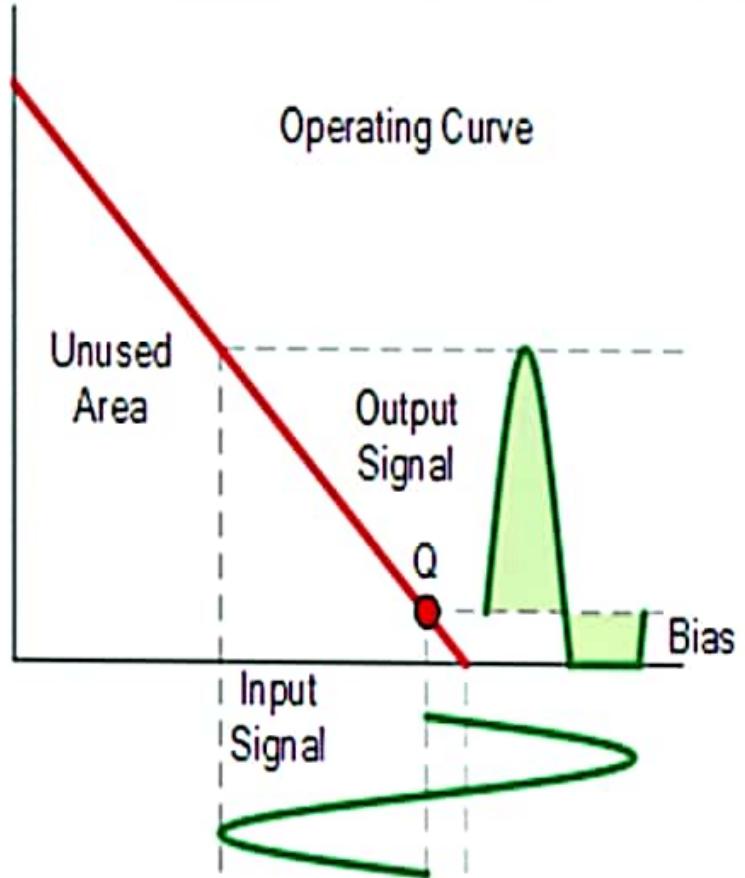
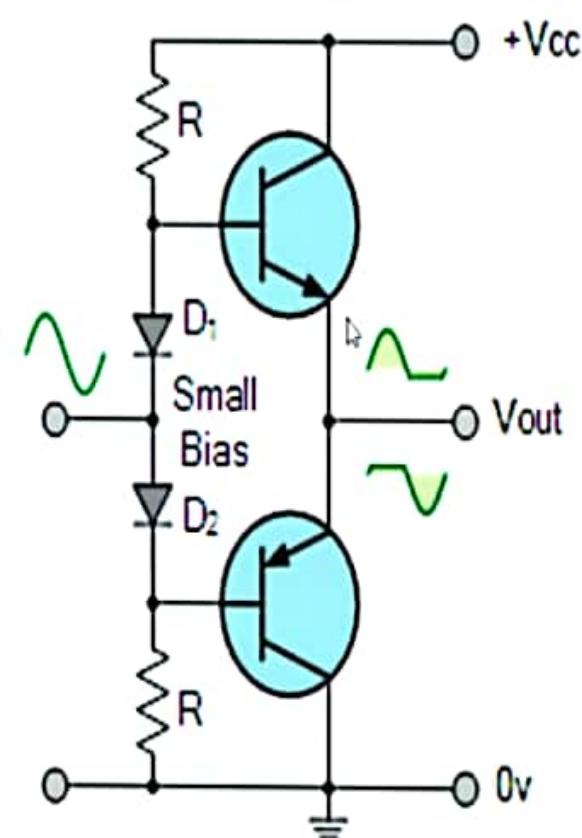


# Diode Biased Class AB – Push Pull PA



<https://www.electronics-tutorials.ws/amplifier/amplifier16.gif>

# \* BIASING OF CLASS AB POWER AMPLIFIERS

Drawback of conventional biasing (Use of  $V_{BB/2}$ )

