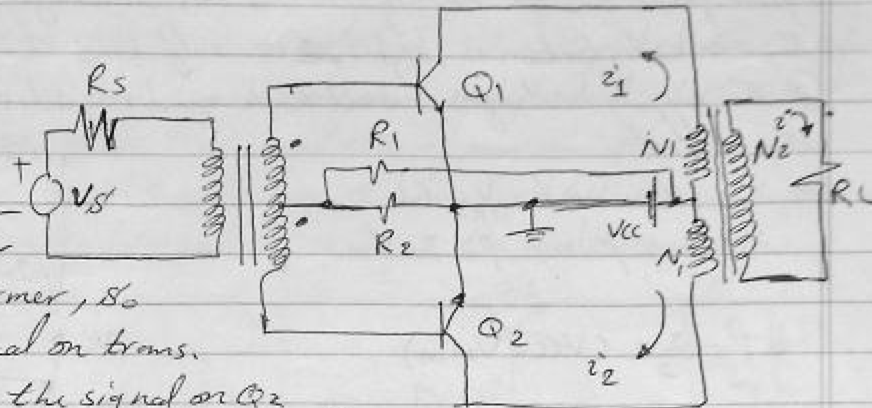
6.1.6 Push-Pull Amplifier :-

In this cct the excitation is introduced through a center tapped transformer, so when the signal on trans. Q1 is positive, the signal on Q2 is negative by an equal amount.



we have $i_{b1} = I_{bm} \cos\omega t$

$$\therefore i_1 = I_C + B_0 + B_1 \cos\omega t + B_2 \cos 2\omega t + \ldots$$

$$\therefore i_{b2} = -i_{b1} = I_{bm} \cos(\omega t + \pi)$$

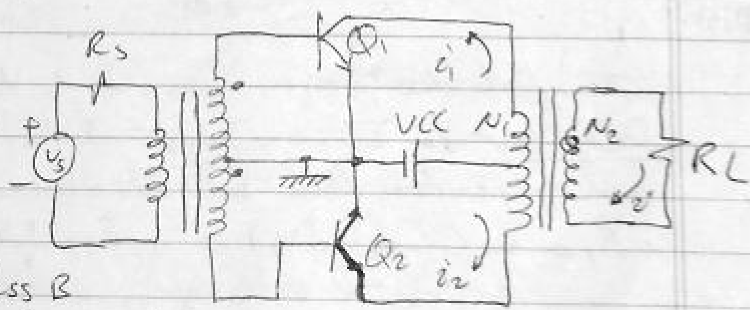
$$\therefore i_2 = I_C + B_0 - B_1 \cos\omega t + B_2 \cos 2\omega t - \ldots$$

$$i = K(i_1 - i_2) = 2K(B_1 \cos\omega t + B_3 \cos 3\omega t + \ldots)$$

This expression shows that a push-pull circuit will balance out all even harmonics in the o/p and will leave the third-harmonic term as a the principal source of distortion.

6.2 Class B Amp :-

The silicon Trans. is at cut off if the base is shorted to the emitter.



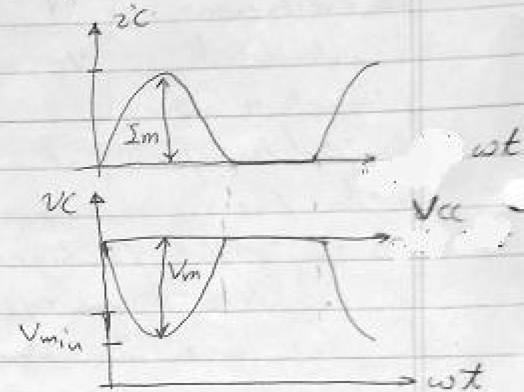
The advantages of class B as compared with class A operation are the following:

① Greater power o/p. ② higher efficiency. ③ There is negligible power loss at no signal. The disadvantages are ① the harmonic distortion is higher, ② self bias cannot be used, ③ The supply voltages must have good regulation.

we have $R_L' = \frac{1}{n^2} R_L$

The o/p power $P = \frac{I_m V_m}{2}$

$\therefore P = \frac{I_m}{2} (V_{CC} - V_{min})$



P_i = dc input power from the supply

$P_i = 2 I_{dc} V_{CC}$

$P_i = \frac{2 I_m V_{CC}}{\pi}$

without Distortion. $\eta = \frac{P}{P_i} * 100\% = \frac{\pi}{4} \frac{V_m}{V_{CC}} = \frac{\pi}{4} (1 - \frac{V_{min}}{V_{CC}}) * 100\%$.

The dissipation Power (P_C) is given by $P_C = P_i - P$

$P_C = 2 \frac{I_m V_{CC}}{\pi} - \frac{I_m V_m}{2}$ and since $I_m = \frac{V_m}{R_L'}$

without Dist. $\therefore P_C = 2 \frac{V_m V_{CC}}{\pi R_L'} - \frac{V_m^2}{2 R_L'}$.

