Electronic Circuits
Chapter 6: Power Amplifiers

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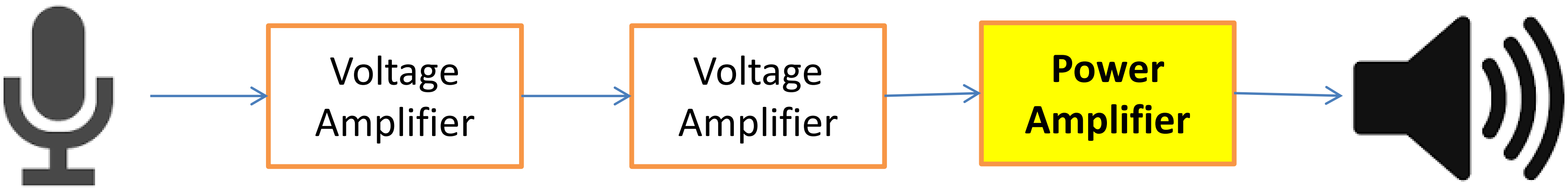
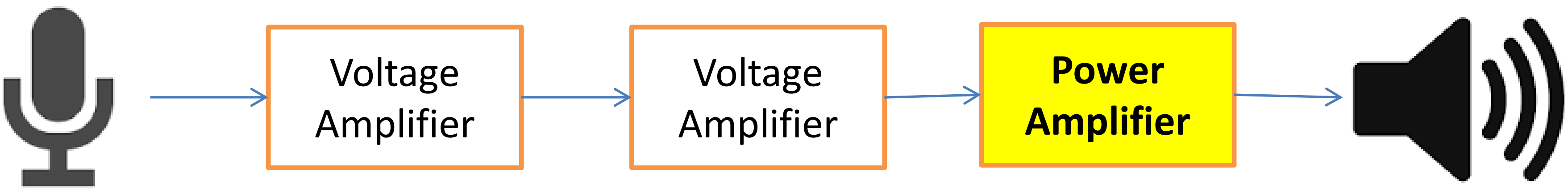
Content

Small Signal vs Large Signal Amplifiers



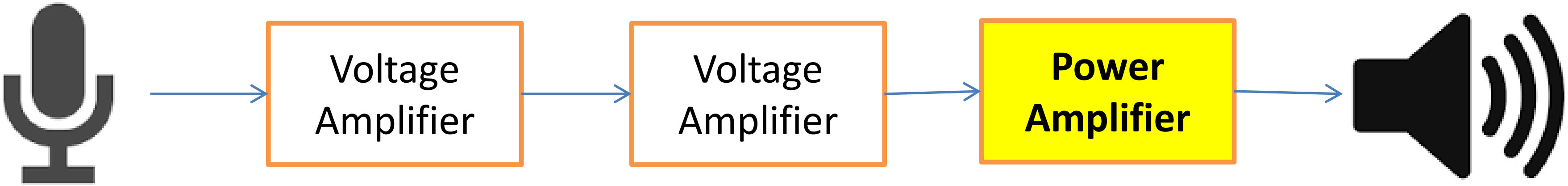
- **Small signal amplifiers (Voltage Amplifier):** Those amplifiers which handle small input AC signals (a few µV or a few mV).
  - Placed at the **input stage** & the **intermediate** (gain) stages.
  - Amplify the signal with little or no distortion
- **Large signal amplifiers (Power Amplifier):** handle large input a.c. signals (a few volts). They are normally used as **the final stage** of a communications receiver or transmitter to provide signal power to speakers or to a transmitting antenna.
  - Placed at the final stage.
  - be capable of **delivering a large voltage or current transfer maximum power**.

Small Signal vs Large Signal Amplifiers



- The voltage amplifiers are designed to achieve high voltage amplification. Therefore they have to have the following features:
  - ✓ A transistor with high β are used.
  - ✓ A relative high load R_C is used in the collector.
- A power amplifier is required to deliver a large amount of power and as such it has to handle large current. In order to achieve large current:
  - ✓ The size of power transistor is made considerably larger in order to dissipate the heat.
  - ✓ The base is made thicker to handle large currents.

Small Signal vs Large Signal Amplifiers



❖ Performance Quantities of Power Amplifiers:

✓ **Efficiency:** Power dissipation is small.

- An amplifier converts DC power from supply into AC power output.
- *Effectiveness of an amplifier* measures the ability of a power amplifier to convert DC power from supply into AC output power.
- *The ratio of AC output power to the DC signal power of a power amplifier is known as collector efficiency*.

✓ **Linearity:** must be high (measured by **Total harmonic distortion - THD**).

- Distortion is not a problem with small signal amplifiers.
- However a power amplifier handles large signals and, therefore, the problem of distortion immediately arises.

Small Signal vs Large Signal Amplifiers

- A voltage amplifier is designed to achieve maximum voltage amplification.
- A power amplifier is designed to obtain maximum output power.

No	Particular	Voltage Amplifier	Power Amplifier
1	β	High (>100)	Low (5 to 20)
2	R_C	High ($4-10k\Omega$)	Low (5 to 20Ω)
3	Coupling	Usually R-C Coupling	Invariably transformer coupling
4	Input Voltage	Low (few mV)	High (2-4V)
5	Collector Current	Low ($\sim mA$)	High (>100mA)
6	Power Output	Low	High
7	Output Impedance	High ($10k\Omega$)	Low (200Ω)

Power Transistors

- In our previous discussions, we have **ignored** any physical transistor limitations in terms of **maximum current, voltage, and power**.

- In power amplifiers, we must be concerned with **transistor limitations**:
  - ✓ Maximum rated current (on order of amperes).
  - ✓ Maximum rated voltage (on order of 100V).
  - ✓ Maximum rated power (on order of Watts or tens of Watts).

Parameter	Small-Signal BJT (2N2222A)	Power BJT (2N3055)	Power BJT (2N6078)
V_{CE}(max) (V)	40	60	250
I_C(max) (A)	0.8	15	7
P_D(max) (W) (at $T = 25\ ^\circ\mathrm{C}$)	1.2	115	45
β	35–100	5–20	12–70
f_T (MHz)	300	0.8	1

Table: Comparison of the characteristics and maximum ratings of a small-signal and power BJT

Power Transistors

- The current gain is generally smaller in the power transistors, typically in the range of 20 to 100, and may be a strong function of collector current and temperature.

