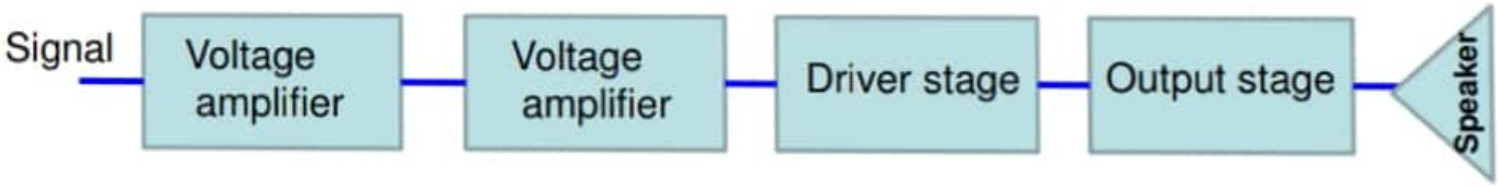
Power Amplifiers

- A Power amplifier is large signal amplifier and this is generally a last stage of a multistage amplifier.

- The function of a practical power amplifier is to amplify a weak signal until sufficient power is achieved to operate a loudspeaker or output device.

- Typical output power rating of a power amplifier will be 1W or higher. The schematic diagram of a practical power amplifier is shown below –



- The driver stage operates as a class A power amplifier and supplies the drive for the output stage.

- The last output stage is essentially a power amplifier and its purpose is to transfer maximum power to the output device (speaker). The output stage generally employ class B amplifiers in push-pull arrangement.

Power Amplifiers

- A large signal amplifier means much larger portion of load line is used during signal operation compared to small signal amplifier.

- A small signal amplifier (handle ac signal <10mV) operate over a linear portion of load line.

- In case of power amplifier, we can not use small signal approximation directly to calculate voltage gain, current gain and input/output impedance.

- Ideal power amplifier will deliver 100% of the power it draws from the supply to load. In practice, this can never occur.

- The reason for this is the fact that the components in the amplifier will all dissipate some of the power that is being drawn form the supply.

Performance parameters of power amplifier

Amplifier Efficiency : A **figure of merit** for the power amplifier is its efficiency

- **It is defined as a ratio of output ac power to the input dc power.**

$$\eta = \frac{ac \quad output \quad power}{dc \quad input \quad power} \times 100\% = \frac{P_o(ac)}{P_i(dc)} \times 100\%$$

Distortion

- **The change in output wave shape from the input wave shape of an amplifier is known as distortion.**

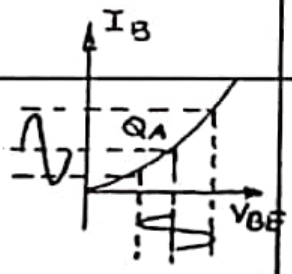
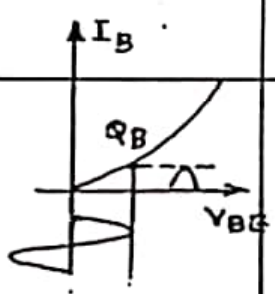
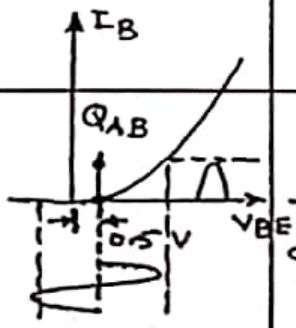
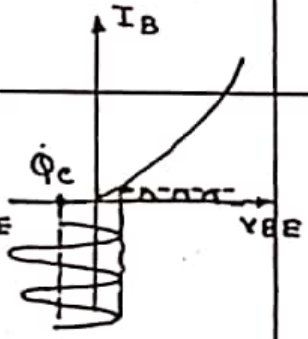
The distortion can be reduced using negative feedback in amplifier.

Power dissipation capability

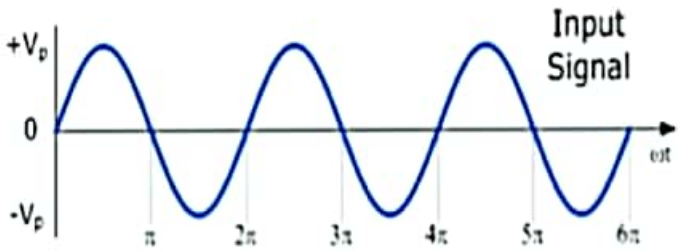
- **The ability of a power amplifier to dissipate heat is known as power dissipation capability.**

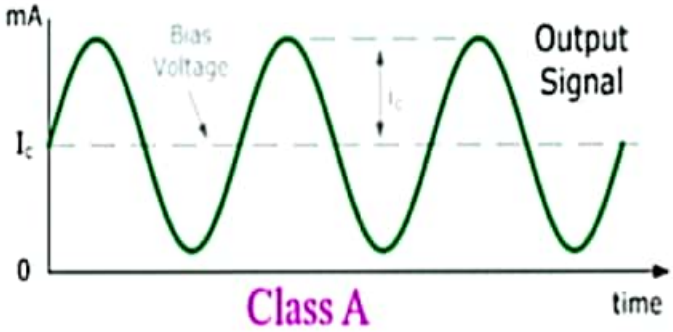
- To achieve better heat dissipation heat sink (metal case) is attached with power transistor. The increase surface area allows heat to escape easily.

