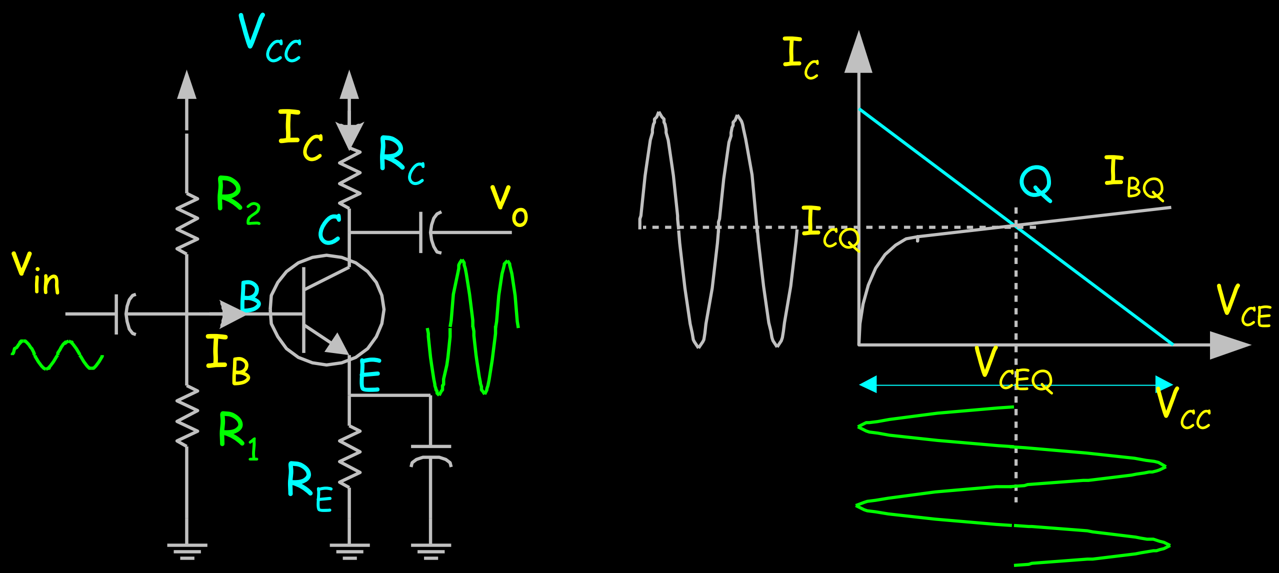
8. CLASS A POWER AMPLIFIERS (16.1 – 16.3)

- Classification of Power Amplifiers
- Series-fed Class A Power Amplifiers
- Transformer Coupled Class A Amplifiers

Classification of Power Amplifiers

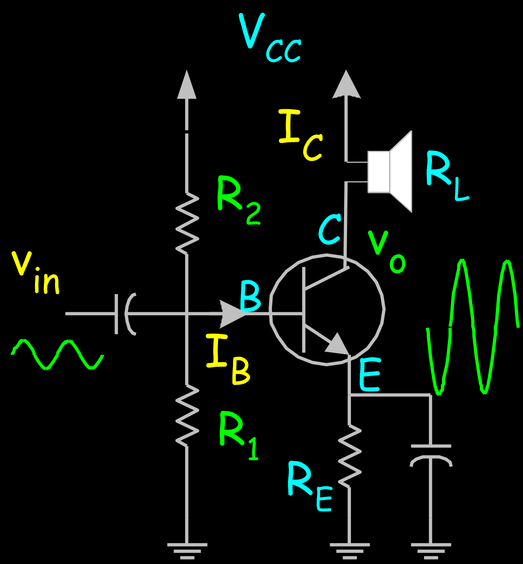
Class A operation



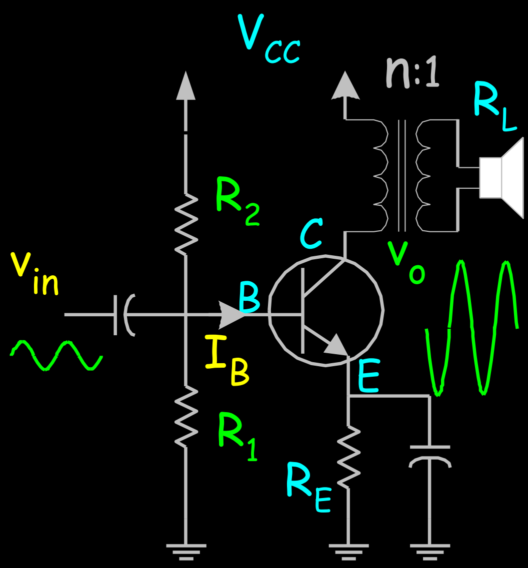
In Class A operation, I_C should be flowing the whole cycle (2π)
Q point is at the center of the operating range. $I_{BQ}>0$