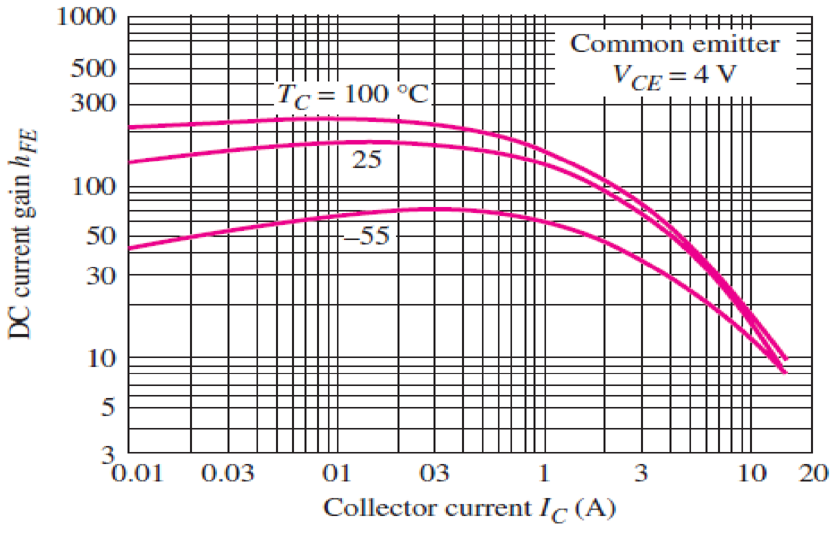
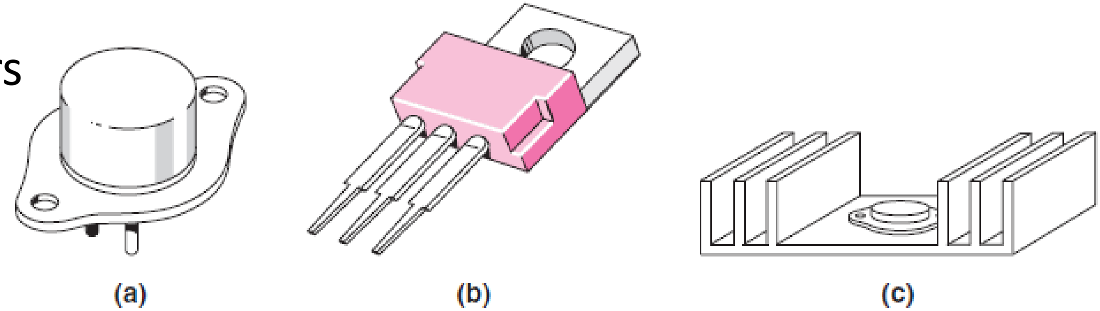


Figure: DC beta characteristics (h_{FE} versus I_C) for 2N3055

- Heat Sinks:
  a,b: for power transistors
  c: typical heat sink



Power Transistors

❖ Power calculation are extremely important for the following reasons:

- The transistor may be **destroyed** if its **maximum allowable dissipation is exceeded**.
- The power supply is capable of supplying only finite amount of power.
- The resistors have a power rating (such as 0.1 1, 2, 10W), which, if exceeded, will cause them to burn out.

❖ **The instantaneous power** $P(t)$ supplied to or dissipated by any device:

$$\boldsymbol{P(t) = V(t)I(t)}$$

$V(t)$: Voltage across the device, $V(t) = V_{av} + v(t)$

$I(t)$: Current across the device, $I(t) = I_{av} + i(t)$

Power Transistors - BJT

- **The average power:**

$$P_{av} = \frac{1}{T}\int_0^T V(t)I(t)dt = V_{av}I_{av} + \frac{1}{T}\int_0^T v(t)i(t)dt$$

- The average power supplied or dissipated by a device consist of the **sum of** the ***power in the dc (average) terms*** and ***the power in the ac term.***

- The **instantaneous power dissipation** in a BJT:

$$P(t) = v_{CE}(t)i_C(t) + v_{BE}(t)i_B(t) \simeq v_{CE}(t)i_C(t)$$

- The **average power dissipation** in a BJT:

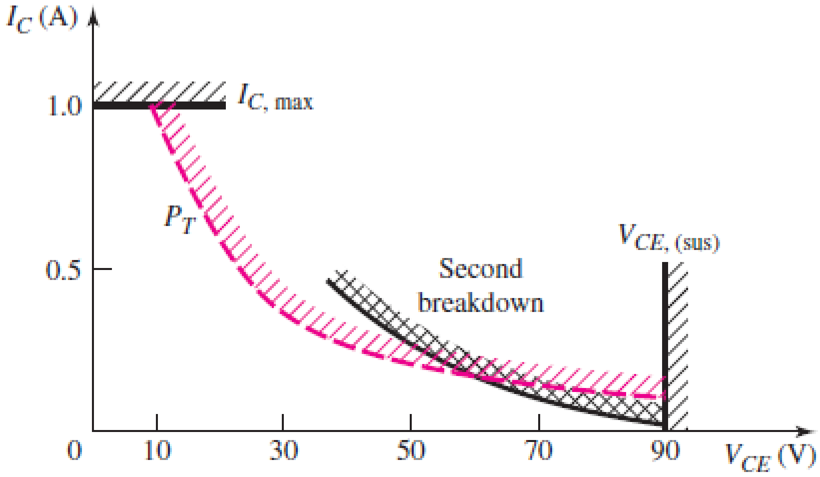
$$P_{av} = \frac{1}{T}\int_0^T v_{CE}(t)i_C(t)\, dt$$

Power Transistors - BJT

❖ The *average power dissipated* in a BJT *must be kept below a specified maximum value*, to ensure that the temperature of the device remains below a maximum value.

