low Input Impedance	High Input Impedance
Consumes more power	Consumes less power
High Noise level	Low noise level
Low thermal stability	High thermal stability
Large size	Small size
Preferred in low current application	Preferred in low voltage application
High gain	Low – medium gain

THE IDEAL OPERATIONAL AMPLIFIER



Ideal op-amp,



Equivalent circuit of an op-amp

➢The **<u>input resistance of an op amp must be very high</u>** where as the **<u>output resistance should be quite low</u>**.

➢An op amp should also **<u>have very high open loop gain</u>**.

➢In **<u>Ideal Cases,</u>** the input resistance and open loop gain of an op amp should be infinity whereas the output resistance would be zero.

Characteristic	Value
Open Loop Gain (A)	$\propto$
Input Resistance (Impedance)	$\propto$
Output Resistance (Impedance)	0
Bandwidth of Operation	$\propto$
Offset Voltage	0

$$V_o = A(V_1 - V_2)$$

It can be observed that

(i) An ideal op-amp allows zero current to enter into its input terminals, i.e. $i_1 = i_2 = 0$.

Due to infinite input impedance, any signal with source impedance can drive the op-amp without getting inflicted with any loading effect.

(ii) The gain of the ideal op-amp is infinite.

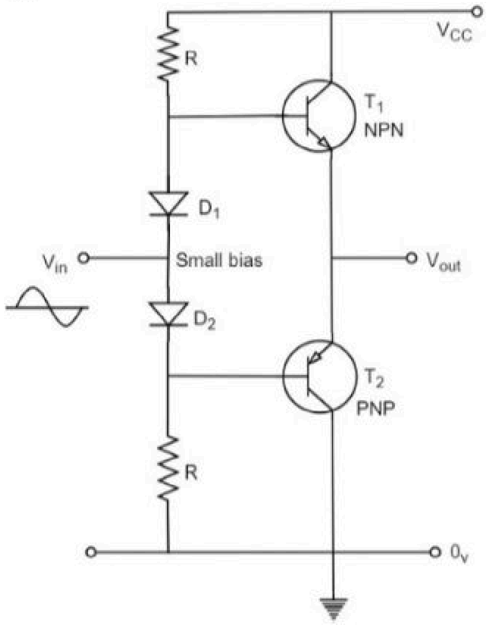
Hence, the voltage between the inverting and non-inverting terminals is essentially zero for a finite output voltage.

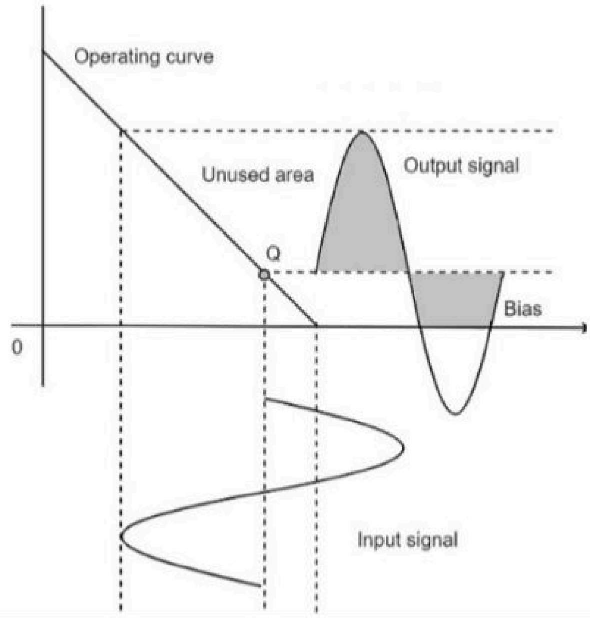
(iii) The output voltage V_o is independent of the output current drawn from the op-amp, since $R_o = 0$.

This means that the output can drive an infinite number of output devices of any impedance value.

CLASS AB POWER AMPLIFIER

- class AB is a combination of class A and class B type of amplifiers. As class A has the problem of low efficiency and class B has distortion problem, this class AB is emerged to eliminate these two problems, by utilizing the advantages of both the classes.
- The cross over distortion is the problem that occurs when both the transistors are OFF at the same instant, during the transition period. In order to eliminate this, the condition has to be chosen for more than one half cycle. Hence, the other transistor gets into conduction, before the operating transistor switches to cut off state.