Here R_1 and R_2 provide required I_{BQ} for class A operation. Q point is at the center of the operating range. $I_{BQ}>0$

Class A Power Amplifiers



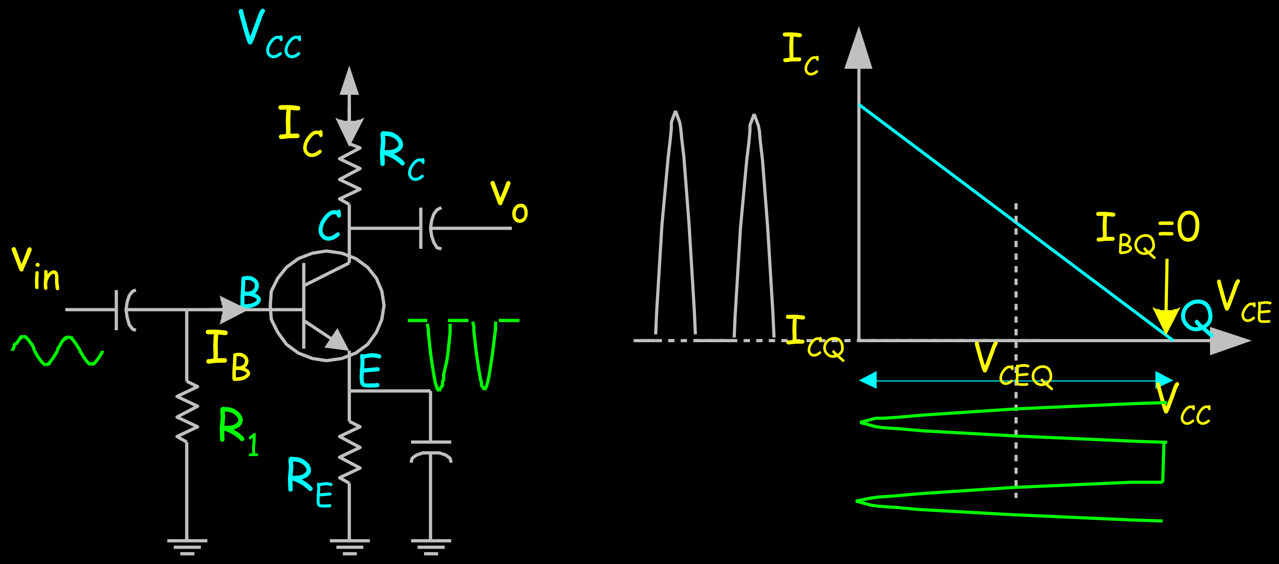
Series-fed Class A
Power Amplifier



Transformer Coupled
Class A Power Amplifier

Here dc power from V_{CC} is converted into ac output power in R_L

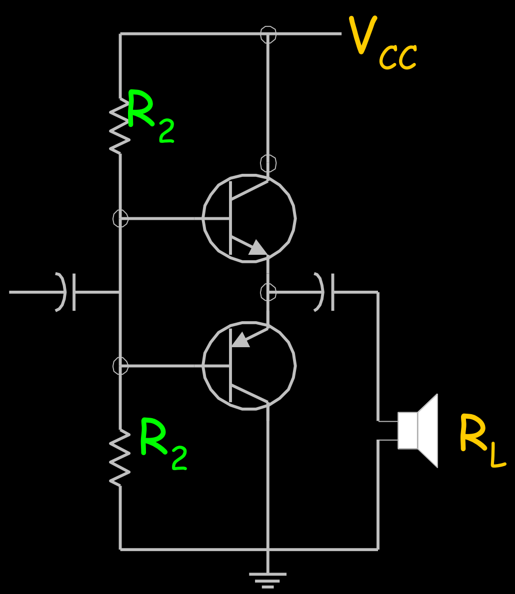
Class B operation



In Class B operation, I_C should be flowing half cycle (π)
Q point is at cutoff (I_C=0) of the operating range. I_{BQ}=0

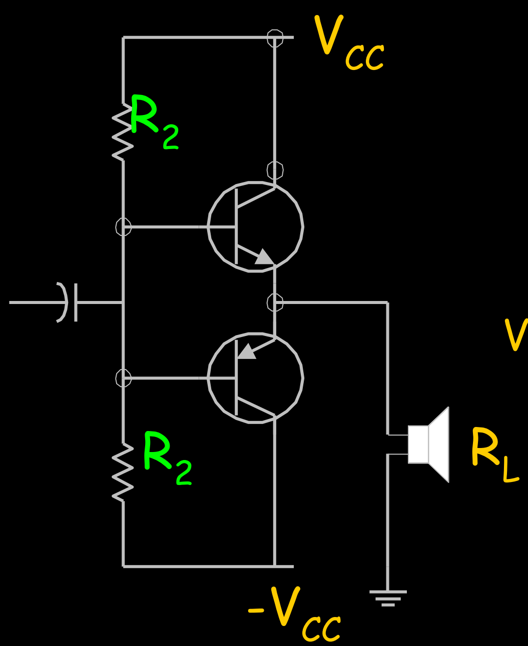
Here R_1 provides required I_{BQ} =0 for class B operation. Q point is at the cutoff of the operating range. I_{BQ}=0