COMPARISION BETWEEN DIFFERENT CLASS OF POWER AMPLIFIERS

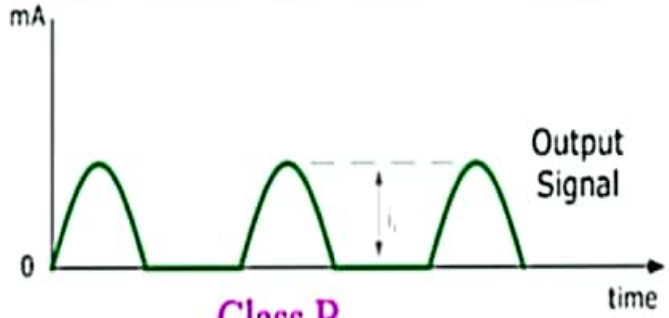
Parameter	CLASS A	CLASS B	CLASS AB	CLASS C
No. of Transistor used	Two	Two	Two	One + Tank circuit
Voltage of Base	+ve	Zero	0.5V (for Si Ter) = V_{BE}	–ve
Q-point				
Angle of conduction of Transistor	$\theta = 360°$	180° per Ter	180° per Ter	< 180°
Power η or conversion η or collector η	50% transformer coupled	78.5%	78.5%	Very high upto 95%
P_{Dmax}	$P_{Dmax} = 2\ P_{acmax}$	$P_{Dmax} = 0.2\ P_{acmax}$	$P_{Dmax} = 0.2\ P_{acmax}$	Very small

Classification of Power Amplifier



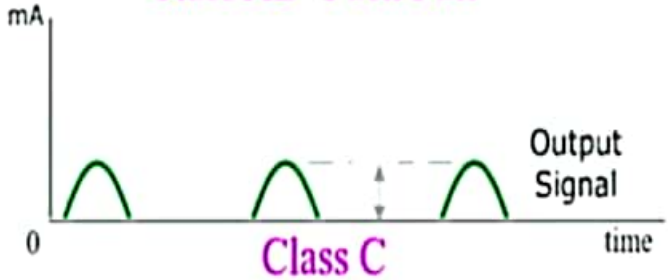


Class A



Class B

Class AB- Push Pull



Class C

Conduction Angle:

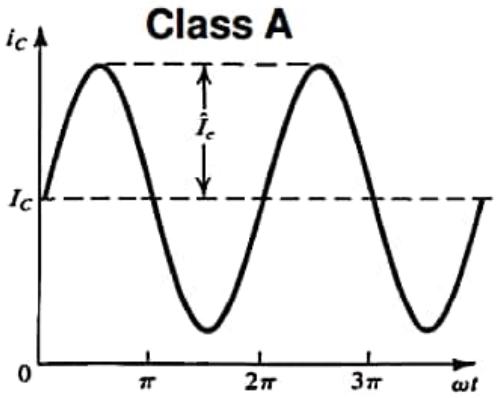
Class A > Class AB > Class B > Class C

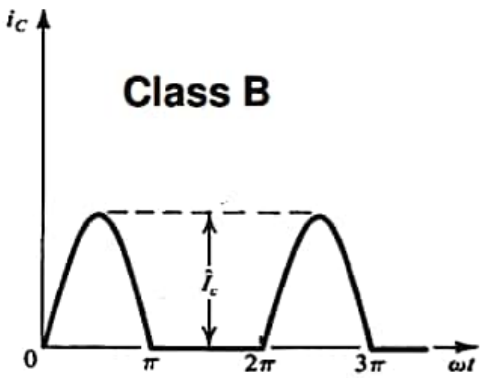
Efficiency:

