

A transformer coupled class A power amp^{9/4/15}
is driving a 8Ω speaker.

The circuit component values result in a
dc base current of 6mA, and the o/p signal (V_o)
results in a peak base current swing of 4mA.
The following values are noted from the characteristic

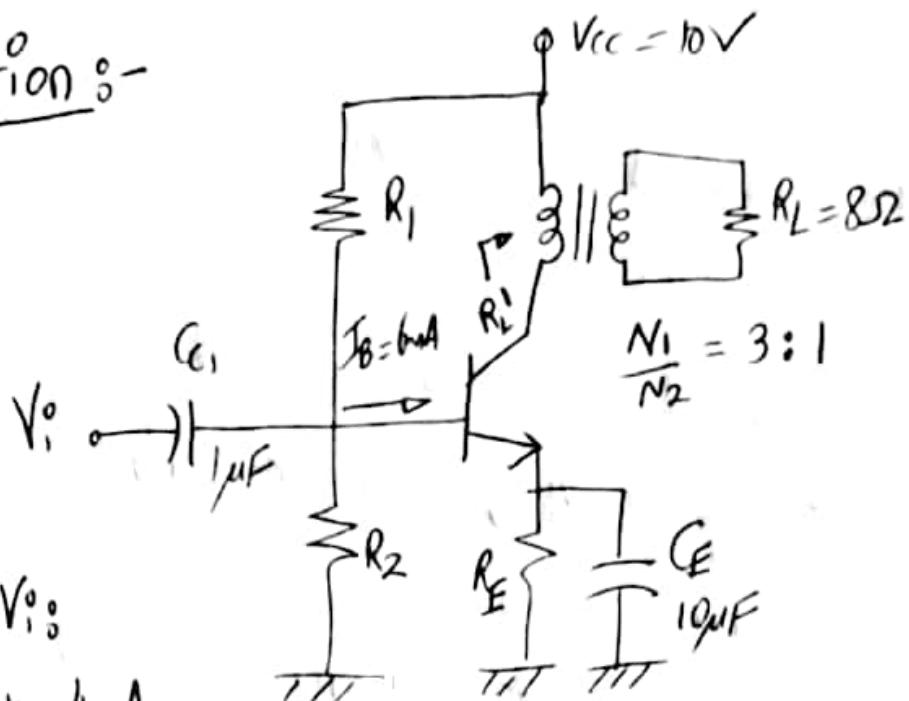
$$V_{CE}(\text{max}) = 18.3V, V_{CE}(\text{min}) = 1.7V$$

$$I_C(\text{max}) = 255mA, I_C(\text{min}) = 25mA.$$

(calculate

- 1) RMS value of load current & voltage
- 2) AC Power delivered to the load.
- 3) DC o/p power
- 4) Power dissipated by the transistor
- 5) Efficiency of the amplifier.

Solution :-



Due to V_i :

$$I_{Bpeak} = 4mA$$

i) RMS value of voltage on the primary

$$\begin{aligned} V_1(\text{rms}) &= \frac{V_{CE}(\text{pp})}{2\sqrt{2}} \\ &= \frac{V_{CE(\text{max})} - V_{CE(\text{min})}}{2\sqrt{2}} = \frac{(18.3 - 1.7)}{2\sqrt{2}} \\ &= \underline{\underline{5.87V}} \end{aligned}$$

ii) RMS value of voltage on the secondary (load),

$$V_L(\text{rms}) = \frac{V_1(\text{rms})}{3} = \frac{1.957V}{3} \quad \boxed{\left(\frac{V_1}{V_2} = \frac{N_1}{N_2} = K \right)}$$

iii) RMS value of load current

$$I_L(\text{rms}) = \frac{V_L(\text{rms})}{R_L} = \frac{1.957}{8} = \underline{\underline{0.244A}}$$

→ Effective ac resistance seen at the primary is,

$$R_L' = \left(\frac{N_1}{N_2}\right)^2 R_L = (3)^2 \times 8 = \underline{72\Omega}$$

iv) AC Power delivered to the load:- (P_{AC})

$$P_{AC} = \frac{(V_{CE\max} - V_{CE\min})(I_{C\max} - I_{C\min})}{8}$$
$$= \frac{(18.3 - 1.7)(255mA - 25mA)}{8}$$

$$\boxed{P_{AC} = 0.477W}$$

v) DC IP Power :-

$$P_{DC} = V_{CC} I_{CQ}$$

$$\rightarrow I_{CQ} = \frac{I_{C(\max)} + I_{C(\min)}}{2} = \frac{255 + 25mA}{2}$$
$$= \underline{140mA}$$

$$\text{ie } P_{DC} = V_{CC} \times I_{CQ} = 10 \times 140mA = \underline{1.4W}$$

Note:- For transformer-coupled amplifiers, the power dissipated by the transformer is small (due to small dc resistance of a coil)

Thus, the only power loss considered here is that dissipated by the power transistors & is given by

$$P_D = P_{i_P DC} - P_{o_P AC}$$

→ Amount of Power dissipated by the Transistor is the difference b/w that drawn from the dc supply & the amount delivered to the ac load.

$$\begin{aligned} P_D &= P_{i_P DC} - P_{o_P AC} \\ &= 1.4W - 0.477W \end{aligned}$$

v)

$$P_D = 0.92W$$

vii) Efficiency:-

$$\eta = \frac{P_{AC}}{P_{DC}} \times 100 = \frac{0.477}{1.4} \times 100$$

$$\therefore \boxed{\eta = 34.1\%}$$

→ Maximum theoretical Efficiency :-

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For a class A transformer-coupled power amplifier, the maximum theoretical efficiency goes up to 50%. Based on the signals obtained using the amplifier, the efficiency can be expressed as,

$$\% \eta = 50 \left[\frac{V_{CEmax} - V_{CEmin}}{V_{CEmax} + V_{CEmin}} \right]^2$$

→ The larger the value of V_{CEmax} and the smaller the value of V_{CEmin} , the closer the efficiency approaches the theoretical limit of 50%

Calculate the efficiency of a transformer-coupled class A power amplifier for a supply of 12V and O/Ps of :

a. $V_o(p) = 12V$

b. $V_o(p) = 6V$

c. $V_o(p) = 2V$

Solution:

a) Since $V_{CEQ} = V_{CC} = 12V$, the maximum and minimum of the voltage swing are,

$$V_{CE\max} = V_{CEQ} + V_o(p) = 12 + 12 = 24V$$

$$V_{CE\min} = V_{CEQ} - V_o(p) = 12 - 12 = 0V$$

$$\therefore \% \eta = 50 \left[\frac{24V - 0V}{24V + 0V} \right]^2$$

$$\boxed{\eta \approx 50\%}$$

When $V_{o(P)} = 6V$

$$b) V_{CEmax} = V_{CEQ} + V_{o(P)}$$
$$= 12V + 6V = \underline{18V}$$

$$V_{CEmin} = V_{CEQ} - V_{o(P)} = 12V - 6V = \underline{6V}$$

$$\therefore \% n = 50 \left[\frac{18 - 6}{18 + 6} \right]^2$$

$$\boxed{n = 12.5\%}$$

c) When $V_{o(P)} = 2V$

$$V_{CEmax} = V_{CEQ} + V_{o(P)} = 12V + 2V = \underline{14V}$$

$$V_{CEmin} = V_{CEQ} - V_{o(P)} = 12V - 2V = \underline{10V}$$

$$\therefore \% n = 50 \left[\frac{14V - 10V}{14V + 10V} \right]^2$$

$$\boxed{n = 1.39\%}$$