❖ If we assume that the collector current and collector–emitter voltage are dc quantities, then at the **maximum rated power** P_T for the transistor, we can write:

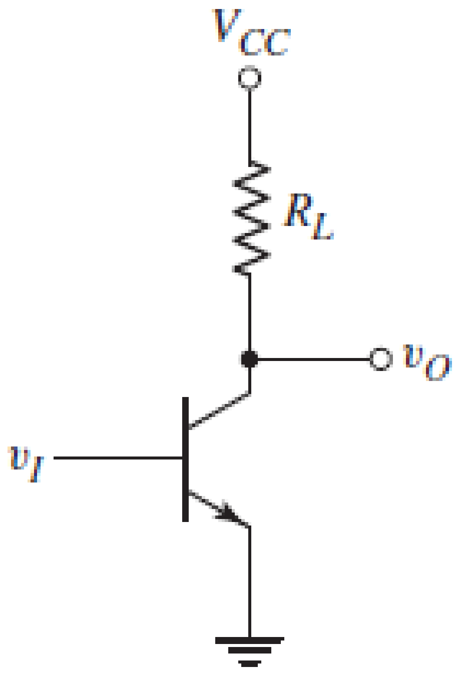
$$P_T = V_{CE} I_C$$



The safe operating area of a bipolar transistor

Power Transistors - BJT

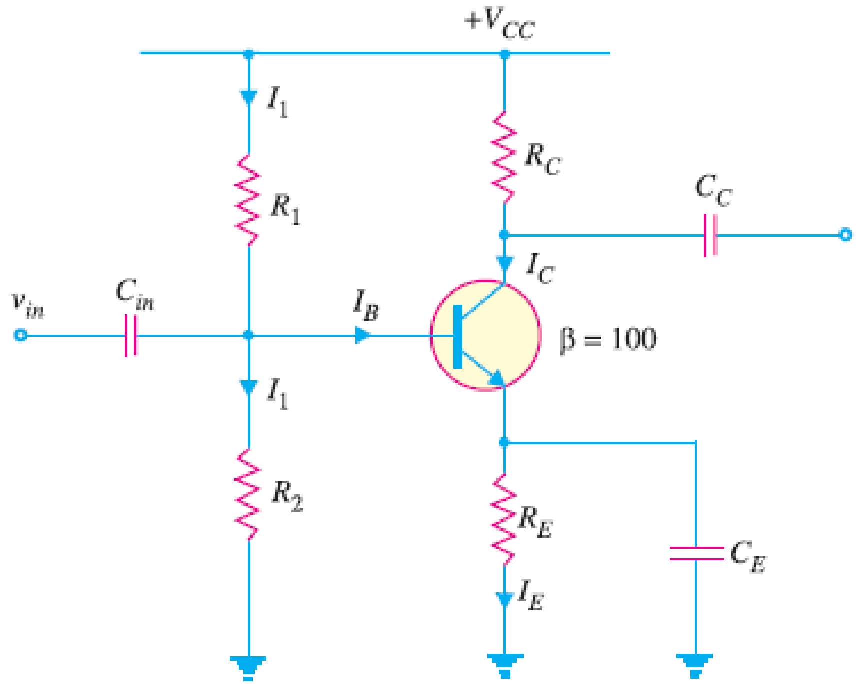
Example 1: Consider the common-emitter circuit in the following figure where the parameters are $R_L = 8\Omega$ and $V_{CC} = 24V$. Determine the required current, voltage, and power ratings of a power BJT.



Power Transistors - BJT

Example 2: In the following Figure, $R_1 = 10k\Omega$, $R_2 = 2.2k\Omega$, $R_C = 3.6\ k\Omega$, $R_E = 1.1k\Omega, V_{CC} = 10V$.

Find the DC power draw from the supply by the amplifier P_{CC}?



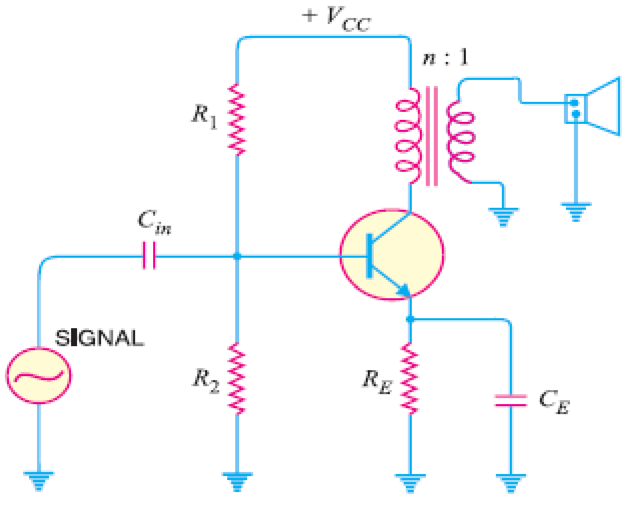
$$P_{CC} = 18.2mW$$

Classification of power amplifiers

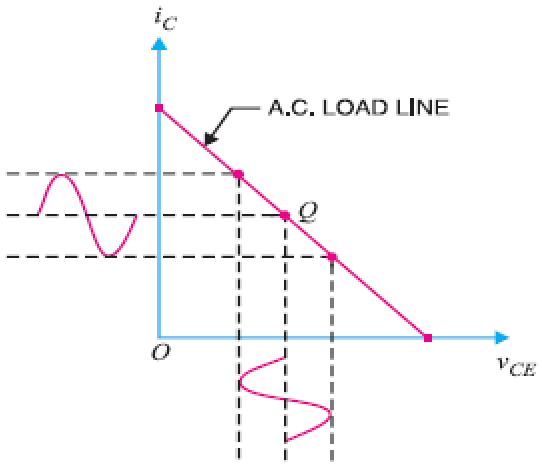
- Many of them are driven so hard by the input large signal that **collector (Drain)** current is either **cut-off** or is in the **saturation region** during a large portion of the input cycle.
- Therefore, power amplifiers **are classified** according to the **portion of the input sine-wave cycle** during **which load current flows**:
  - Class A power amplifier.
  - Class B power amplifier.
  - Class C power amplifier.
  - Class AB power amplifier.

Classification of power amplifiers

- **Class A power amplifier**: *If the collector current flows at all times during the full cycle of the signal, the power amplifier is known as* **class A power amplifier**.
  - The operating point *Q* is selected so that I_C flows at all times throughout the full cycle of the applied signal.
  - They have the disadvantage of low power output and low collector efficiency (about 25%).