Class B Power Amplifiers



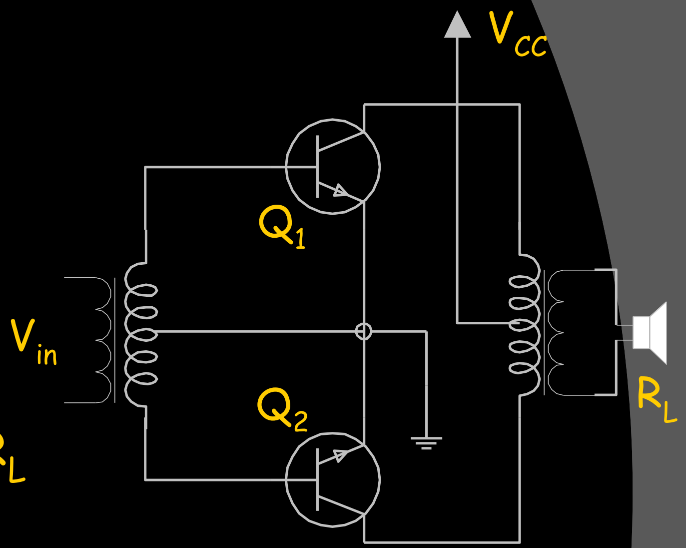
OTL Class B Power Amplifier

Output Transformer-Less



OCL Class B Power Amplifier

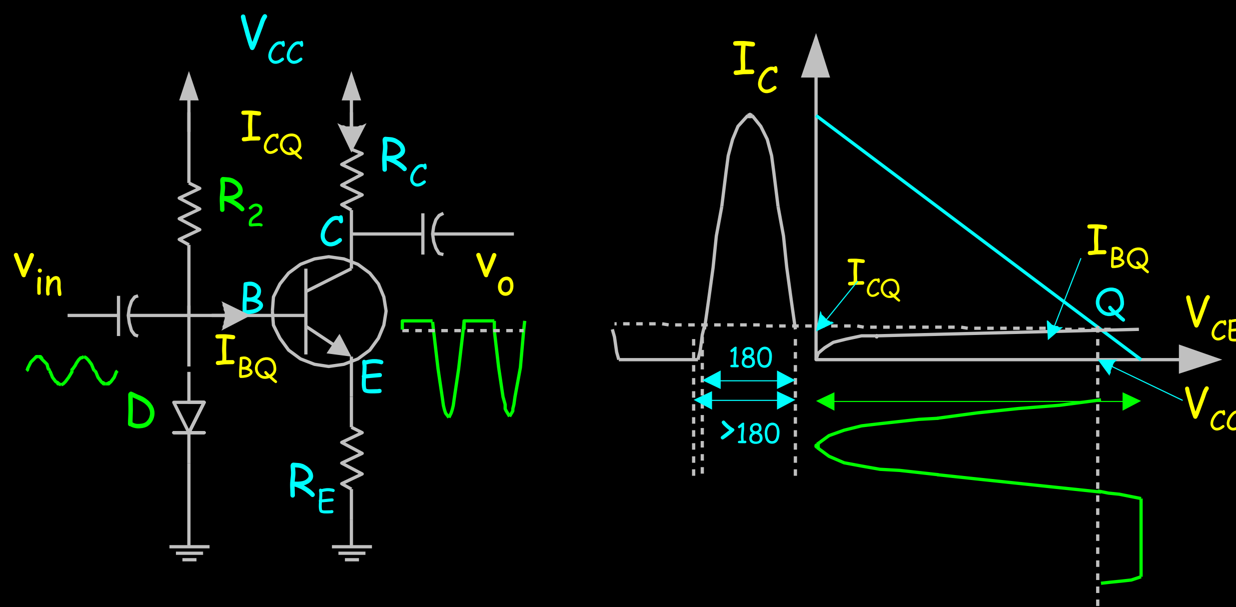
Output Capacitor-Less



Transformer Coupled Class B Power Amplifier

Here dc power from V_{CC} is converted into ac output power in R_L

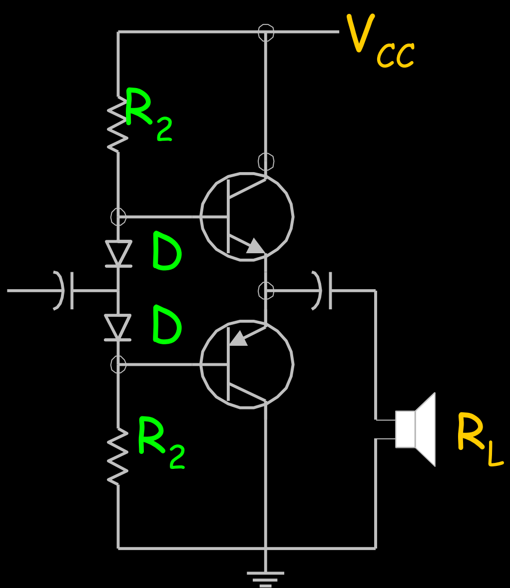
Class AB operation



In Class AB operation, I_C should be flowing more than half cycle ($>\pi$)
Q point is at small amount above cutoff ($I_C>0$) of the operating range. $I_{BQ}>0$

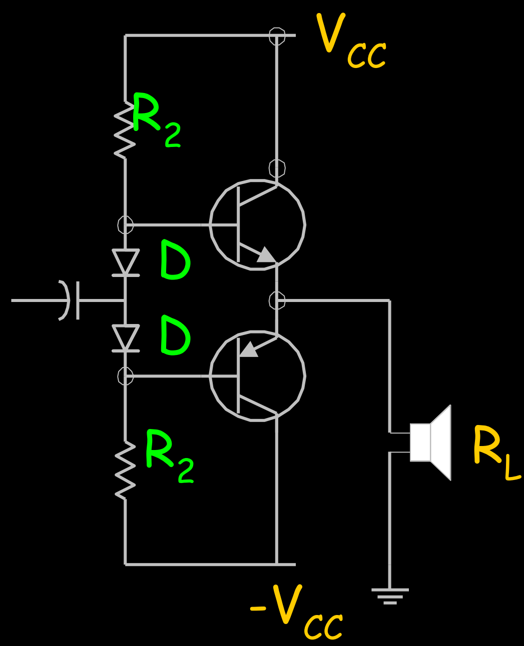
Here R_2 and diode D provides required small I_{BQ} for class AB operation. Q point is above the cutoff of the operating range. $I_{BQ}>0$

