Large Signal Amplifiers

Introduction:-

Handling the large signals is called large signal amplifier or power Amplifier.

Voltage amplifiers or small signal amplifiers will amplify the signal up to certain level. Almost all electronic circuits require large signal amplifiers that can be done by power ampliers.

Power Amplier converts DC power to AC power whose action is controlled by AC input signal.

Some Applications of Power Ampliers are Public Addres system, radio receivers, driving servo-motor in industrial control systems, tape players, TV receivers, CRT etc...

Features of Power Amplifiers:-

→ Input signal level or amplitude of a power amp is large of the order of few volts.

→ The output of power amplifier has large current and voltage swings. As it handles large signals called power amplifiers.

→ The h-parameter analysis is applicable to small signal amplifiers and hence cannot be used for analysis of power amplifiers. The analysis of power amplifiers is carried out graphically by drawing a load line on the O/P characteristics of transistor used in it

→ A voltage amp provide voltage amplification to increase the voltage of i/p signal. Power amp primarily provide sufficient power to o/p load to drive other power devices (speaker).

→ The main feature of power amp are circuit's power effic... the max amount of power that the circuit is capable of and the impedance matching to the O/P device.

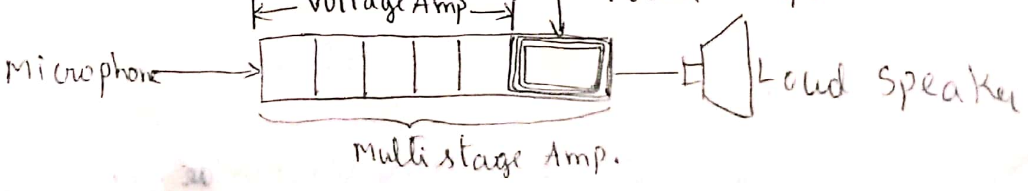
→ The power amplifiers must have low O/P ...
Hence CC or emitter follower circuit is very ... in power ampliers. The CE circuit with a s... down transformer for impedance matching is also commonly used in power amplifiers.

→ The transistors used in the power amplifiers are of large size, having large power dissipation rating, called power transistors.

→ Power Transistors having a heat sinks. A heat sink is a metal cap having bigger surface are press fit on the body of a transistor, to get mo... surface area, in order to dissipate the heat to the surroundings. In general, the power amplifi... have bulky components.

→ A faithful reproduction of the signal is very important. Due to non linear nature of the transistor characteristics, there exists a harmonic distortion in the signal. Hence the analysis of signal distortion in case of the power amplifiers is important.

→ Many audio circuits to supply large power to the loud speakers. Hence power amplifiers are also called audio amplifiers or audio frequency (AF) power ampliers.



Comparison of Small signal and Large signal Amplifier

Small signal	Large signal
(1) voltage is amplified.	1. Power or current is amplified.
(2) h-parameter analysis is used.	2. Graphical analysis is used.
(3) Harmonics are not present for sinusoidal signals.	3. Harmonics are present and must be considered while designing the amplifier.
(4) Normal transistors are sufficient.	(4) Power transistors are required
(5) The heat sinks are not required as heat dissipation is not the problem.	(5) The heat sinks are essential so as to dissipate large heat produced.
(6) The size is small.	(6) Due to large size transistors and transformers the overall size is large and bulky.
(7) Distortion is not present.	(7) Due to harmonics, signal likely to be distorted.
(8) The power handling capacity is small.	(8) The power handling capacity is large.
(9) The O/P current and voltage swings are small.	(9) There are large O/P current and voltage swings.
(10) The Q-point is always on the linear portion of transfer char.	(10) The Q-point can be anywhere on the transfer char including nonlinear region
(11) collector resistance is Maximum.	(11) collector resistance R_c is minimum.
(12) Base Region is thin.	(12) Base region is thick

Ex:- Small signal Transistor:- BC107, BC108, BC157(P) etc..

Ex:- Power Transistors: 2N3055, 2N6078, 2N3904

BD136

Types of power Amplifiers:-

Based on ① Audio frequency power amplifier

② Radio " " "

③ conduction angle and selection of O.P

25% & 50% (i) Class - A (360°) O/P → (middle) (on x-axis)

78.5% (ii) class - B (180°) → (above on x-axis)

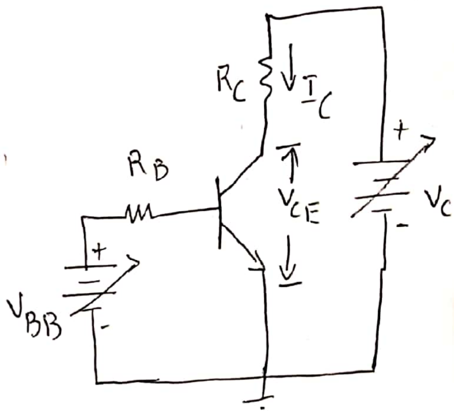
5% or 50% to 78.5% (iii) Class - AB (180° to 360°)

(iv) Class - C (< 180°) — Tuned ~~Amplit~~ (below on x-axis)

90% (v) class - D } Switched type

(vi) class - S

DC Load Line Analysis:-



Apply KVL on O/P side

$V_{CC} - I_C R_C - V_{CE} = 0$

$V_{CC} = I_C R_C + V_{CE}$

where RC = Load resistance

$\therefore I_C R_C = V_{CC} - V_{CE}$

$I_C = \frac{V_{CC}}{R_C} - \frac{V_{CE}}{R_C} = \left[-\frac{1}{R_C}\right] V_{CE} + \frac{V_{CC}}{R_C}$ CE circuit