Advantages of Class AB power amplifier.

No cross over distortion.

No need for the bulky coupling transformers.

No hum in the output.

Disadvantages of Class AB power amplifier.

Efficiency is slightly less when compared to Class B configuration.

There will be some DC components in the output as the load is directly coupled.

Capacitive coupling can eliminate DC components but it is not practical in case of heavy loads.

- The efficiency of this type of Class A amplifier configuration can be calculated as follow

$$\eta_{(max)} = \frac{P_{ac}}{P_{dc}} \times 100\%$$

- R.M.S. Collector voltage is given as

$$V_{CE} = \frac{V_{C(max)} - V_{C(min)}}{2\sqrt{2}} = \frac{2V_{CC} - 0}{2\sqrt{2}}$$

$P_{ac} = V_{ac}$

$= V_{CC}$

- R.M.S. Collector current is given as

$$I_{CE} = \frac{I_{C(max)} - I_{C(min)}}{2\sqrt{2}} = \frac{2I_C - 0}{2\sqrt{2}}$$

- The r.m.s. Power delivered to the load (Pac) is therefore given as

$$P_{ac} = V_{CE} \times I_{CE} = \frac{2V_{CC}}{2\sqrt{2}} \times \frac{2I_C}{2\sqrt{2}} = \frac{2V_{CC}\,2I_C}{8}$$

- The average power drawn from the supply (Pdc) is given by

$$P_{dc} = V_{CC} \times I_C$$

$\eta_{max} =$

- Efficiency of a Transformer-coupled Class A amplifier is given as

$$\eta_{(max)} = \frac{P_{ac}}{P_{dc}} = \frac{2V_{CC}\,2I_C}{8V_{CC}I_C} \times 100\%$$

- An output transformer improves the efficiency of the amplifier by matching the impedance of the load with that of the amplifiers output impedance.
- By using an output or signal transformer with a suitable turns ratio, class-A amplifier efficiencies reaching 50%.

Advantages

- Provides good DC isolation as there is no physical connection between amplifier output and load

Disadvantage - Additional cost and size of the audio transformer required.

Class A	Class B	Class C
In this P.A the operating point of RJT is at centre of load line.	In this P.A operating point of BJT is in cut off region.	In this P.A the operating point of BJT is below the cut off region.
Under no signal condition TX is ON	Under no signal condition TX is OFF	Under no signal condition TX is OFF
Conduction angle $\theta = 0^\circ$ to 860°	Conduction angle $\theta = 0^\circ$ to 180°	Conduction angle $\theta = 60^\circ$ to 20°
O/p signal is not distorted.	O/p is distorted i.e. o/p is just like rectified o/p.	O/p is distorted i.e. o/p current flows in the form of pulse.
$\eta = 50\%$	$\eta = 78.5\%$	$\eta \geq 95\%$

Comparison of the ideal inverting and non-inverting op-amp

Ideal Inverting amplifier	Ideal non-inverting amplifier
1. Voltage gain=$-R_f/R_1$	1. Voltage gain=$1+R_f/R_1$
2. The output is inverted with respect to input	2. No phase shift between input and output
3. The voltage gain can be adjusted as greater than, equal to or less than one	3. The voltage gain is always greater than one
4. The input impedance is R_1	4. The input impedance is very large

Amplifiers are used in **music equipment, electronic devices such as television and radio receivers, audio equipment, and computers** to increase the amplitude of a signal.

- It is used to amplify the audio signals (speaker, VHF, PA system Ship horn)
- It is used as a voltage and current regulator
- It is used as an analogue to digital converter & vice versa
- It is used as a servo amplifier in motor
- The output signal from the amplifier is supplied to a relay in a circuit
- It is used in Gyrocompass
- It is used in the Engine room, deck and other alarms
- It is used in various Sensors
- It is used in electrical protection systems

Application of Oscillators

- Oscillators are used to generate signals, e.g.
  - Used as a local oscillator to transform the RF signals to IF signals in a receiver;
  - Used to generate RF carrier in a transmitter
  - Used to generate clocks in digital systems;
  - Used as sweep circuits in TV sets and CRO.