Class AB Power Amplifiers



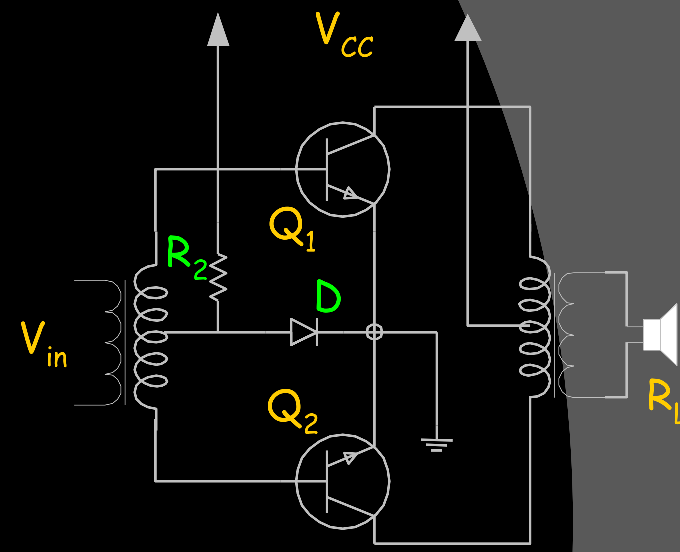
OTL Class AB Power Amplifier

Output Transformer-Less



OCL Class AB Power Amplifier

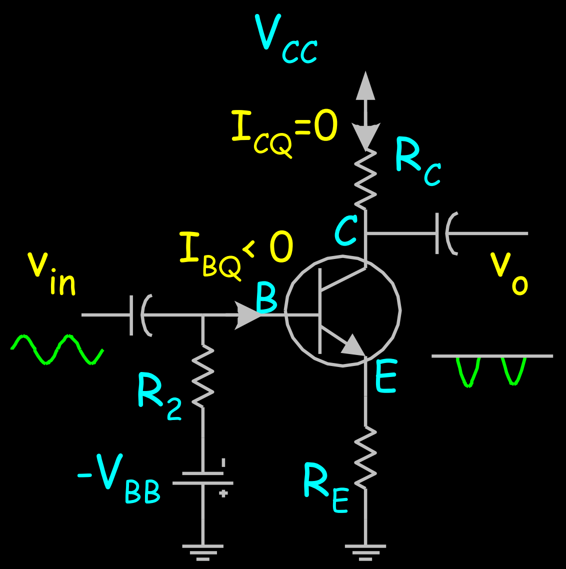
Output Capacitor-Less

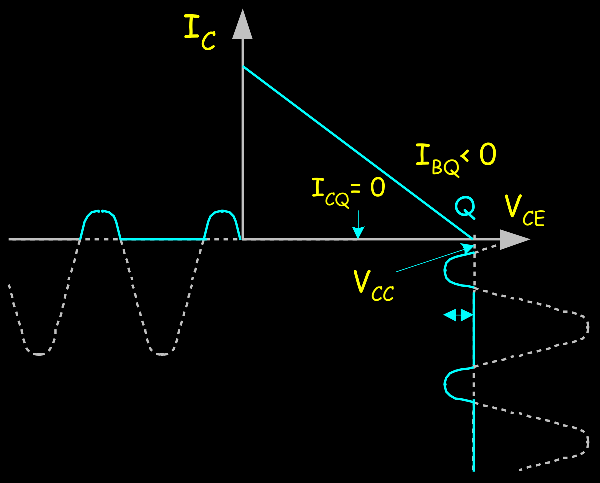


Transformer Coupled Class AB Power Amplifier

Here dc power from V_{CC} is converted into ac output power in R_L

Class C operation

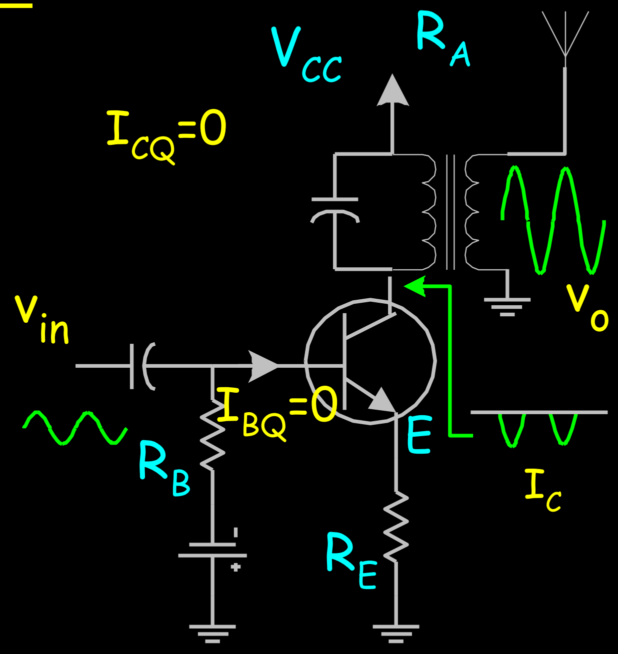




In Class C operation, I_C should be flowing less than half cycle (< π)
Q point is at below cutoff (I_C< 0) of the operating range. I_{BQ}< 0

Here R_B and $-V_{BB}$ provides required below cutoff I_{BQ} for class C operation. Q point is below the cutoff of the operating range. I_{BQ}<0