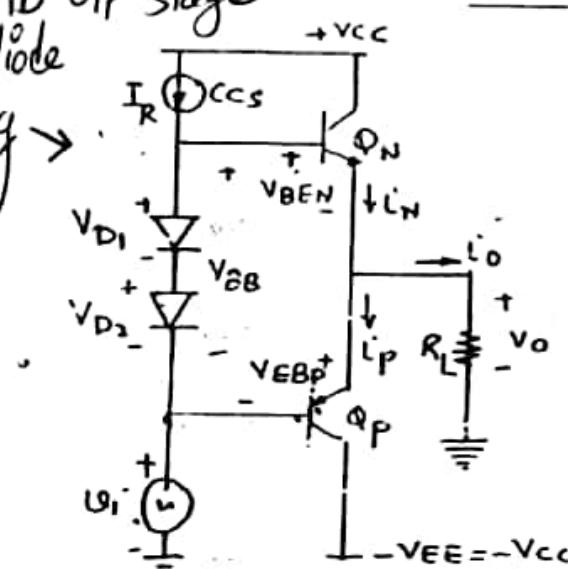
As temp increases  $V_{BE}$  of  $Q_N$  and  $Q_P$  decreases by  $2.5mV/^\circ C$ . With  $V_{BB}$  (or  $V_{BE}$ ) constant,  $I_C$  increases this increases  $P_D$  in transistor in terms of heat. Temp of transistor further increases and transistor enter in thermal runaway causing burning or damage of transistor.

In order to avoid thermal runaway THE BIASING VOLTAGES MUST DECREASE AS TEMP. INCREASES. This is obtained with different biasing methods some are given below.

## 1] BIASING WITH DIODES AND AN ACTIVE CURRENT SOURCE

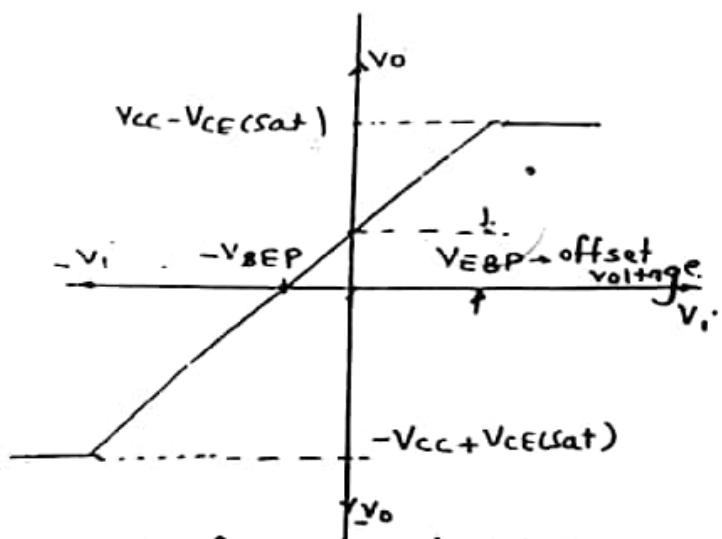
Class AB O/p stage

With diode biasing



D<sub>1</sub> and D<sub>2</sub> are diode  
Connected BJT

SOURCE



Transfer characteristics

Normally  $Q_N$  and  $Q_P$  handle large amount of power  $\therefore$  their geometry must be large. But diodes can be smaller device such that  $I_A = \frac{I_\Phi}{n}$  where  $n = \frac{\text{Emitter junction area of } Q_N, Q_P}{\text{Junction area of } D_1 \& D_2}$

$\therefore$  the saturation Current Is of  $Q_N$  and  $Q_P$  can be n times biasing diodes.