→ comparing this equation with straight line equation,

$y = mx + c$ where m = slope

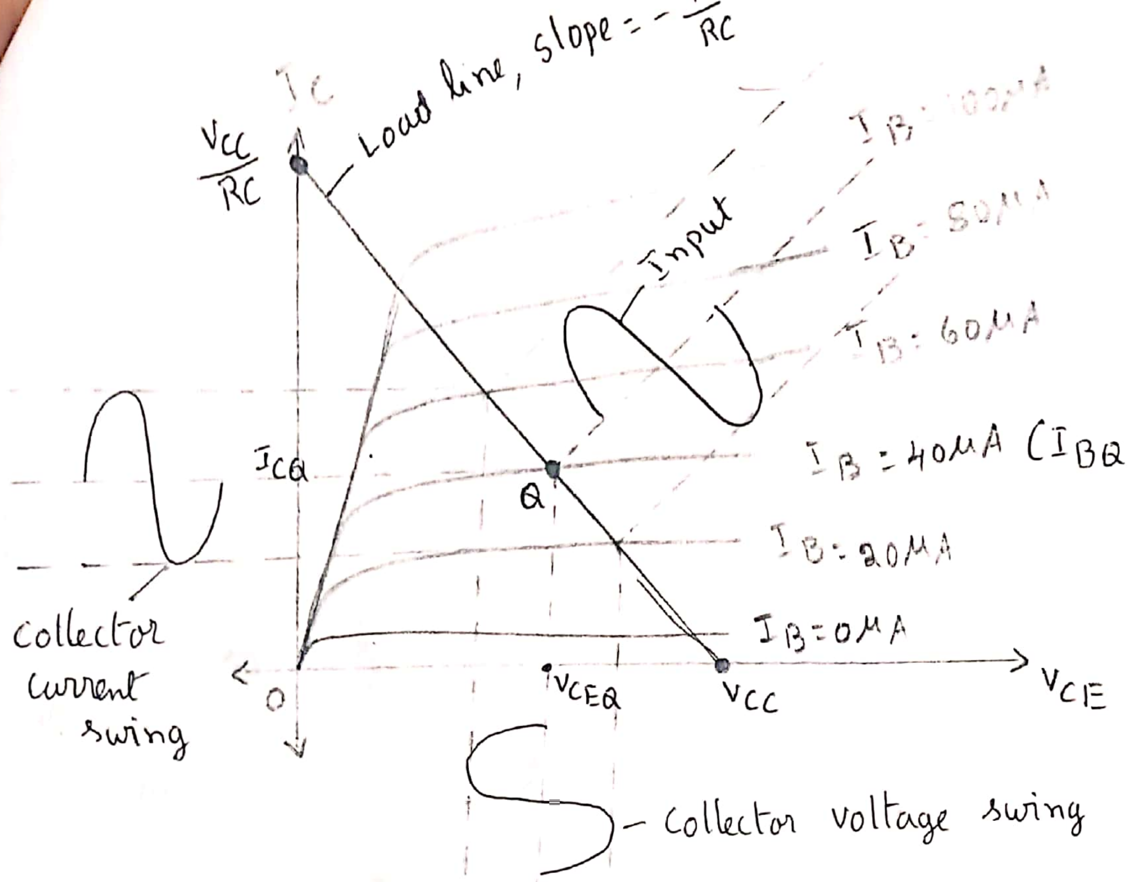
$\therefore$ slope is $-\frac{1}{R_C}$ and constant is $\frac{V_{CC}}{R_C}$.

The equation $I_C = -\frac{1}{R_C} V_{CE} + \frac{V_{CC}}{R_C}$

when $V_{CE} = V_{CC} \Rightarrow I_C = 0$

$V_{CE} = 0 \Rightarrow I_C = \frac{V_{CC}}{R_C}$

→ These two points can be located to draw a straight line on the O/P characteristics. Such a line having slope as reciprocal of the load resistance, drawn on the O/P char. is dc load line.



O/P characteristics with Load line and I_B, I_C and V_{CE} swi

→ The co-ordinates of the Q-Point are (V_{CEQ}, I_{CQ}), t corresponding value of the base current is denoted as I_B

→ The collector current varies above and below its quiescent value, in phase with the base current.

→ The collector to Emitter voltage varies above and below its Q-value, 180° out of phase with base current.

Class - A Power Amplifier:-

It is a power amplifier, in which the operating point (or) Q-Point and amplitude of the i/p signal are selected in a ways such that, the O/P ~~signal is obtained~~ current flows for the complete cycle of the ~~full~~ (360°) i/p cycle.

In this for all values of i/p signal, the transistor remains in the active region and never enters into cut off or saturation region.

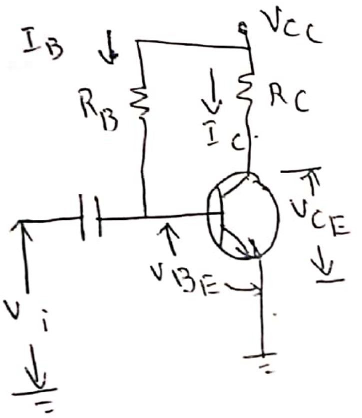
When AC i/p signal is applied, the collector voltage and collector current varies sinusoidally.

The collector current flows for (360°) full cycle of i/
In this, full i/p cycle, a full O/P cycle is obtai
Hence signal is faithfully reproduced, at the O/P,
without any distortion. This is an important featur
of a class A operation. The efficiency of class A
operation is very small.

There are two types of class-A Power Amp.

① Series fed / Directly coupled class-A Power Amplifier
② Transformer coupled class-A Power Amplifier.

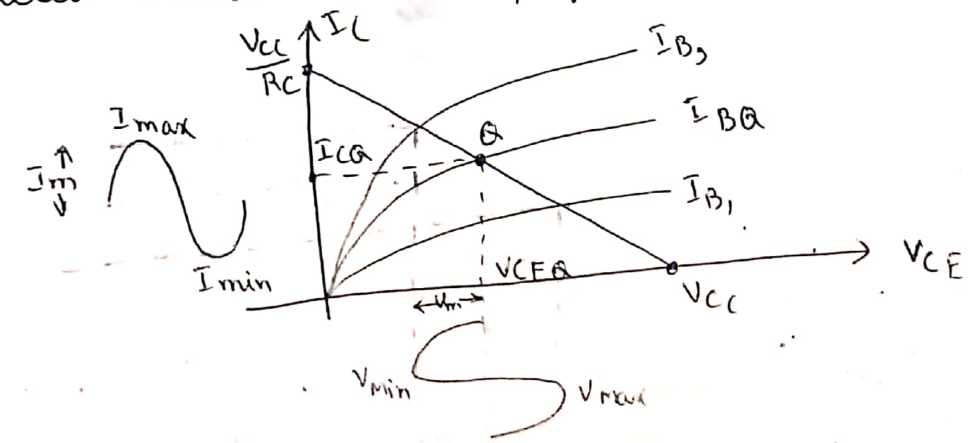
① Series Fed Class - A Power Amplifier:-



A simple fixed bias circuit can be used as a large signal class-Power amp. It is similar to fixed bias configuration, but only the difference is in class - A, we use power transistor.

Large Signal Class-A amp.

In this circuit collector resistance or load resist is connected in series with the load or O/P, hence it is called Series Fed amplifier.



Analysis:-

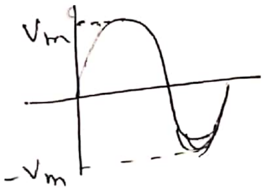
Efficiency is defined as ratio of output power delivered or transferred to load from the dc input power.
It is also called conversion efficiency.

$$\eta = \frac{P_{ac}\,(o/p)}{P_{dc}\,(i/p)}$$

$$P_{DC} = V_{dc}\cdot I_{dc} = V_{CC}\cdot I_{CQ}$$

Using peak or max values:-

$$P_{ac} = V_{rms}\cdot I_{rms} = \frac{V_m}{\sqrt{2}} \times \frac{I_m}{\sqrt{2}} = \frac{V_m I_m}{2}$$



$$V_{pp} = V_{max} - V_{min} = V_m - (-V_m) = 2V_m$$

$$V_m = \frac{V_{pp}}{2} = \frac{V_{max} - V_{min}}{2}$$

$$I_m = \frac{I_{pp}}{2} = \frac{I_{max} - I_{min}}{2}$$

Using rms values:-

$$P_{ac} = V_{rms}\cdot I_{rms} = I_{rms}^2 R_L = V_{rms}^2/R_L$$

Using peak to peak values

$$P_{ac} = \frac{V_m I_m}{2} = \frac{\frac{V_{pp}}{2}\times\frac{I_{pp}}{2}}{2}$$

$$P_{ac} = \frac{V_{pp} I_{pp}}{8} = \frac{I_{pp} R_L I_{pp}}{8} = \frac{I_{pp}^2 R_L}{8}$$

$$\boxed{P_{ac} = \frac{V_{pp}^2}{8R_L}}$$

$$I = \frac{V}{R}$$

$$\frac{IR}{8} = \frac{V\cdot I}{R\,8} = \frac{V\cdot I}{R_1} = \frac{V}{8}$$

Max voltage is possible is V_{CC}, and current is $2I_{CQ}$ for max. swing

$$\therefore P_{ac} = \frac{(V_{max} - V_{min})(I_{max} - I_{min})}{8}$$

$$\therefore \eta = \frac{P_{ac}}{P_{DC}} = \frac{(V_{max} - V_{min})(I_{max} - I_{min})}{8} \times \frac{1}{V_{CC}\cdot I_{CQ}}$$

$$= \frac{(V_{CC} - 0)(2I_{CQ} - 0)}{8 \times V_{CC} \times I_{CQ}} = \frac{2V_{CC}I_{CQ}}{8V_{CC}I_{CQ}} = \frac{1}{4} = 0.25$$

$\therefore \% \eta = 25\%$

→ This maximum efficiency is an ideal value. For a practical circuit, it is much less than 25% of the order of 10 to 15%.