(i)



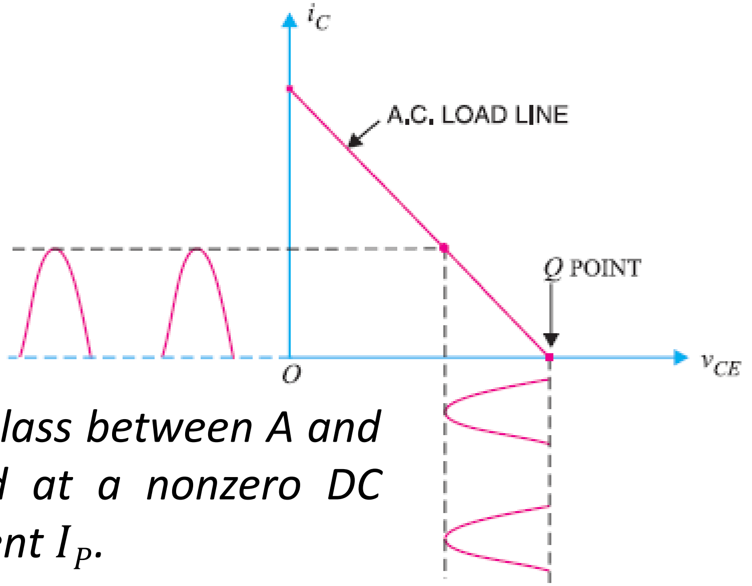
(ii)

Classification of power amplifiers

- **Class B power amplifier**: *If the collector current flows only during the positive half-cycle of the input signal, it is called a* **class B power amplifier**.
  - No biasing circuit is needed at all.
  - The operating point *Q* is located at collector cut-off voltage.
  - Severe distortion occurs.
  - Provide higher power output and collector efficiency $(50-60\%)$.

✓ *Positive half-cycle of the signal*: the input circuit is forward biased and hence collector current flows.

✓ *Negative half-cycle of the signal:* the input circuit is reverse biased and no collector current flows

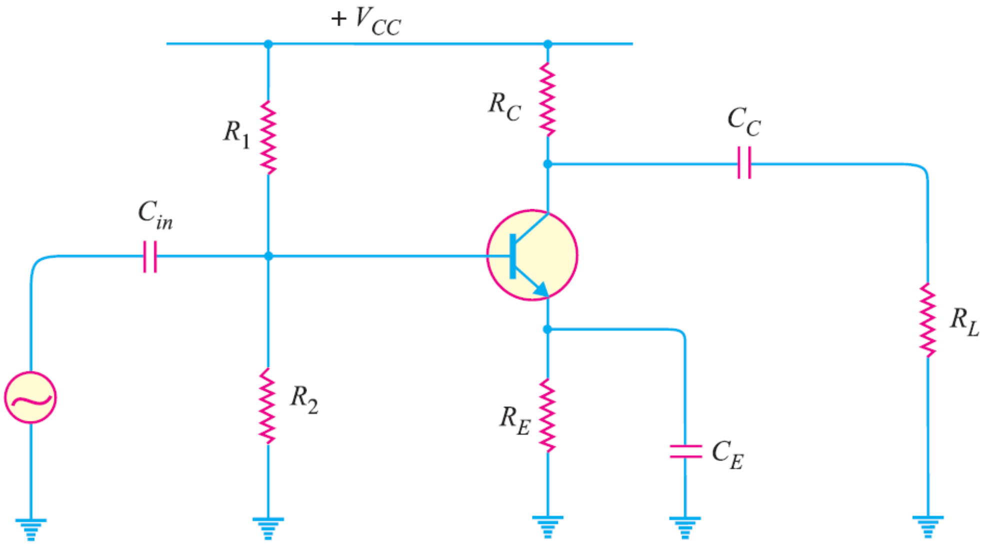


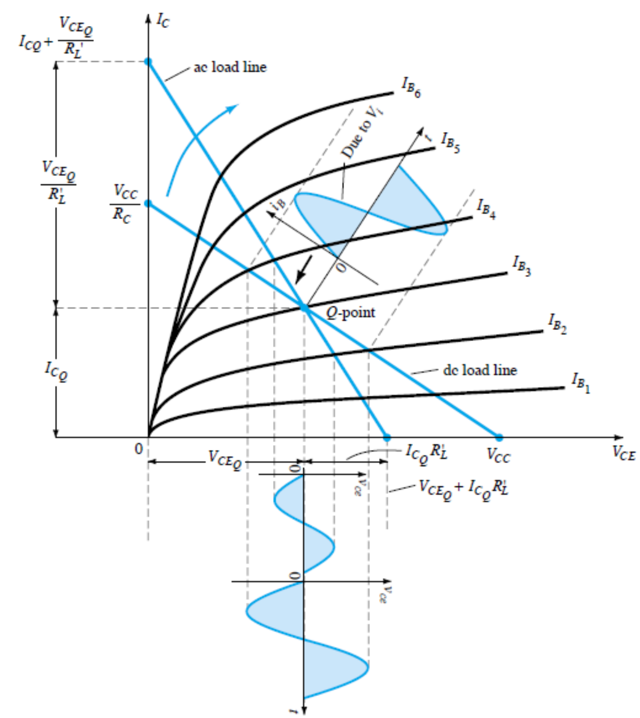
- **Class AB power amplifier**: *An intermediate class between A and B in which the output transistor is biased at a nonzero DC current I_{CQ} much smaller than the peak current I_P.*

Reviews – AC and DC Load Line

❖ ***DC Load Line:*** $I_{CQ} = f(V_{CE}) = \dfrac{V_{CC}}{R_C + {R_E}/{\alpha}} - \dfrac{V_{CE}}{R_C + {R_E}/{\alpha}} \approx \dfrac{V_{CC}}{R_C + R_E} - \dfrac{V_{CE}}{R_C + R_E}$

❖ ***AC Load Line:*** $i_C = f(v_{CE}) = I_{CQ} + i_c = I_{CQ} - \dfrac{v_{ce}}{R_C \parallel R_L} = I_{CQ} + \dfrac{v_{CEQ}}{R_C \parallel R_L} - \dfrac{v_{CE}}{R_C \parallel R_L}$