Transfer characteristics : From ckt

$$V_{BB} = V_{D1} + V_{D2} = 0.7 + 0.7 = 1.4V \quad \therefore \text{Base emitter voltage of } Q_N \quad V_{BEN} = V_{BB} - V_{EBP} = 1.4 - V_{EBP} \quad \therefore I_{BE}$$

of both  $\Phi_N$  &  $\Phi_p$  are always forward biased

Due to  $D_1$  and  $D_2$ ,  $Q_N$  and  $Q_P$  remains in active region when  $V_i = 0$ . The  $V_o = V_i + V_{BB} - V_{BEN} = V_i + V_{EBP} = V_i - V_{BEP}$ . As can be seen from TC dead zone is eliminated. However there is an offset voltage  $V_{EBP}$ .

## B] BIASING WITH A $V_{BE}$ MULTIPLIER

## Class AB PA with VBE multiplier circuit

shown. The constant curve source

(I<sub>R</sub>) Supplies current to multiplier circuit and base current to Q<sub>n</sub>.

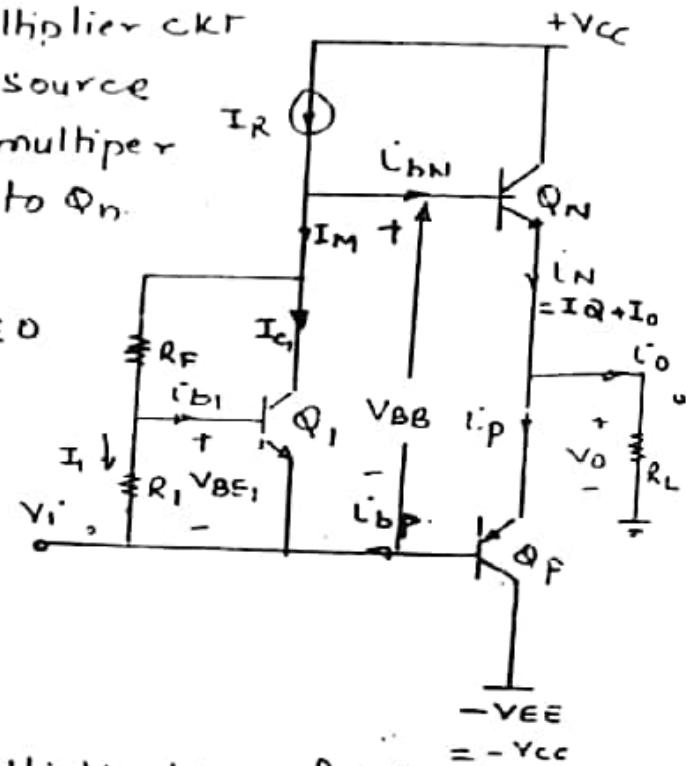
Voltage across  $R_1$  is  $V_{BE}$

$\therefore I_1 = \frac{V_{BE1}}{R_1}$ . Assuming  $I_{b1} \approx 0$   
because  $I_{b1} \ll I_1$ .

$$V_{BB} = I_1 (R_{r+R_1})$$

$$V_{BB} = V_{BE_1} \left( 1 + \frac{R_F}{R_1} \right)$$

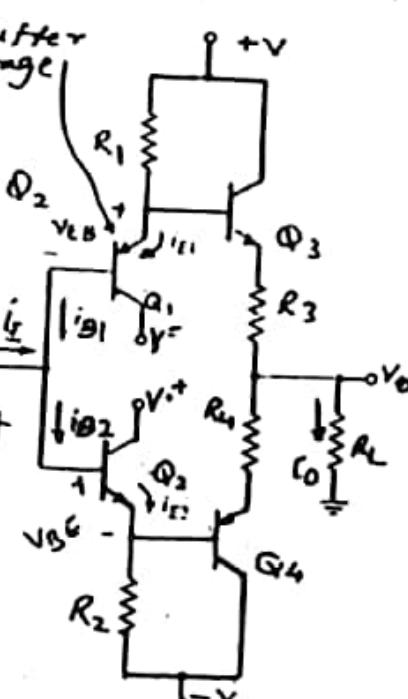
Since voltage  $V_{BB}$  is a multiplication of  $V_{BE_1}$ , the circuit is known as  $V_{BE}$  multiplier.  $\therefore$  by selecting ratio  $R_F/R_1$  we can adjust value of  $V_{BB}$  to give a desired quiescent current  $I_Q$ . For  $R_F/R_1 = 1$   $V_{BB} = 2 V_{BE_1}$