Class C Power Amplifiers

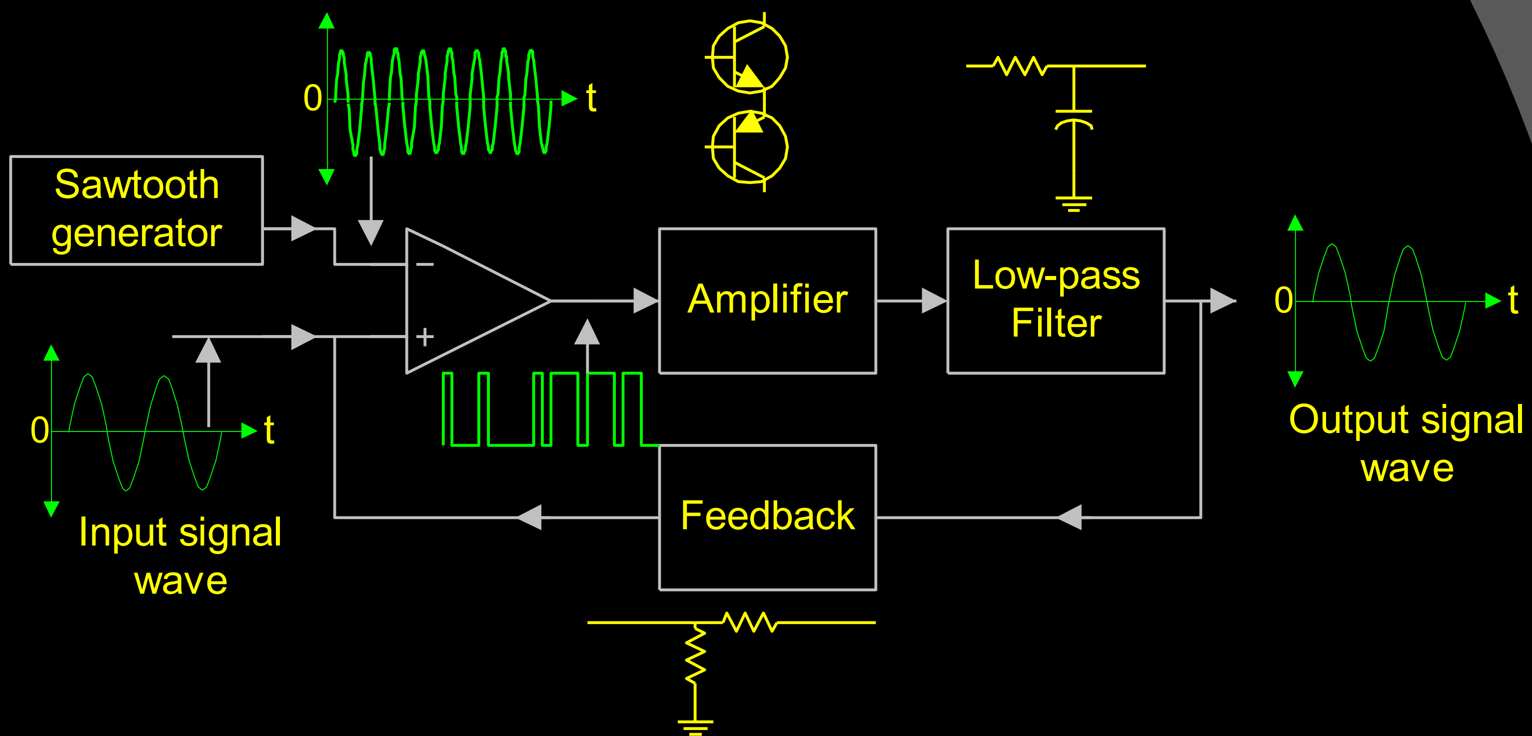


Tuned Class C RF
Power Amplifier

Radio Frequency Amplifier

Here dc power from V_{CC} is converted into ac output power in R_L

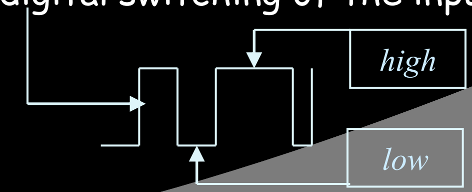
Class D Power Amplifiers



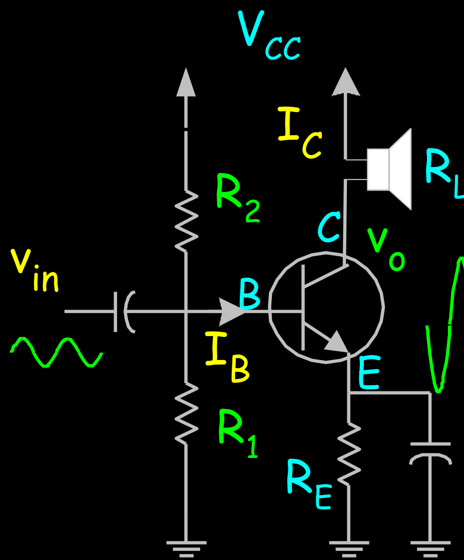
IC conducting only when digital version of the input wave is high ---- CLASS-D operation.

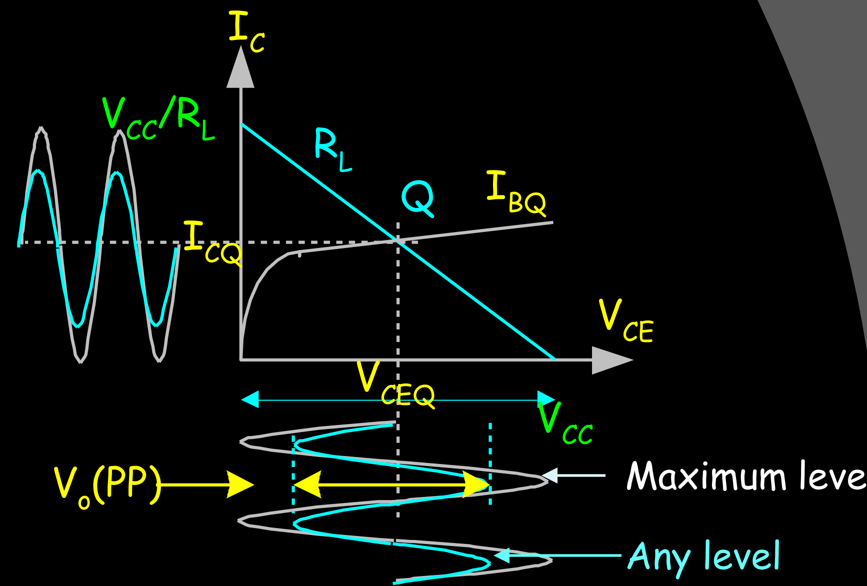
digital switching of the input wave

Efficiency is very high = over 90%



Series-fed Class A Power Amplifiers





At maximum $V_o(pp)$ level $V_o(pp) = V_{CC}$

$$P_{ac}(max) = \frac{\left(V_o(pp) / 2\sqrt{2} \right)^2}{R_L} = \frac{V_{CC}^2}{8R_L}$$

$$P_{dc}(max) = V_{CC} \times I_{CQ} = V_{CC} \times \frac{V_{CC}/2}{R_L} = \frac{V_{CC}^2}{2R_L}$$

$$\eta(max) = \frac{P_{ac}}{P_{dc}} = \frac{V_{CC}^2}{8R_L} \times \frac{2R_L}{V_{CC}^2} = 0.25 = 25\%$$