→ Very low efficiency is the biggest disadvantage of class A amplifier

The ac power delivered by the amplifier to load can be expressed by using rms value, max or peak values and peak to peak values.

Note:- In class - A series fed power amplifier ... of DC power is converted to ac power. ... 75% is wasted.

Power Dissipation:-

The amount of power that must be dissipated by the transistor is the difference between the dc power input P_{dc} and the AC power delivered to the load P_{ac}

Power Dissipation $P_d = P_{DC} - P_{ac}$

→ The maximum power dissipation occurs when there is zero ac i/p signal.

→ When ac i/p is zero, ac o/p is also zero. But transistor operates at a point condition, drawing dc i/p power from the supply equal to $V_{CC} I_{CQ}$. This entire power gets dissipated in the form of heat.

→ Thus dc power i/p without ac i/p signal is the maximum power dissipation.

$$\therefore P_{d(max)} = V_{CC} I_{CQ}$$

i/p power $P_{ac} \to$ o/p

$P_{DC} = \eta +$ losses (dissi...

$= 25\% + 75\%$

$P_{DC} = P_{ac} + P_D$

$P_D = P_{DC} - P_{ac}$

Advantages:-

→ The circuit is simple to design and to implement.

→ The load is connected directly in the collector hence the o/p transformer is not necessary. This makes the circuit cheaper.

→ Less no. of components required as load is directly ~~conne~~ coupled.

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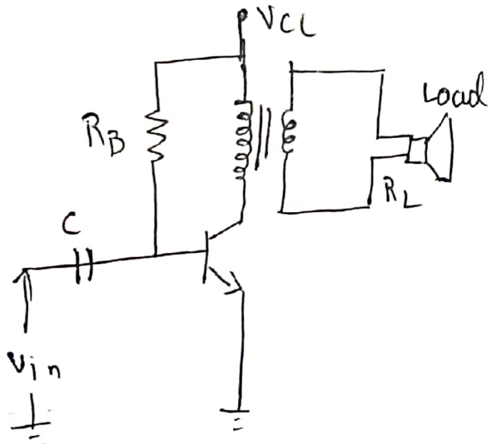
Disadvantages:-

→ More wastage of Power.
→ Power dissipation is more. Hence heat sink are esssential
→ The efficiency is very Poor, due to large power dissipation

② Transformer coupled class A Amplifier:-

For maximum power transfer to the load, the impedance matching is necessary. For load like loud speaker having low impedance values and series fed/ direct coupled class A Amplifier is very high. Hence impedance mismatch due to this efficiency is reduced This problem can be eliminated by using transformer coupled class-A Amplifier.



Transformer coupled Class-A Amp.

→ The circuit shows the transformed coupled class-A power Amplifier. which is used to increase the effici... of a clas-A Amplifier.

→ Assume the winding resistances are zero ohms. hence DC resistance $R_{dc}=0$

→ The sloap of the dc load line is $-\frac{1}{R_{dc}}$

$\therefore -\frac{1}{R_{dc}} = -\frac{1}{0} = \infty$ This tells that the dc load line in ideal condition is vertically straight line.

Apply KVL on O/P, $V_{CC} - V_{CE} = 0$ $[\because R_{dc}=0]$

$V_{CC} = V_{CE}$

$\therefore V_{CC} = V_{CEQ}$ This is DC bias voltage.

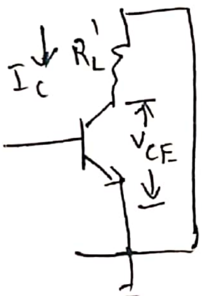
→ Hence DC load line is vertical straight line through a voltage on x-axis which is $V_{CEQ} = V_{CC}$.

→ The intersection of dc load line and base current set by the Q-point of circuit. The corresponding collector current is I_{CQ}.

→ The dc power i/p is provided by the supply voltage with no signal i/p, the dc current drawn is the collector bias current I_{CQ}.

$$\therefore P_{DC} = V_{DC} I_{DC} = V_{CC} I_{CQ}.$$

AC load line



$R_L' = R_L || R_C$

$I_C R_L' + V_{CE} = 0$

$$I_C = \frac{-V_{CE}}{R_L'} = -\frac{1}{R_L'} V_{CE} + c$$

$V_{CC} = I_C R_E + V_{CE}$

$I_C =$

$y =$

Generally A_C value = Total value − DC value.

$$= I_C - I_{CQ}$$

$$= -\frac{1}{R_L'} V_{CE} - I_{CQ}$$

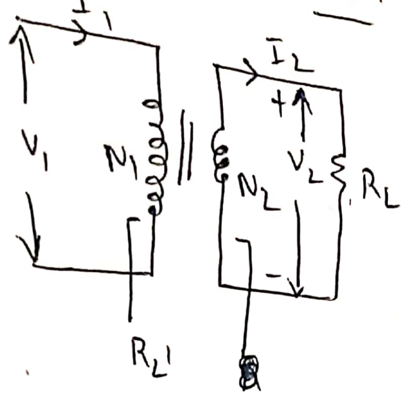
$$\therefore \left[I_C - I_{CQ}\right] = -\frac{1}{R_L'}\left[V_{CE} - V_{CEQ}\right]$$

$$y - y_1 = m(x - x_1)$$ — straight line eq.

→ In transformer, secondary has load impedance R_L and reflected load on the primary is R_L'

→ The load line drawn with a sloap of $\left(-\frac{1}{R_L'}\right)$ and passing through the operating point Q is called ac load line.

Transformer with load



→ Impedance of the load on secondary is R_L.

→ Primary and secondary winding resistances are assumed to be zero

→ This load impedance R_L, gets reflected on the primary side and it behaves as if connected in the primary side.