C] CLASS AB OUTPUT STAGE WITH  
I/P BUFFER TRANSISTOR

Incket  $R_1$ ,  $R_2$  and emitter follower establishes  $I_Q$  required in this configuration.  $R_3$  &  $R_4$  are used with short circuit protection device (not shown).

The input signal  $v_i$  may be the output of a low power amplifier. Also since this is an emitter follower the output voltage is approx. input voltage.



If input voltage  $V_I$  is from low power amp, the next stage (amplifier under consideration) should provide much higher power gain. This is achieved by configurations which provides highest current gain ( $1+\beta$ ).

Let us see how use of Buffer stage (cc) improves current gain (hence power gain) of output stage.

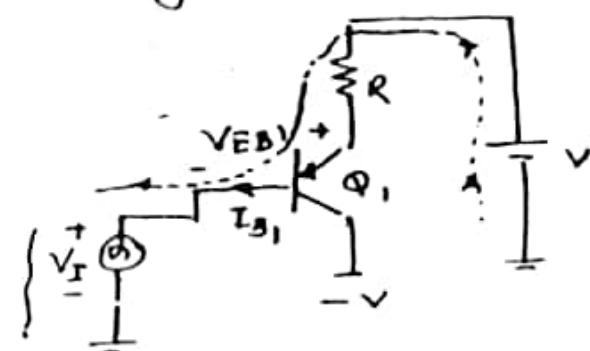
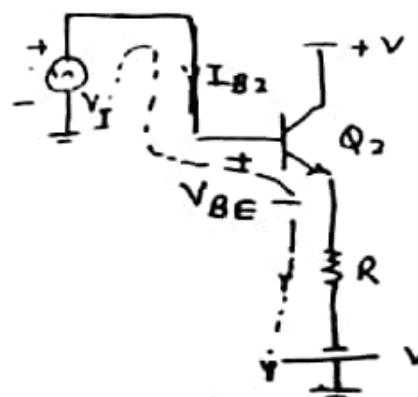
From diagram  $I_{B2} = I_i + I_{B1} \therefore I_i = I_{B2} - I_{B1}$ .

Assuming  $-V_{EB1} = V_{BE2} \quad \beta_2 = \beta_1 = \beta \quad R_3 = R_4 = 0$

$I_{B3} = I_{B4} = 0 \quad R_1 = R_2 = R$ .

Following are circuits considering input is increasing.

Ckt for  $I_{B2}$



Ckt for  $I_{B1}$ .

$$I_{B2} = \frac{V_I - V_{BE} + V}{(1+\beta)R}$$

$$I_{B1} = \frac{V - V_{EB1} - V_I}{(1+\beta)R}$$

$$\therefore I_i = I_{B2} - I_{B1} = \frac{V_I - V_{BE} + V - V_{EB1} + V_I}{(1+\beta)R} = \frac{2V_I}{(1+\beta)R}$$

∴ circuit is of cc configuration  $V_o = V_i$ .

$$\therefore I_i = \frac{2V_o}{(1+\beta)R} = \frac{2I_o K_L}{(1+\beta)R}$$

$$\therefore \frac{I_o}{I_i} = A_I = \frac{(1+\beta)R}{2R_L} \text{ Wow!}$$

very high gain; providing very high power gain also.

## Class C amplifier (short note)

In class C operation the Q point is located below cut off and output current flows for less than half the input signal cycle. The current flows in the form of pulses. The efficiency is very high. The angle of conduction of transistor is  $< 180^\circ$ .