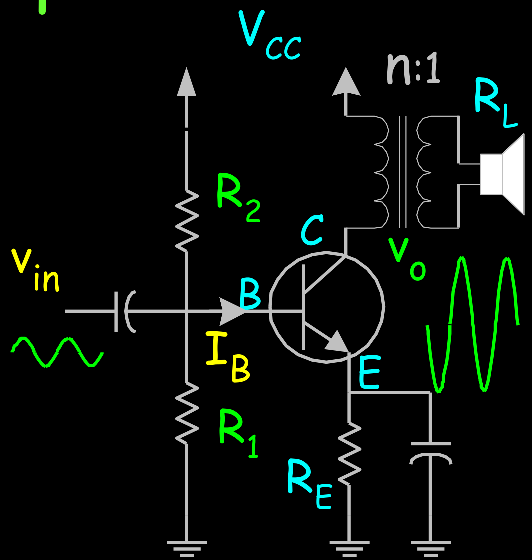
At any $V_o(pp)$ level

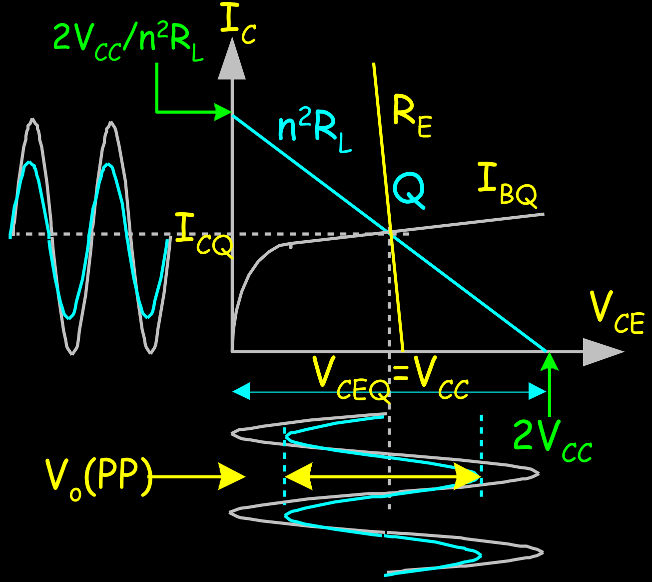
$$P_{ac} = \frac{\left(V_o(pp) / 2\sqrt{2} \right)^2}{R_L} = \frac{(V_o(pp))^2}{8R_L}$$

$$P_{dc} = V_{CC} \times I_{CQ}$$

$$\eta = \frac{P_{ac}}{P_{dc}}$$

Transformer Coupled Class A Power Amplifiers





At maximum $V_o(pp)$ level $V_o(pp) = 2V_{CC}$

$$P_{ac}(max) = \frac{\left(\frac{V_o(pp)}{2\sqrt{2}}\right)^2}{R_L} = \frac{(2V_{CC})^2}{8n^2R_L}$$

$$P_{dc}(max) = V_{CC} \times I_{CQ} = V_{CC} \times \frac{V_{CC}}{R_L} = \frac{V_{CC}^2}{R_L}$$

$$\eta(max) = \frac{P_{ac}}{P_{dc}} = \frac{4V_{CC}^2}{8n^2R_L} \times \frac{R_L}{V_{CC}^2} = 0.5 = 50\%$$