→ Such impedance transferred from secondary to primary is denoted as R_L' (reflected impedance)

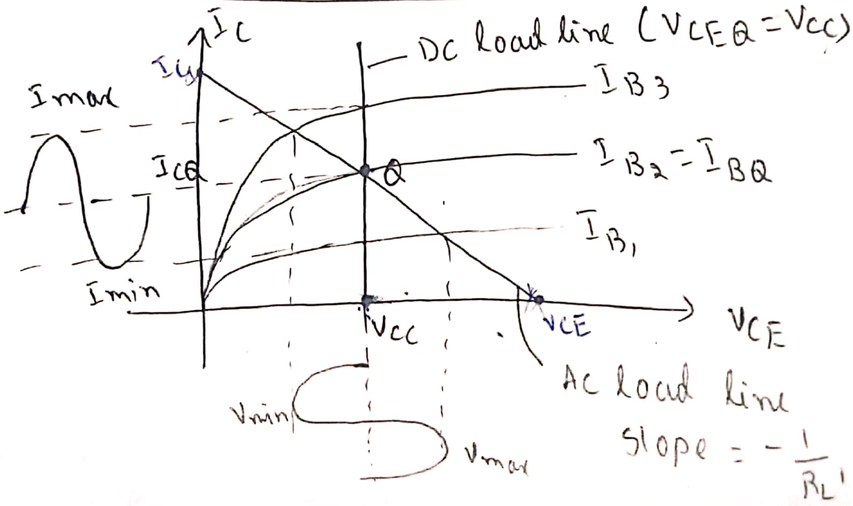
$$\therefore R_L = \frac{V_2}{I_2} \quad \text{and} \quad R_L' = \frac{V_1}{I_1}$$

But
$$\frac{V_1}{V_2} = \frac{N_1}{N_2} \qquad \frac{I_1}{I_2} = \frac{N_2}{N_1} \qquad \left[\because N = \frac{N_2}{N_1}\right]$$

$$\therefore V_1 = \frac{N_1}{N_2} V_2 \qquad I_1 = \frac{N_2}{N_1} I_2$$

$$\therefore R_L' = \frac{N_1}{N_2} V_2 \Big/ \frac{N_2}{N_1} I_2 = \left[\frac{N_1}{N_2}\right]^2 \times \frac{V_2}{I_2} = \left[\frac{N_1}{N_2}\right]^2 R_L = \frac{R_L}{N^2}$$

$$\boxed{\therefore R_L' = \frac{R_L}{N^2} = \left[\frac{N_1}{N_2}\right]^2 R_L}$$



$$I_C = I_{CQ} + \frac{V_{CEQ}}{R_{ac}}$$

$$V_{CE} = V_{CEQ} + I_{CQ} R_{ac}$$

$$R_{ac} = R_L'' \parallel R_C$$

AC output power (P_{ac}) :-

-> The ac power developed is on the primary side ac power delivered to the load is on the secondary side of transformer.

-> while calculating primary side power, we have consider primary values of voltage, current and reflected load R_L'. such as V_{1m}, I_{1m}, V_{1rms}, I

$$\therefore P_{ac} = \frac{V_{1m}}{\sqrt{2}} \cdot \frac{I_{1m}}{\sqrt{2}} = \frac{V_{1m} I_{1m}}{2}$$

$$\therefore P_{ac} = \frac{I_{1m}^2 R_L'}{2} = \frac{V_{1m}^2}{2 R_L'}$$

-> while calculating secondary side power, we have to consider secondary values of voltage, current and load R_L. such as V_{2m}, I_{2m}, V_{2rms}, I_{2rms} e

$$\therefore P_{ac} = V_{2rms} I_{2rms} = I_{2rms}^2 R_L = \frac{V_{2rms}^2}{R_L}$$

$$\text{or } P_{ac} = \frac{V_{2m} I_{2m}}{2} = \frac{I_{2m}^2 R_L}{2} = \frac{V_{2m}^2}{2 R_L}$$

-> Power delivered on primary is same as power delivered to load on secondary assuming Ideal Transformer

-> In practical circuit, the power delivered to the load on secondary is slightly less than power developed on the primary. In such case, the transformer efficiency must be considered for calculating various parameters on the primary and secondary sides of the transformer.

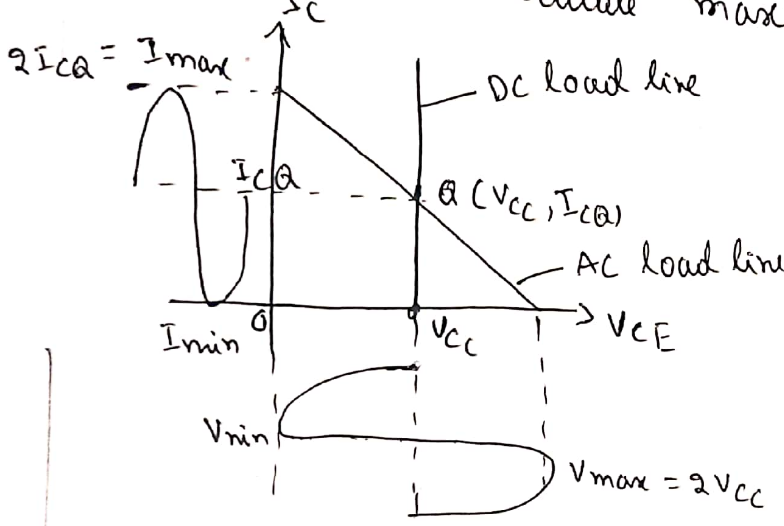
General expression for Efficiency

$P_{ac} = \frac{(V_{max} - V_{min})(I_{max} - I_{min})}{8}$

$$\% \eta = \frac{P_{ac}}{P_{dc}} \times 100$$

$$= \frac{(V_{max} - V_{min})(I_{max} - I_{min})}{8 V_{CC} I_{CQ}} \times 100.$$

Assume maximum swings on both the o/p voltage and o/p current to calculate maximum efficiency,



$\therefore V_{min} = 0V$

$V_{max} = 2V_{CC}$

$I_{max} = 2 I_{CQ}$

$I_{min} = 0$

$$\therefore \% \eta_{max} = \frac{(2\cancel{V_{CC}} - 0)(2\cancel{I_{CQ}} - 0)}{8 \cancel{V_{CC}} \cancel{I_{CQ}}} \times 100 = \frac{4}{8} \times 100 = 50\%$$

→ Hence maximum possible efficiency in case of transformer coupled class A amplifier is 50%.

→ For practical circuits it is about 30 to 35%

Power Dissipation:-

It is defined as the difference between ac power output and dc power input.

The power dissipated by the transformer is very small due to negligible dc winding resistances, so it can be neglected. $\therefore P_d = P_{DC} - P_{ac}$

-> when the i/p signal is large, more power delivered to the load and less is the power dissipation.

-> But, when there is no i/p signal, the entire dc power gets dissipated in the form of heat, wh is the maximum power dissipation.

$$\therefore P_{d\,max} = V_{cc} I_{CQ}.$$

-> Thus class A amplifier dissipates less power whe delivers maximum power to the load.

-> Hence the maximum power dissipation decides the ma power dissipation rating for the power transistor to be selected by an amplifier.

Advantages:-

-> The efficiency of the operation is higher than direct coupled amplifier.

-> The dc bias current that flows through th load in case of directly coupled amplifier is stopped.

-> It provides impedance matching.

Disadvantages:-

-> Due to the transformer, the circuit becomes bulkier, heavier and costlier.