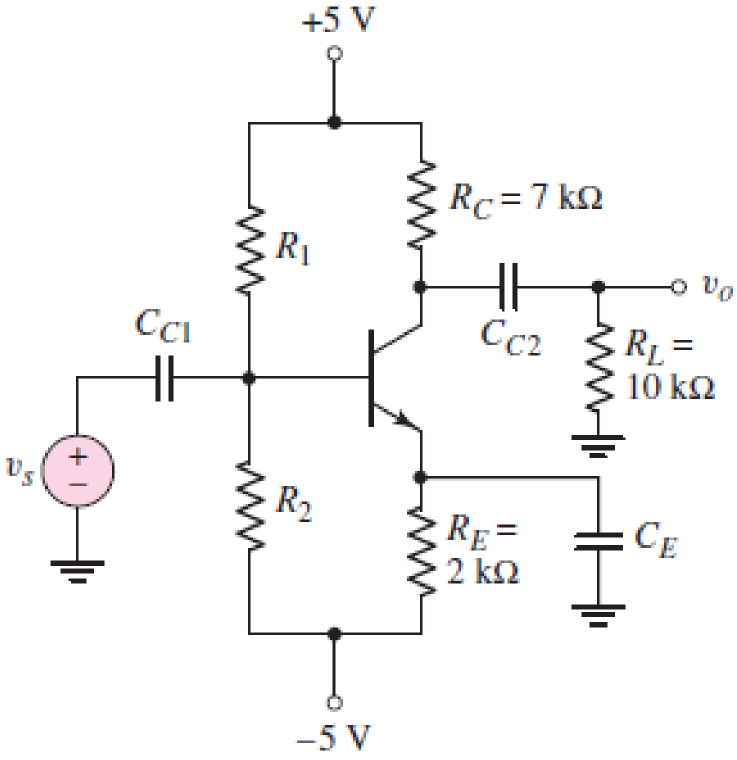


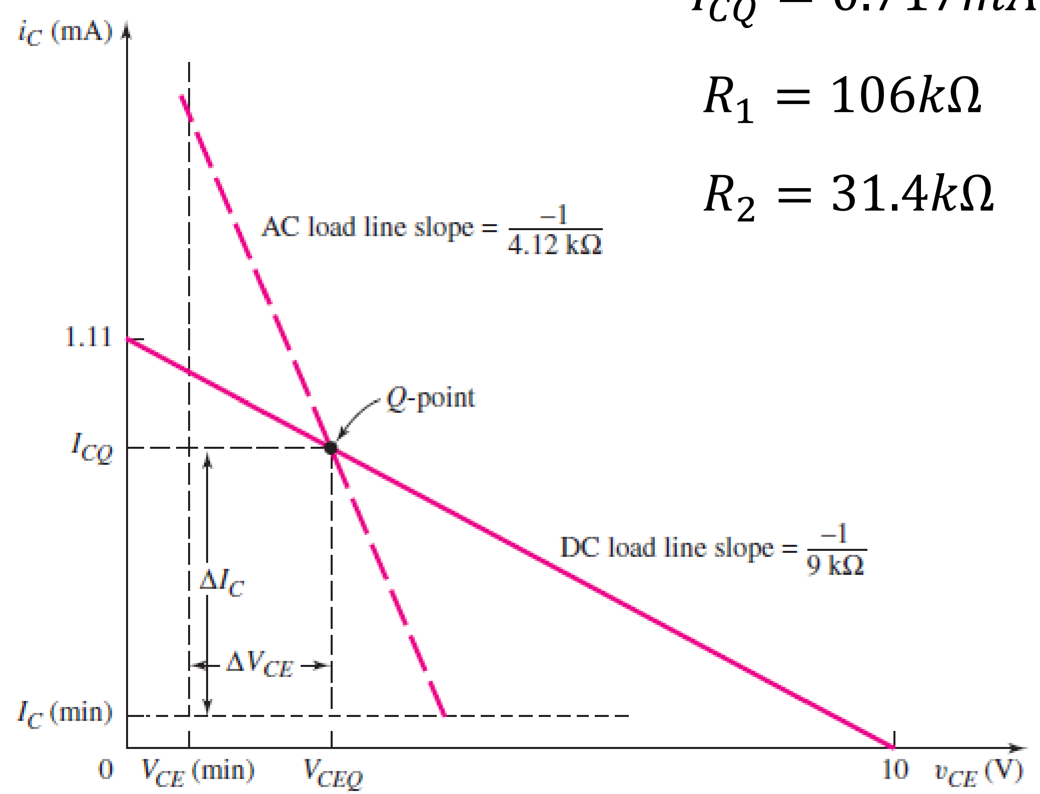


❖ ***Max-Swing Condition:*** $\boldsymbol{I_{CQ} = \dfrac{V_{CC}}{R_{ac} + R_{DC}}}$

Reviews – AC and DC Load Line

Example 3: Design (choose value of R1 and R2 of) the following circuit to achieve a maximum symmetrical swing in the output voltage.