Since the output is in the form of pulses it will contain lot of harmonics if resistive load is used. Hence a tuned resonant circuit (tank circuit) is used as load. The tank circuit is tuned to fundamental frequency of output current pulses.

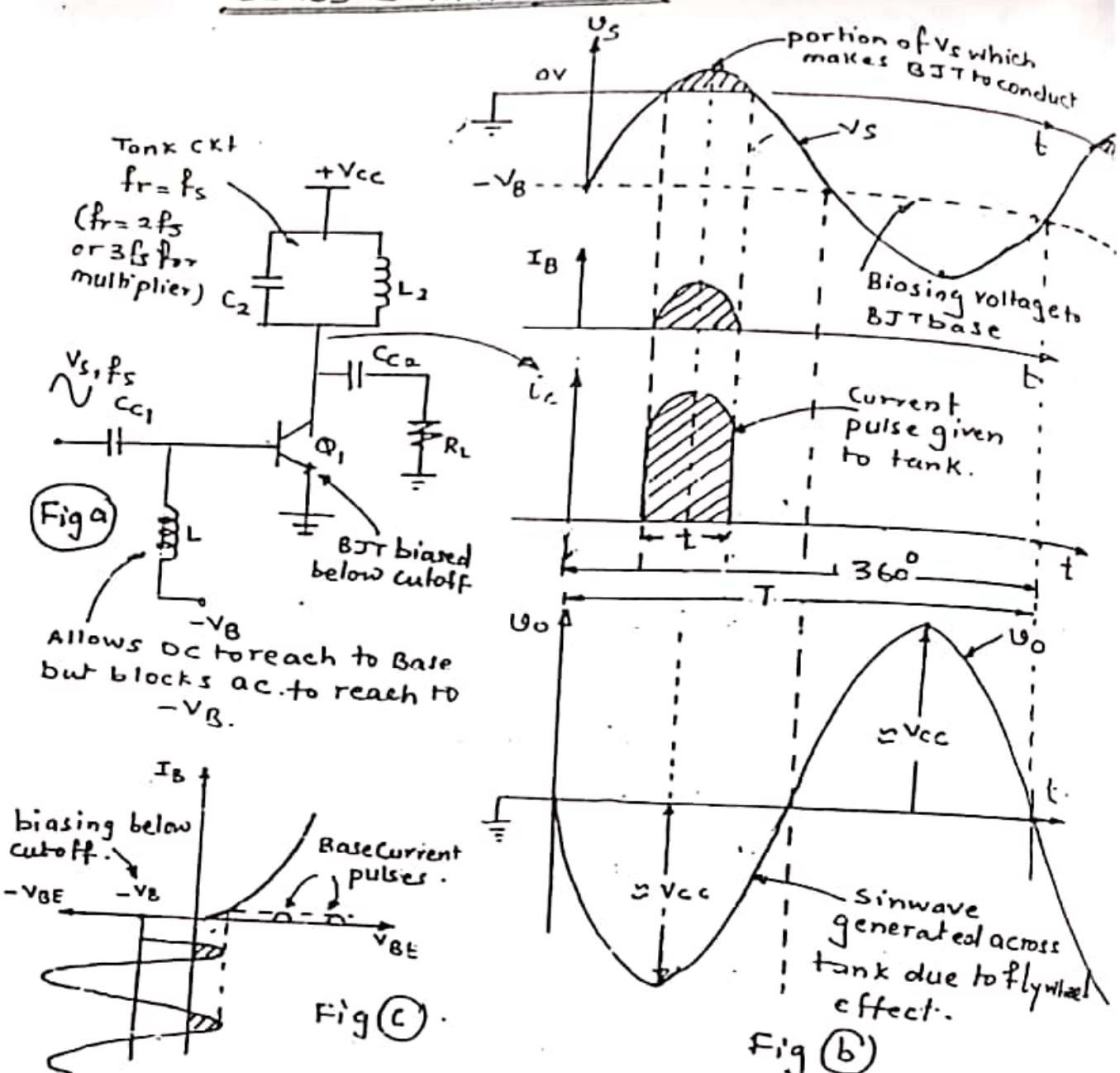
∴ a tuned class C amplifier works as narrow band amplifier and can amplify only a small band of frequencies around resonant frequencies of tuned circuit.