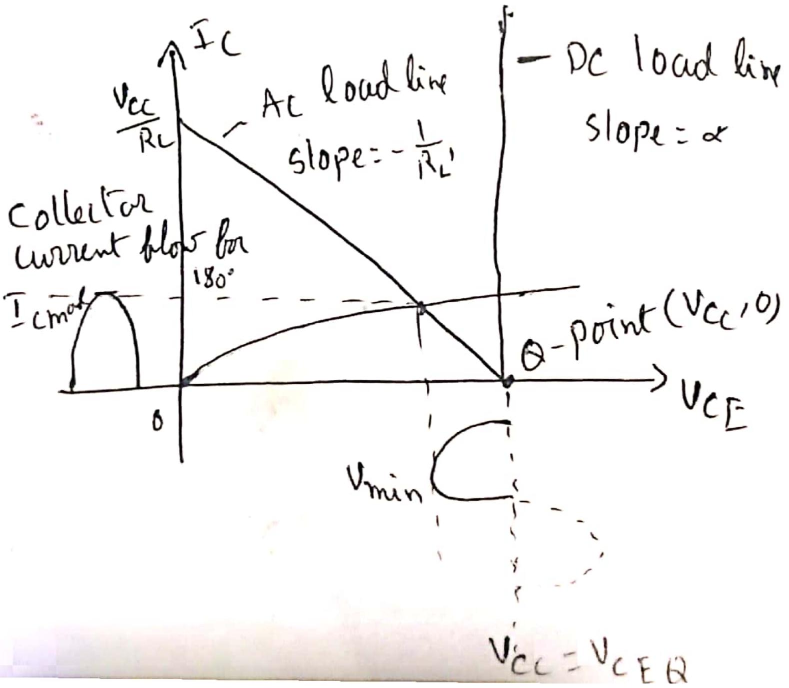
-> The circuit is complicated to design and implement

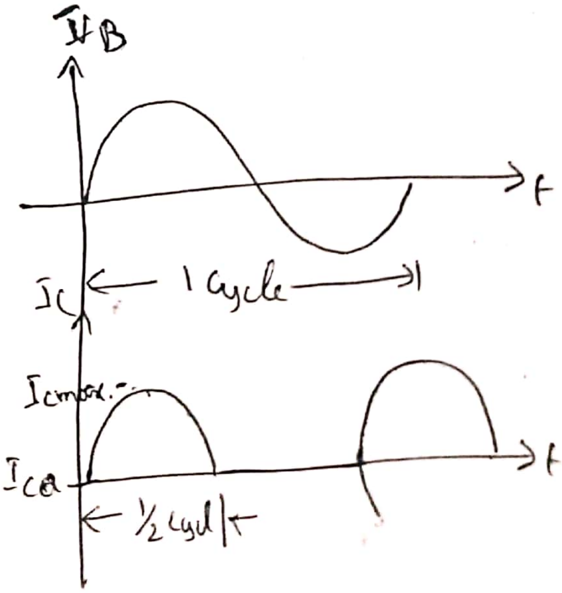
-> The frequency response of the circuit is poor.

Class B Power Amplifier:-

The Power Amplifier is said to be class B amp if the Q-point and the input signal are selected, such that the output signal is obtained only for one half cycle for a full input cycle.

Due to the selection of Q-point on the x-axis the transistor remains in the active region only for positive half cycle of the input signal. Hence this half cycle is reproduced at the output. But in the negative half cycle of the input signal, the transistor enters into a cut off region and no signal is produce at the output. The collector current flows only for half cycle (180°) of the input signal.





Due to this output signal is distorted. To get a full cycle across the load, a pair of transistors is used in class B operation.

The two transistors conduct in alternate half cycles of the i/p signal and a full cycle across the load is obtained. The two transistors are identical in characteristics are called matched transistors.

Depending upon the types of the two transistors whether PNP or NPN, class-B Power amplifiers are classified two types.

① Push Pull class-B Power Amplier:

When the both the transistors ~~are~~ of same ty i.e either NPN or PNP then the circuit is called Push Pull class B Power Amplifier.

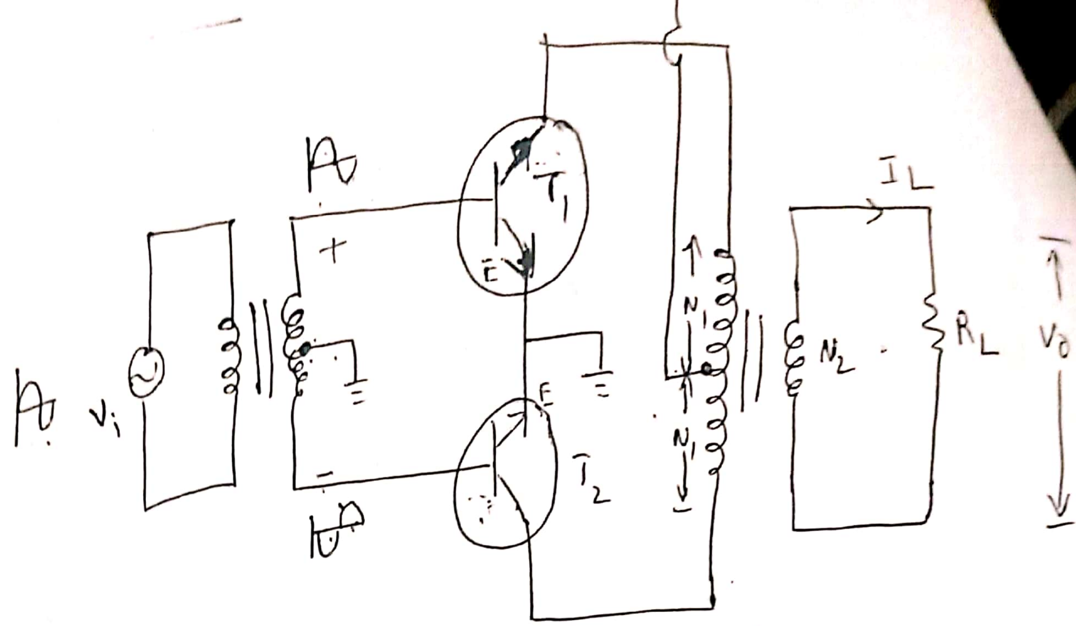
② Complementary Symmetry class B Power Amplifier:

When the two transistors form a complement pair i.e one NPN and other PNP then the circuit is called complementary symmetry class B Amplifier.

Push Pull class B Power Amplifier:-

The push pull circuit requires two same type of transistors and two transformers with center taped. In this circuit both the transistors are NPN type. Both the transistors are in CE configuration.

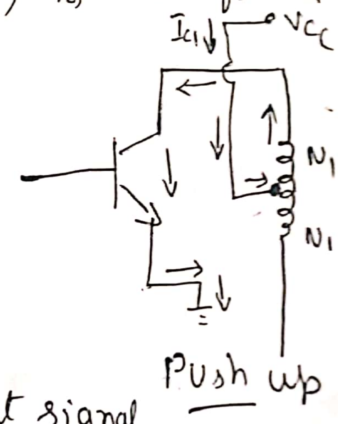
The i/p signal is applied to the primary of the driver transformer. The center tap on the secondary is grounded. The center tap on the primary of the o/p transformer is connected to the supply voltage +Vcc.



Push pull class B Amplifier

-> During the +ve half cycle of the i/p wave form given to primary side, Transformer secondary upper end made +ve with respect to lower end. So, transistor T_1 will get into ON position and T_2 will OFF position.

-> Hence i/p signal (+ve half cycle) is transformed to the load through transistor T_1.



Push up

-> During this case the current push up in the transistor T_1 like as shown in fig.

-> During -ve half cycle of the input signal, transformer secondary winding lower end is made +ve with respect to upper end. So transistor T_1 is OFF and T_2 will get into ON position. Then the i/p signal transfered to the load through the transistor T_2.