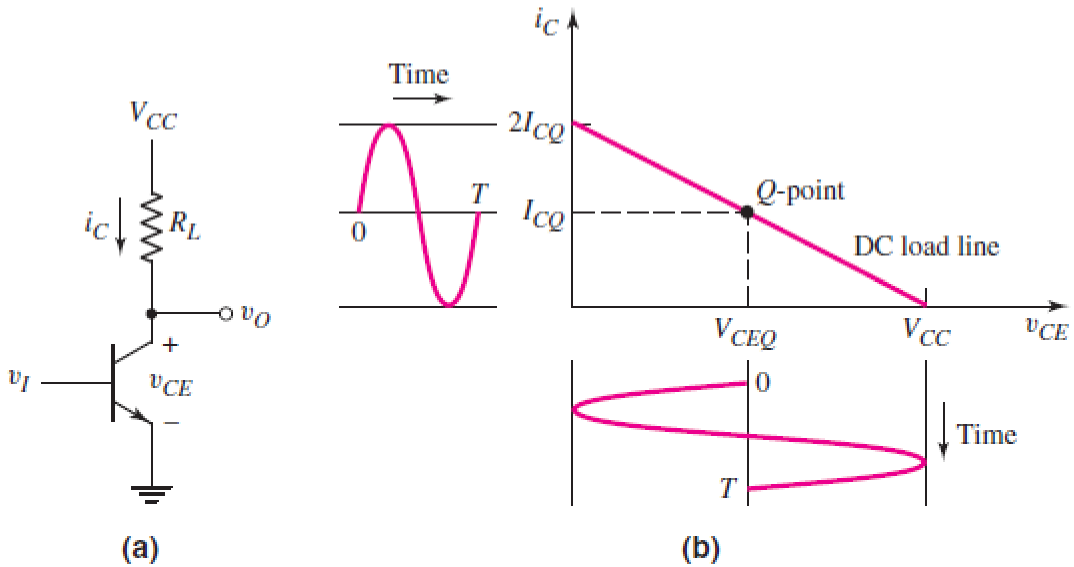
$$I_{CQ} = 0.717mA$$

$$R_1 = 106k\Omega$$

$$R_2 = 31.4k\Omega$$

Class A Operation

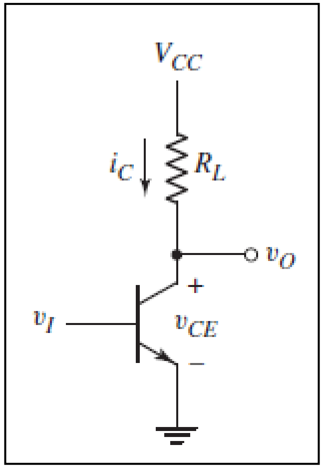
- The most common type of amplifier class due mainly to their simple design.
- The highest linearity over the other amplifier classes and as such operates in the linear portion of the characteristics curve.
- Maximum class A output occurs when the Q-point is centered on the ac load line.



Power Calculations

- **The average power delivered by the supply P_{CC}**
- **The average power dissipated by the load P_L**
- **The average power dissipated in the Collector P_C.**
- **Efficiency.**

Power Calculations - P_L



❖ The average AC power dissipated in the Load or output power:

$$P_L = \frac{1}{T}\int_0^T i_c^2(t)R_C dt = \frac{V_P}{\sqrt{2}}\frac{I_P}{\sqrt{2}} = \frac{1}{2}V_P I_P = \frac{R_C I_P^2}{2}$$

V_p, I_p: the peak values of the AC output voltage and current.

$$V_P = \frac{V_{CE(max)} - V_{CE(min)}}{2} \qquad I_P = \frac{I_{CE(max)} - I_{CE(min)}}{2}$$

❖ When $V_{CE,min} = 0, I_{C,min} = 0, V_{CE,max} = V_{CC}$, I_C is chosen for max- swing:

$$I_P = I_C = \frac{V_{CC}}{2(R_C + R_E)}$$

❖ Then the *maximum average power dissipated in the load resistor* $P_{L,max}$:

$$P_{L,max} = \frac{R_C I_P^2}{2} = \frac{R_C V_{CC}^2}{2(R_C + R_E)^2} \simeq \frac{V_{CC}^2}{8R_C} \quad when\ R_C \gg R_E$$

Power Calculations - P_{CC}

❖ The average DC power required from the power supply:

$$\boxed{P_{CC} = \frac{1}{T}\int_0^T i_c\ (t)V_{CC}dt = V_{CC}I_C}$$

❖ When $V_{CE,min} = 0, I_{C,min} = 0, V_{CE,max} = V_{CC}, I_C$ is chosen for max- swing:

$$I_P = I_C = \frac{V_{CC}}{2(R_C + R_E)}$$

❖ Then the *maximum average power dissipated in the load resistor* $P_{L,max}$:

$$\boxed{P_{CC,max} = V_{CC}I_C = \frac{V_{CC}^2}{2(R_C + R_E)} \simeq \frac{V_{CC}^2}{2R_C} \quad when\ R_C \gg R_E}$$

Power Calculations - P_C

❖ The power dissipated in the collector P_C:

$$P_C = \frac{1}{T}\int_0^T i_C\,(t) v_{CE}(t) dt = \frac{1}{T}\int_0^T i_C\,(t)\left[V_{CC} - \left(V_{CC} - v_{CE}(t)\right)\right] dt$$

$$= P_{CC} - (R_C + R_E)\frac{1}{T}\int_0^T i_C^2(t) dt = P_{CC} - P_L - P_E = P_{CC} - (R_C + R_E)\left(I_C^2 + \frac{I_P^2}{2}\right)$$

❖ The collector dissipation is a maximum P_{Cmax} when no signal is present

$$P_{Cmax} = P_{CC} - (R_C + R_E) I_C^2 = \frac{V_{CC}^2}{4(R_C + R_E)} \simeq \frac{V_{CC}^2}{4R_C} \quad when\ R_C \gg R_E$$

❖ In most low-power transistor circuits, the power dissipated in the input circuit signal is small ⇒ P_C represents the **total dissipation internal to the transistor**.

Power Calculations - P_C

- P_{Cmax} is always specified by the manufacturer, P_{Cmax} must not be exceeded if the junction temperature is to be kept within safe limits.
- The useful power dissipated in the Load is ac power
- Increasing the ac current ⇒ Increasing the ac generated power ⇒ Decreasing the collector dissipation and Increasing the power delivered to the load.
- $P_{Cmax} = 2PL_{(\max)}$ ⇒ to obtain 1 W dissipation in the load requires a transistor capable of handling 2 W of collector dissipation ⇒ **a very inefficient power amplifier**. Ideally, one would like no power to be dissipated if there were no signal present.
- Ex: Consider using this amplifier in the receiver of an intercom system, the receive is always ON, yet we do not want to dissipate power in the receiver unless a voice signal is present. Use of the amplifier above would not be economical in this application.