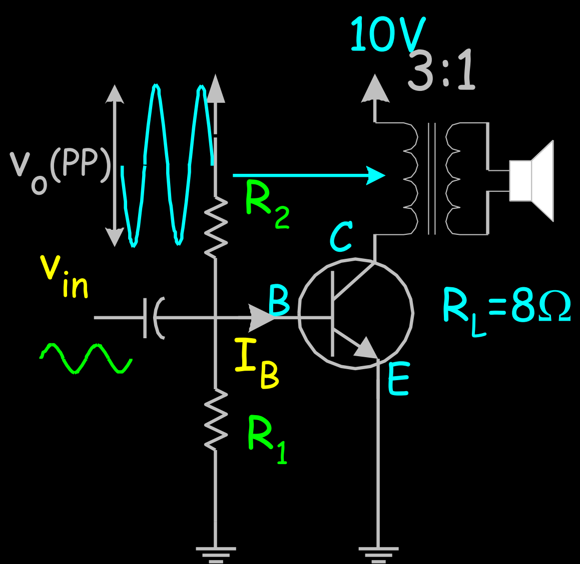
At any $V_o(pp)$ level

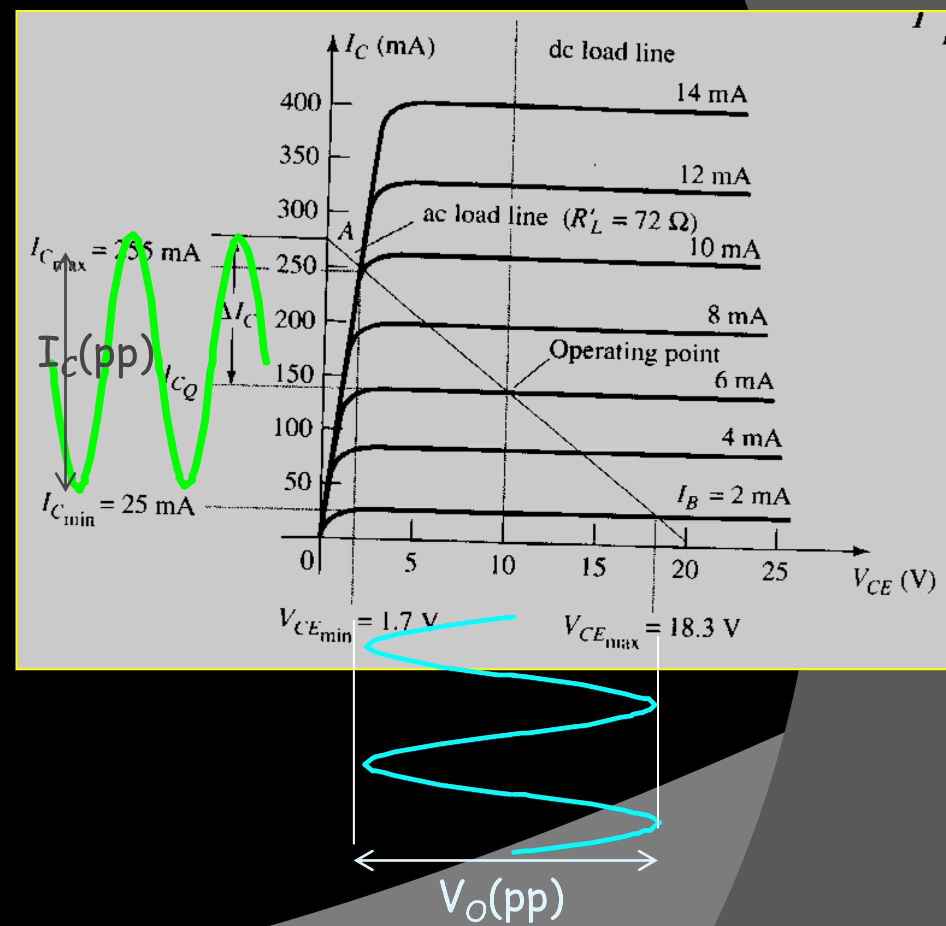
$$P_{ac} = \frac{\left(\frac{V_o(pp)}{2\sqrt{2}}\right)^2}{n^2R_L} = \frac{(V_o(pp))^2}{8n^2R_L}$$

$$P_{dc} = V_{CC} \times I_{CQ}$$

$$\eta = \frac{P_{ac}}{P_{dc}}$$

Example: Transformer Coupled class A is operating with V_{CC}=10V, R_L=8Ω, and transformer turn ratio n=3. Measurements at V_{CE} gives V_{CE}min=1.7V and V_{CE}max=18.3V,and measurements at I_C gives $I_C$min=25mA and $I_C$max=255mA. Find (a) V_o(pp) ,(b) V_L(pp) (c) P_{ac} (d) P_{dc} (e) efficiency η at that moment.





At any V_o(pp) level (a) $V_o(pp) = 18.3 - 1.7 = 16.6V$

(b) $\dfrac{V_L(pp)}{V_o(pp)} = \dfrac{1}{3} \Rightarrow V_L(pp) = \dfrac{16.6V}{3} = 5.33V$

(c) $P_{ac} = \dfrac{\left(V_o(pp)/2\sqrt{2}\right)^2}{n^2 R_L} = \dfrac{(18.3-1.7)^2}{8 \times 3^2 \times 8\Omega} = \underline{\underline{0.4784W}}$

(d) $P_{dc} = V_{CC} \times I_{CQ} = 10 \times \left(\dfrac{255-25}{2}\right) mA = 1.15W$

(e) $\eta = \dfrac{P_{ac}}{P_{dc}} = \dfrac{0.4784}{1.15} = 0.416 = 41.6\%$