The peak dissipation $P_{C max} = 2 V_{CC}^2 / \pi^2 R_L'$ when $V_m = \frac{2 V_{CC}}{\pi}$

Distortion: $I_C = 0$, $I_{max} = -I_{min}$, $I_{1/2} = I_{-1/2}$ for 5th order distortion then $B_0 = B_2 = B_4 = 0$, and

$B_1 = \frac{2}{3} (I_{max} + I_{1/2})$, $B_3 = \frac{1}{3} (I_{max} - 2 I_{1/2})$.

with Distortion $\therefore P = (1 + D_3^2) \frac{B_1^2 R_L'}{2}$.

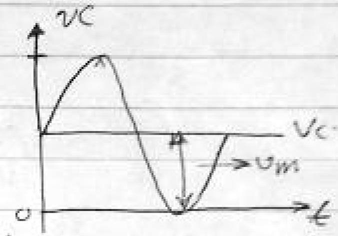
$\eta = \frac{P}{P_i} \times 100\% = \frac{(1 + D_3^2) B_1^2 R_L' / 2}{2 \frac{I_m}{\pi} V_{CC}} * 100\%$

Ex

A Transformer - Coupled Audio power Amplifier operating class A, is designated to deliver a maximum of 5 watt to a 4 Ω load. $V_{CC} = 20V$. $V_{min} = 0$

(a) what is the turn ratio of the transformer n?
(b) what is the peak collector current I_m?
(c) determin I_C, V_{CE}?
(d) determine η. without Distortion.

Solution:



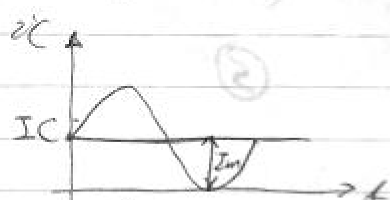
(a) $P = \frac{1}{2} \frac{V_m^2}{R_L'}$

$V_C = V_{CC} = 20V. = V_m$

$\therefore P = \frac{1}{2} * \frac{400}{R_L'} = 5$

$\therefore R_L' = \frac{400}{10} = 40 = \frac{R_L'}{R_L} \Rightarrow n = 1/\sqrt{10}$

(b) $P = \frac{1}{2} I_m^2 R_L' \Rightarrow I_m^2 = 2P/R_L' = 10/40 = 1/4$



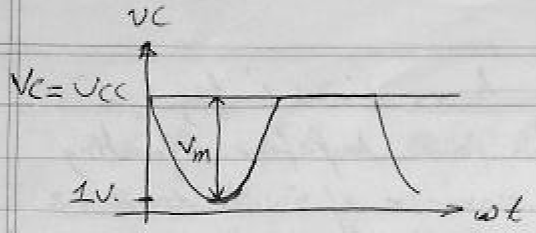
$\therefore I_m = 0.5 A.$

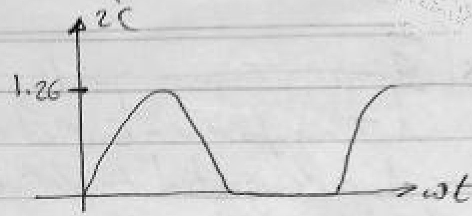
(c) $I_C = I_m = 0.5 A.$

$V_{CE} = V_C = 20 V.$

(d) $\eta = 5/20*0.5 = 0.5 = 50\% . = \frac{P}{P_i} * 100\% = \frac{5}{V_{CC} I_C} * 100\%$

Ex The power Trans. whose waveform iC and vC are given and used in the class B push-pull cct. with $V_{CC} = 20V$, if the Base Current is sinusoidal, with the peak value of 20mA $R_L' = 15 Ω$. (a) The third-harmonic distortion, (b) the power O/p with 0.3 distortion (c) the η. without Distortion.





$I_{max} = 1.26\ A$, $I_{V_2} = 0.75\ A$.

Solution :- ⓐ

$$B_3 = \frac{1}{3}(I_{max} - 2I_{V_2}) = \frac{1}{3}(1.26 - 1.5) = -80\ mA.$$

$$B_1 = \frac{2}{3}(I_{max} + I_{V_2}) = \frac{2}{3}(1.26 + 0.75) = 1.34\ A.$$

$$D_3 = \frac{|B_3|}{|B_1|} = \frac{80}{1340} = 5.97\%.$$

ⓑ $$P = (1 + D_3^2)\frac{B_1^2 R_L'}{2} = (1 + 0.00356)(1.34)^2 * \frac{15}{2}$$

$\therefore P = 13.51$ watt.

ⓒ

$$\eta = \frac{\pi}{4}\left(1 - \frac{V_{min}}{V_{CC}}\right) * 100\% = \frac{\pi}{4}\left(1 - \frac{1}{20}\right) * 100\% = 74.61\%$$

P without

$$P = \frac{I_m}{2}(V_{CC} - V_{min})$$

$$= \frac{1.26}{2}(20 - 1) = 11.97\ \text{watt}.$$

$$\eta_{with} = \frac{P_{with}}{P_i} = \frac{13.51}{(2 I_m V_{CC}/\pi)} = 84.17\%.$$