Power Calculations - Efficiency

❖ The efficiency η of the amplifier: The ratio of the ac power dissipated in the load resistor to the power delivered by the supply:

$$\eta = \frac{P_L}{P_{DC}} \times 100 = \frac{I_P^2 R_C / 2}{V_{CC} / 2R_C} \times 100$$

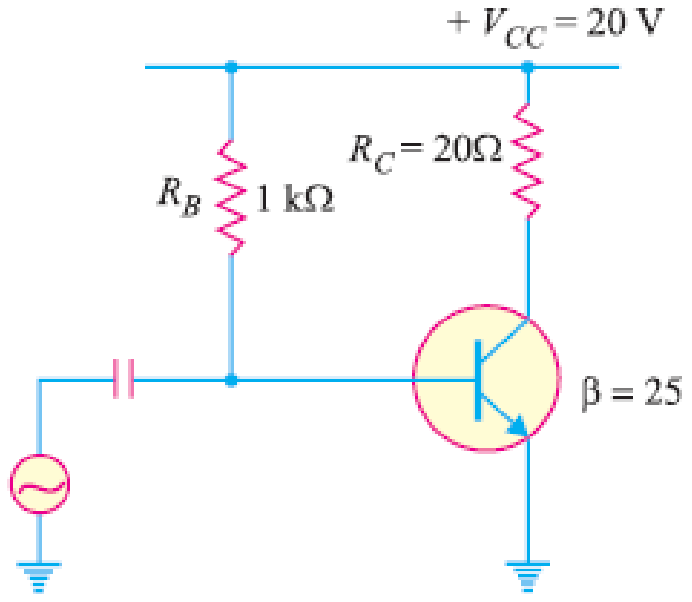
❖ When the signal is maximum, P_{CC} is constant, P_L increases with increase current ⇒ **the maximum efficiency** $\eta_{\max}$

$$\eta_{max} = \frac{V_{CC} / 8R_C}{V_{CC} / 2R_C} \times 100 = 25\%$$

❖ That is 75% of the power supplied by the sources is dissipated in the transistors. This is a waste of power, and it leads to a potentially serious heating problems with the transistors ⇒ **An extremely inefficient power amplifier**

Power Calculations

Example 4: Given the circuit in the following figure, let $V_{BE} = 0.7V$, $\beta = 25$. An input voltage that results in a base current of $10mA$ peak. Calculate the power supplied by the collector supply P_{CC}, the power dissipated in the load P_L and the efficiency of operation $\eta_{\max}$?



$$I_{CQ} = 0.48A$$

$$V_{CEQ} = 10.4V$$

$$P_{CC} = 9.6W$$

$$P_L = 0.625W$$

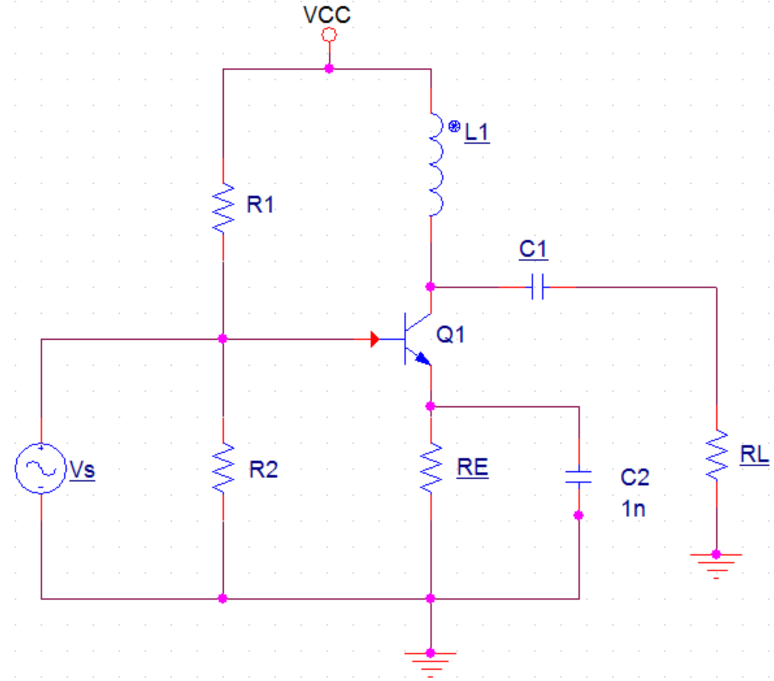
$$\eta_{\max} = 6.5\%$$

Inductor-Coupled CE Amplifier

- In CE Power Amplifier, a large amount of power was dissipated in the collector resistor $R_C \Rightarrow \eta_{\max} = 25\ \%$.

- When 1 W of signal power is to be dissipated in the load under maximum signal conditions ⇒ 4 W must be furnished continuously by the DC power supply.

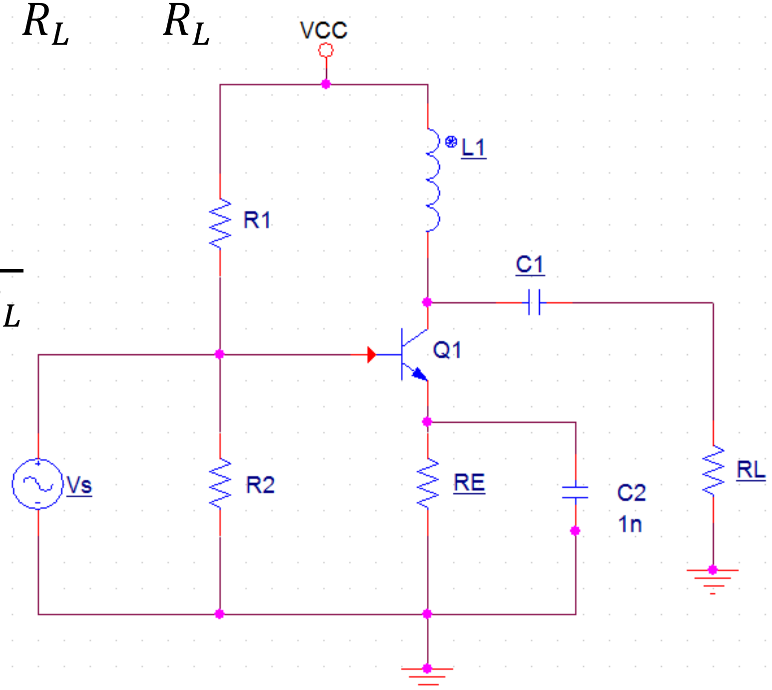
- Replacing R_C with a large inductor (called a “choke”) eliminates some of this dissipation and increase the maximum efficiency to 50 %.