-> During this case the current pull down in the transistor T_2 as shown in fig.

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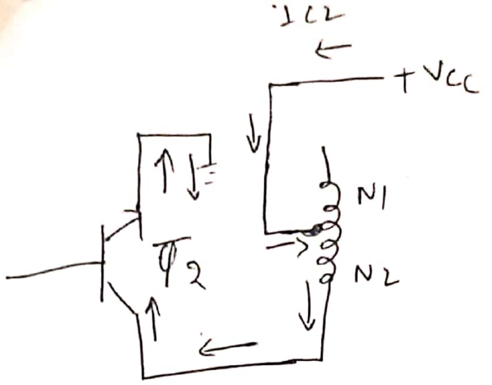
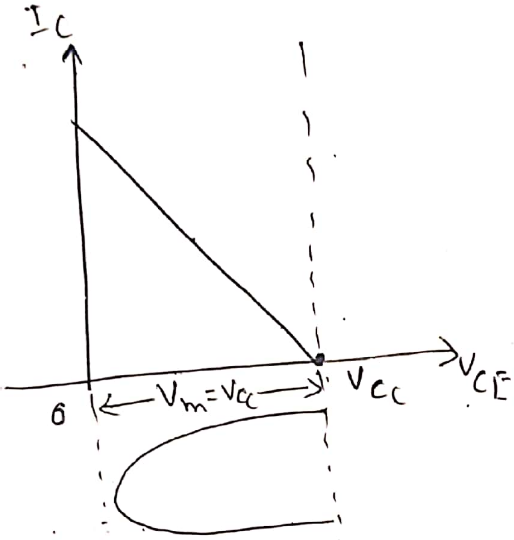
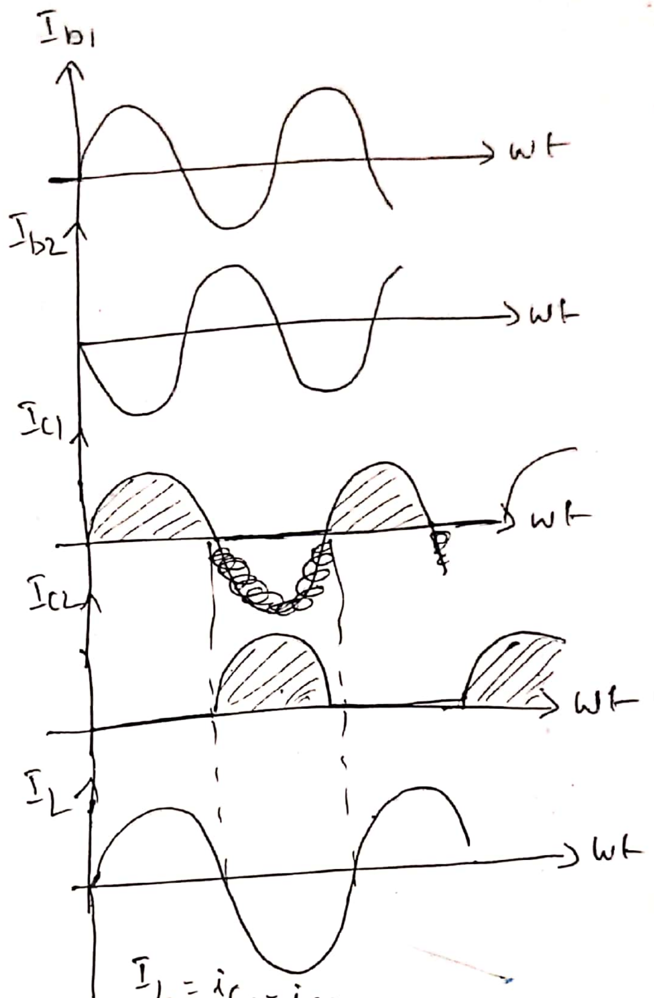


Pull Down



Maximum Possibility of O/P



$I_L = i_{c_1} - i_{c_2}$

Efficiency

→ The dc biasing point i.e Q point is adjusted on the X-axis such that $V_{CEQ} = V_{CC}$ and I_{CQ} is zero.

→ Hence co-ordinates of Q-point are $(V_{CC}, 0)$.

→ Each transistor O/P is in the form of half rectifier waveform. Hence if Im is the peak value of the output current of each transistor, the dc or average value is $\frac{I_m}{\pi}$ due to half rectified form.

→ The two currents, drawn by the two transistors, form the dc supply are in the same direction.

∴ Hence total dc value $I_{dc} = \frac{I_m}{\pi} + \frac{I_m}{\pi} = \frac{2I_m}{\pi}$

$\therefore$ Total dc power input $P_{dc} = V_{dc} I_{dc}$

$$\boxed{P_{DC} = V_{CC} \frac{2 I_m}{\pi}}$$

AC power output $P_{ac} = V_{rms} I_{rm}$

$$= I_{rm}^2 R_L = \frac{V_{rms}^2}{R_L}$$

Using peak values, $P_{ac} = \frac{V_m I_m}{2} = \frac{I_m^2 R_L}{2} = \frac{V_m^2}{2 R_L}$

Efficiency $\eta = \frac{P_{ac}}{P_{dc}} \times 100\%$

$$\% \eta = \frac{\frac{V_m I_m}{2}}{V_{CC} \cdot \frac{2 I_m}{\pi}} = \frac{\pi}{4} \cdot \frac{V_m}{V_{CC}} \times 100.$$

$\boxed{V_m = V_{CC} \text{ for max}}$

Maximum efficiency is $\% \eta_{max} = \frac{\pi}{4} \cdot \frac{V_{CC}}{V_{CC}} \times 100 = 78.5\%$

→ Thus the maximum possible theoretical efficiency in case of push pull class B amplifier is 78.5%. which is much higher than the transformer coupled class-A amplifier. For practical circuits it is upto 65 to 70%..

Power Dissipation:-

$$P_D = P_{DC} - P_{ac} = \frac{2}{\pi} V_{CC} I_m - \frac{V_m I_m}{2} = \frac{2}{\pi} V_{CC} \frac{V_m}{R_L'} - \frac{V_m^2}{2 R_L'}$$

→ In class-A amplifier power dissipation is maximum when no input signal is there. But in class B opr: when the i/p signal is zero, $V_m = 0$ hence the power dissipation is zero and not the maximum.

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Advantages :-

→ The efficiency is much higher than the class A operation

→ When there is no input signal, the power dissipal is zero.

→ Due to the transformer, impedance matching is possible

→ As the dc current components flow in opposite direction through the primary winding, there is no possibility of dc saturation of the core.

Disadvantages :-

→ Two center tap transformers are necessary.