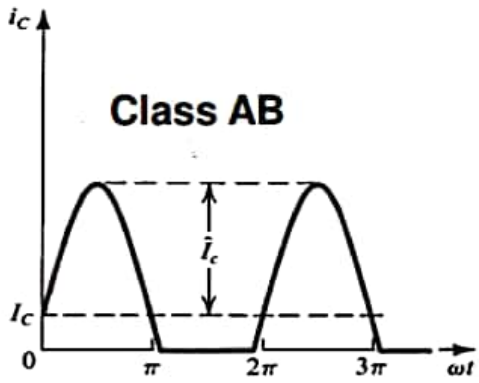
Class A < Class AB < Class B < Class C

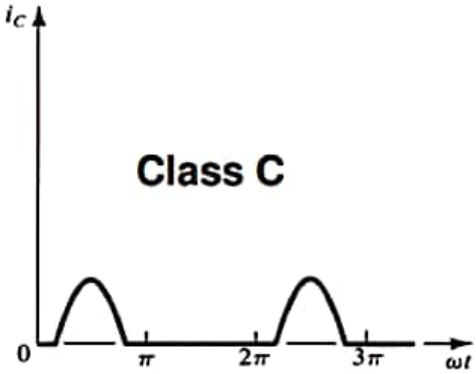
Output Stages: Power amplifier

➢ **Output stages are classified according to the collector current waveform that results when an input signal is applied.**









Amplifier	Maximum Efficiency, η_{max}
Class A	25%
Class B	78.5%
Class C	99%

Class A power amplifier :-

- It is one in which there is output for the entire input cycle period.
(ie the output signal varies for a full 360° of the input cycle)

- For this to happen, the transistor is required to be biased in the active region.

- Thus, all voltage amplifiers are biased in the active region.

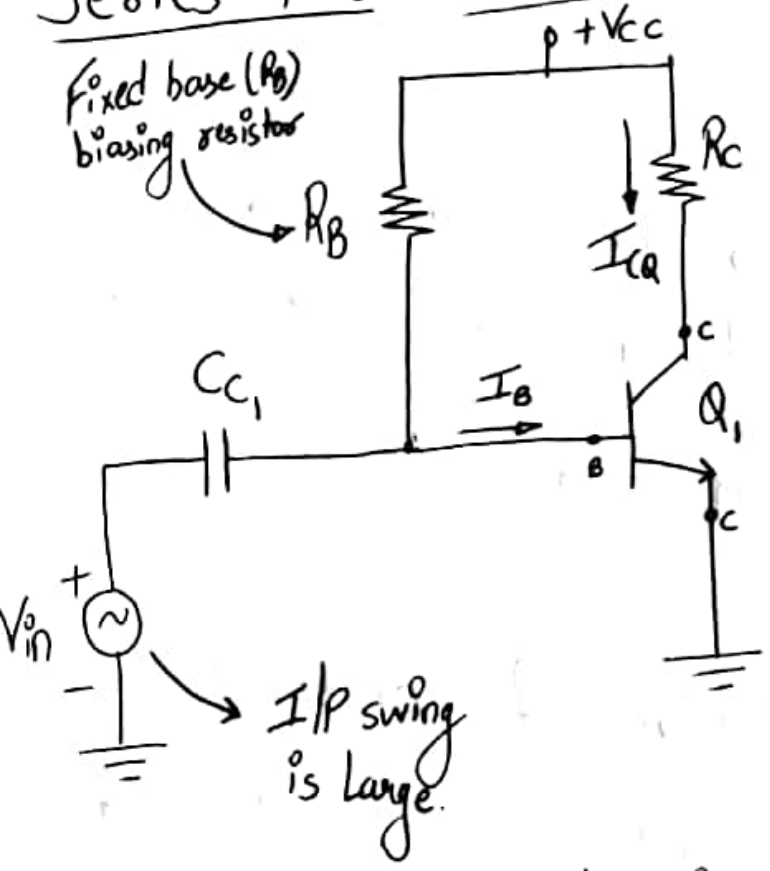
- The major limitation of class A operating is that even when there is no input, there is appreciable power dissipation ($P_D = V_{CE} I_C$) in the transistor.

- If a battery is used as a dc source for biasing the transistor, the life of the battery is reduced as there is drain on the battery even under quiescent (no-signal) condition.

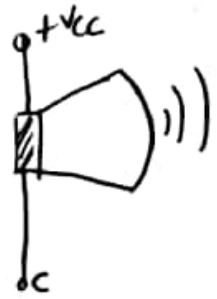
- Types of class A power amplifier :-

1. Series-Fed class A power amplifier.
2. Class A transformer-coupled power amplifier.

Series-Fed Class A power amplifier :-



or



O/p load speaker load (R_L) produces acoustic signals.

Q_1 → Power transistor

- The above circuit is called "series-fed" power amplifier because the load R_C or (R_L) is directly connected to the collector terminal.

- Since, Load (R_C or R_L) is directly coupled to collector it is known as "directly coupled Class A power amplifier."

To calculate the o/p voltage and hence the AC o/p power, we <u>cannot use</u> the small-signal model of the transistor.

- The method of analysis is, therefore, essentially <u>graphical method.</u>

→ The procedure to calculate the o/p power is to first plot the o/p characteristics of the given transistor :-

- Draw the DC Load Line and Locate the Q-point.
- Then, draw the AC Load Line, superimpose a suitable base current swing on the o/p curves, and find out the corresponding collector current swing and the permissible collector voltage swing.

→ Next, we calculate the AC output power.