Class C amplifiers can be used only at RF. Because at AF the size of L & C (used in tank) becomes very large.  
+V<sub>CC</sub> -

### Applications :

- 1) Class C amplifiers are used as frequency multiplier. In this application tank circuit is tuned to 2<sup>nd</sup> or third harmonic of output current pulse.
- 2) If feedback is used to strengthened (strong) the input signal (+ve feedback) then we can get class - C oscillator.

# CLASS-C AMPLIFIER



In class C ampr. as shown in fig (a) BJT is biased to a -ve voltage level ( $-V_B$ ) via inductor  $L$  to keep the device in normally off state.  $\Phi_1$  conducts when the signal voltage ( $V_s$ ) sufficiently positive to drive the transistor base above the level of grounded emitter. The base and collector current flows only during a portion of entire cycle of the signal waveform. The tank circuit is tuned to resonate at signal frequency, and because the waveform across resonant circuit is sinwave, the circuit output voltage ( $U_o$ ) is a sinwave despite the pulsed condition of transistor.

FLYWHEEL EFFECT Some of the energy stored in the tank circuit is dissipated in the load, and is

replaced by current pulse each time the transistor switches ON. The process is sometimes referred as FLYWHEEL EFFECT. A flywheel that gets a kick to keep it turning once in every half cycle will rotate indefinitely. In the same way a tank circuit that receives (a large enough) current pulses once a cycle is will oscillate indefinitely.

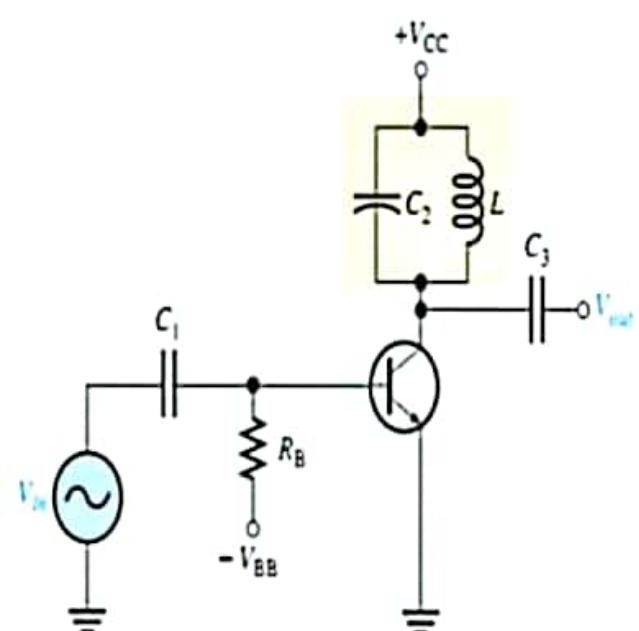
#### USED AS FREQUENCY MULTIPLIER

Tank ckt can be tuned to  $2f_s$  or  $3f_s$  instead of  $f_s$ . Hence at the output we get second or third harmonics.  $\therefore$  ckt works as multiplier.

#### POWER EFFICIENCY

When no signal is applied to class C amplifier; the transistor is off. Also when "ON" the device is driven in saturation and conducts only for a portion of the positive half cycle of the signal waveform. Thus transistor power dissipation is minimum, a very small power is dissipated in resistance of coil. HENCE POWER  $\eta$  or collector  $\eta$  is very high.

# Class C PA (Tuned Amplifiers)



(a) Basic circuit

In order to produce a full sine wave output, the class C uses a tuned circuit (LC tank) to provide the full AC sine wave.