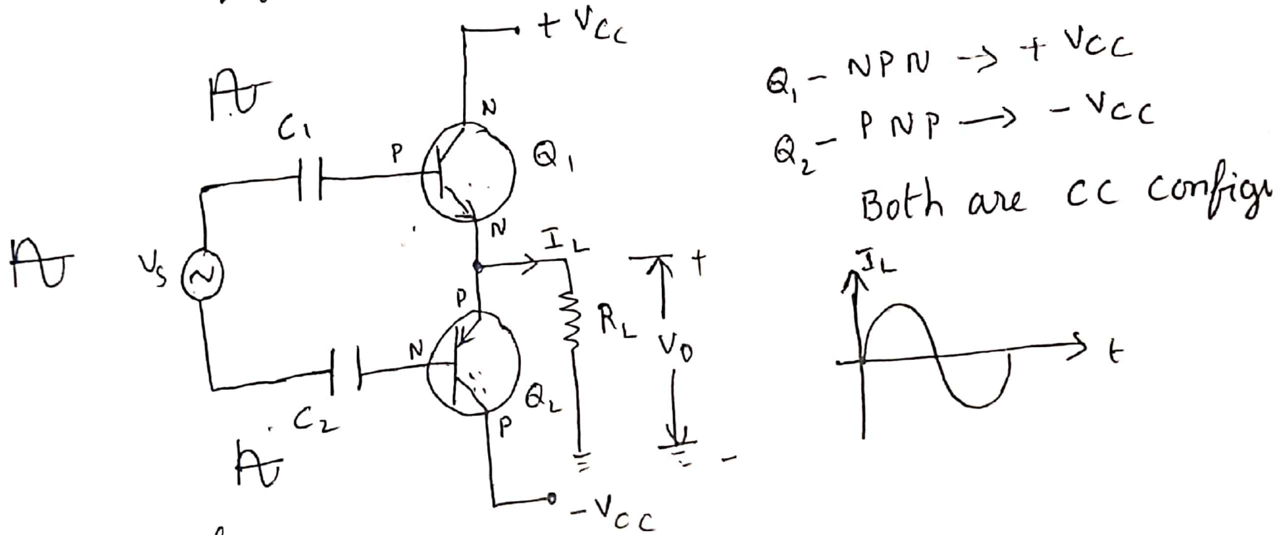
→ Hence circuit is bulky and costilier.

→ Frequency response is poor.

Complementary Symmetry class B Amplifier:-

Instead of using same type of transistors (... pnp), an npn and other PNP is used, the amplifier class B amplifier is called as complementary symmetry class B amplifier.

This circuit is transformer less circuit. But with CE configuration, it becomes difficult to match the O/P impedance for maximum power transfer without an O/P transformers. Hence the complementary transistors are used in CC configuration in this circuit.



Complementary Symmetry class-B Amplifier

→ During the +ve half cycle, the transistor Q_1 gets driven into active region and starts conducting. Q_2 is complementary type, remains in OFF condition. The results into +ve half cycle across the load R_L.

→ During the -ve half cycle, the transistor Q_2 is On condition and Q_1 is OFF condition. Hence the results into -ve cycle across the load R_L.

→ Thus for a complete cycle of i/p, a complete cycle of O/P signal is developed across the load as shown in above fig.

Advantages:-

→ As the circuit is transformerless, its weight, size and cost are less.

→ Due to CC configuration, impedance matching is possible.

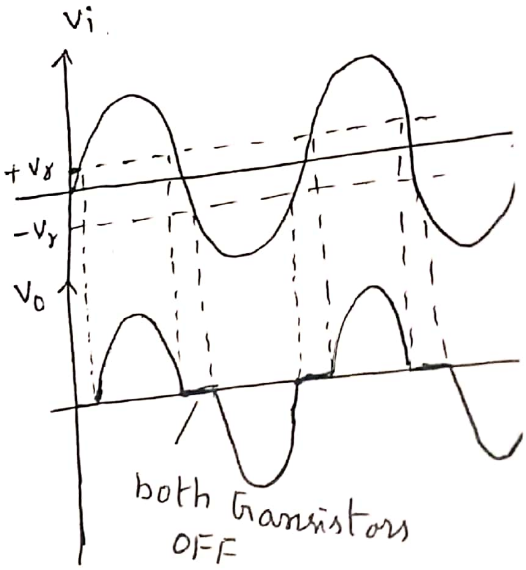
→ The frequency response improves due to transformerless class-B amplifier circuit.

Disadvantages:-

→ The circuit needs two seperate voltage supplies.

→ The o/p is distorted to cross-over distortion.

Cross-over Distortion:-



→ In class-B push pull and complementary symmetry power amplifier, None of the transistor will get into ON position during $(-V_\gamma$ to $+V_\gamma)$.

→ So distortion is introduced. Such a distortion in the o/p signal is called cross-over distortion.

→ Due to cross-over distortion each transistor conducts for less than a half cycle rather than the complete half cycle.

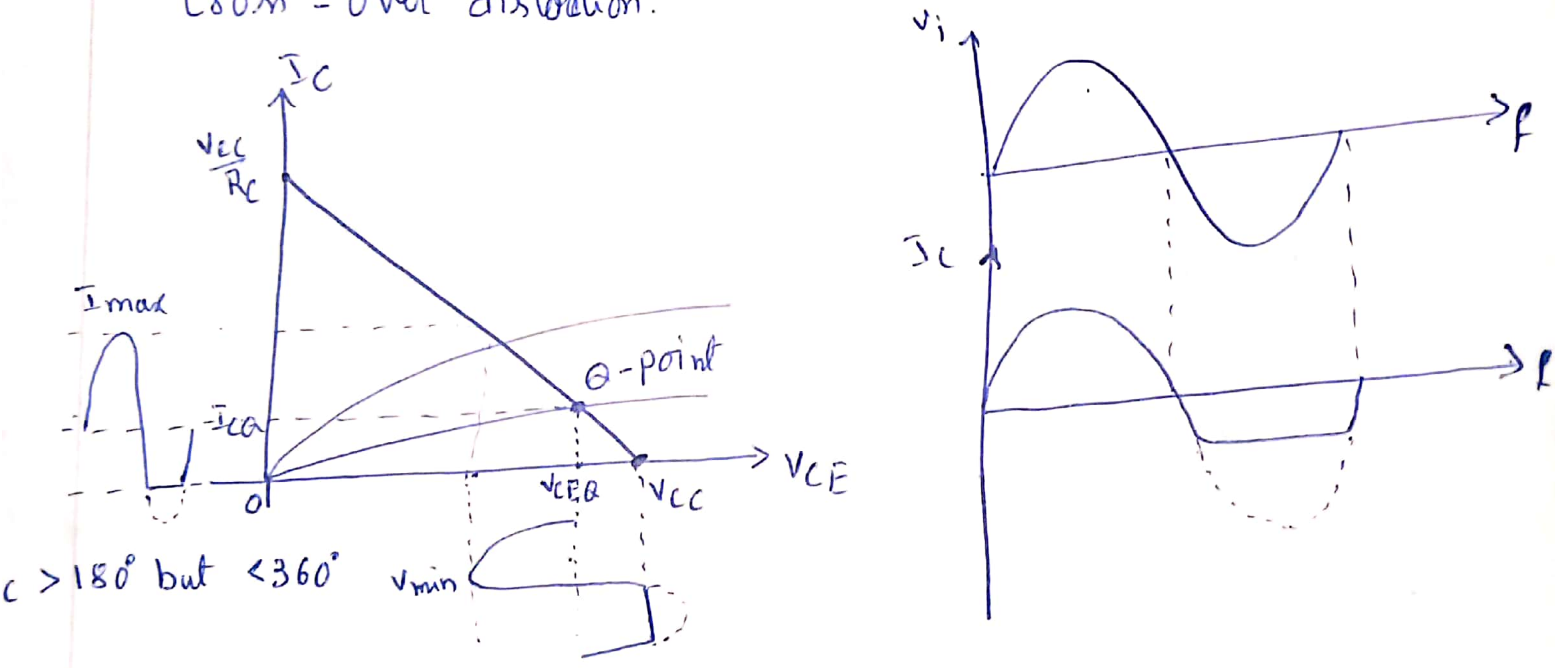
→ It can be elemenated by providing biasing resistance to class B power amplifier which is known as class AB power amplifier.

Class AB Amplifiers:-

The power amplifier is said to be class AB amplifier, if the Q point and the i/p signal are selected such that the o/p signal is obtained for more than 180° but less than 360°, for a full i/p cycle.

→ The Q-point position is above x-axis but below the midpoint of a load line.

→ The efficiency is more than class-A but less than class-B operation. The class-AB operation is important to eliminate cross-over distortion.

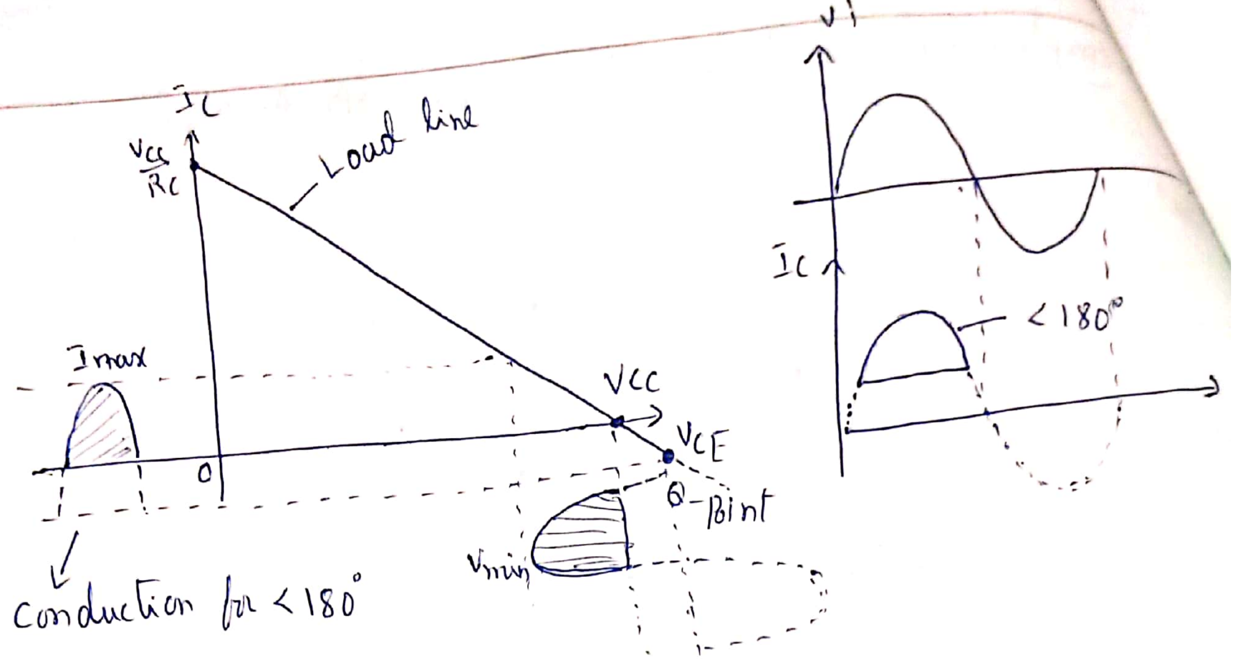


→ The basic reason for the cross over distortion is the cut in voltage of the transistor junction. To overcome this cut-in voltage, a small forward biased is applied to the transistors.

Class - C Amplifier :-

In which the Q-point and the i/p signal are selected such that the O/P signal is obtained for less than a half cycle, for a full i/p cycle.

→ The Q-point is to be shifted below X-axis.



→ In class-c, the transistor is biased well beyond cut-off. As the collector current flows for less than 180°, the o/p is much more distorted and hence the class-c mode is never used for A.F Power Amplifiers.

→ But the efficiency of this class-of operation is much higher and can reach very close to 100%.

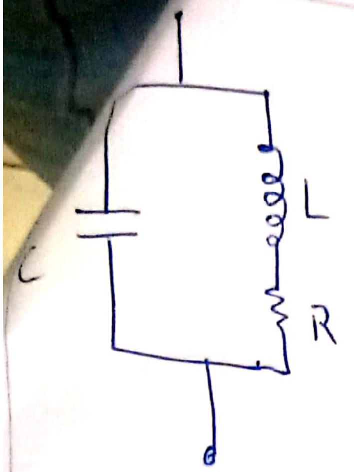
→ The class-c amplifiers are used in tuned circuits used in communication areas and in radio frequency (RF) circuits with tuned RLC loads.

→ As used in tuned circuits, class c amplifiers are called tuned amplifiers.

→ These are also used in mixer or converter circuits used in radio receivers and wireless communication systems.

→ The tuned circuits is capable of amplifing a signal over a narrow band of frequencies centered at fr.

→ The amplifiers with such a tuned circuit as a load are called as Tuned Amplifiers.



Tuned circuit

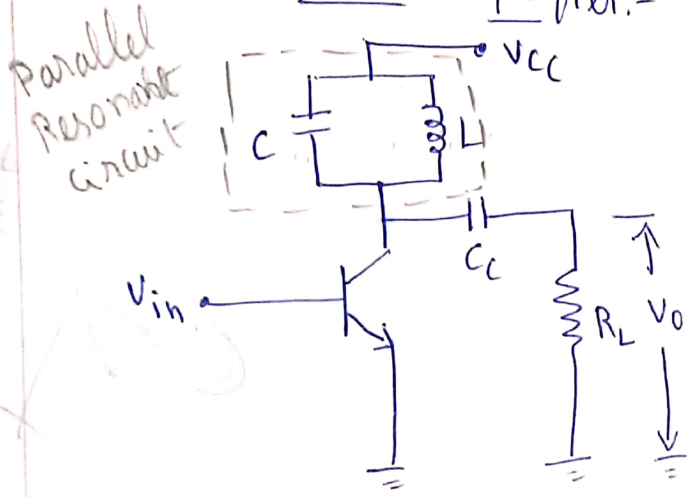
→ The fig shows the tuned parallel LC circuit which resonates at a particular frequency.

→ The resonance frequency $\boxed{f_r = \frac{1}{2\pi\sqrt{LC}}}$

→ Impedance of tuned circuit is

$$\boxed{Z = \frac{L}{CR}}$$

Class-C tuned Amplifier:-



→ The LC parallel circuit is a parallel resonant circuit. This circuit acts as a load impedance.

→ This is also called as Tank circuit.

→ Due to class-c operation, the collector current consists of series of pulses containing harmonics i.e many other freqn components along with fundamental freqn component of i/p.

→ The parallel tuned circuit is designed to be tuned to the fundamental i/p freqn. Hence it eliminates the harmonics and produce a sine wave of fundamental component of i/p signal.

→ As the transistor and coil losses are small, the most of the dc i/p power is converted to ac load power. Hence efficiency of class-c is very high.

Features:-

-> Q point well below cut-off

-> operated at High freq.

-> Conduction Angle is less than 180°

-> Efficiency is more than 90%

-> used as tuned amplifier (BW is low)

-> Heavy Distortions hence not suitable for Audio Am

-> Used in Resonance, provides continues supply and power due to fly-wheel effect.