Inductor-Coupled CE Amplifier

- The inductor has negligible resistance.
- The DC Load Line equation: $I_C = \frac{V_{CC}}{R_E} - \frac{V_{CE}}{R_E}$
- The AC Load Line equation: $i_C = I_{CQ} + \frac{V_{CEQ}}{R_L} - \frac{v_{CE}}{R_L}$
- For max-swing, the Q point:

$$I_{CQ} = \frac{1}{2} i_{C,max} = \frac{1}{2}\left(I_{CQ} + \frac{V_{CEQ}}{R_L}\right) = \frac{V_{CC}}{R_E + R_L}$$



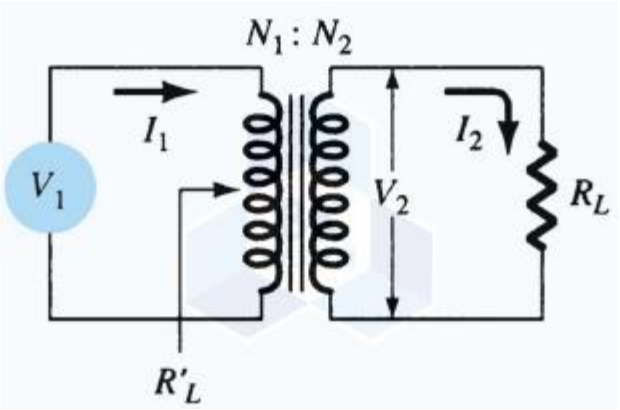
Inductor-Coupled CE Amplifier

- **Supplied Power:** $P_{CC} = V_{CC} I_{CQ} \approx \dfrac{V_{CC}^2}{R_L}$
- **Power transferred to load:** $P_L = \dfrac{R_L I_P^2}{2}$
  - The **maximum average** power dissipated by the load: $P_{L,max} = \dfrac{R_L I_{CQ}^2}{2} = \dfrac{V_{CC}^2}{2R_L}$
- **Power dissipated by the collector:** $P_C = P_{CC} - P_L = \dfrac{V_{CC}^2}{R_L} - \dfrac{R_L I_P^2}{2}$
  - The **maximum** power dissipated in the collector ($I_P = 0$): $P_{C,max} = \dfrac{V_{CC}^2}{R_L}$
  - The **minimum** power dissipated in the collector ($I_P = I_{CQ}$): $P_{C,min} = \dfrac{V_{CC}^2}{2R_L}$
- **Efficiency:** $\eta = \dfrac{P_L}{P_{CC}} = \dfrac{\frac{R_L I_P^2}{2}}{V_{CC} I_{CQ}} = \dfrac{1}{2} \dfrac{I_P^2}{I_{CQ}^2}$ $\eta_{max} = 50\%$

Reviews – Transformer

- A transformer can **increase or decrease voltage or current** levels according to the turns ratio.

- In addition, the impedance connected to one side of a transformer can be made to appear either larger or smaller (step up or step down) at the other side of the transformer, depending on the square of the transformer winding turns ratio.



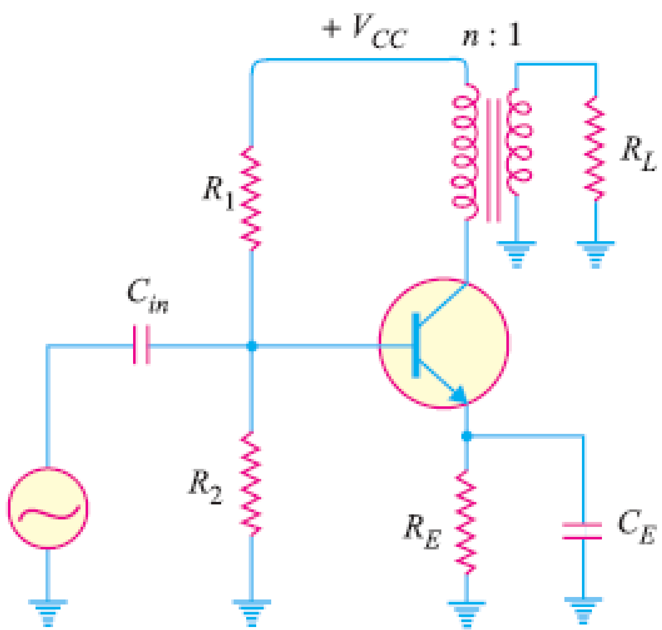
- Voltage transformation: $$\frac{V_2}{V_1} = \frac{N_2}{N_1}$$

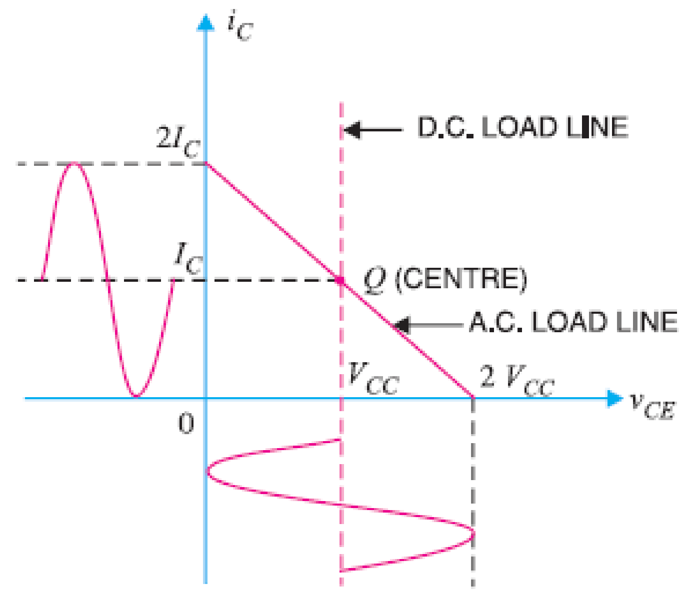
- Current transformation: $$\frac{I_2}{I_1} = \frac{N_1}{N_2}$$

- Impedance transformation: $$\frac{R'_L}{R_L} = \left(\frac{N_1}{N_2}\right)^2$$

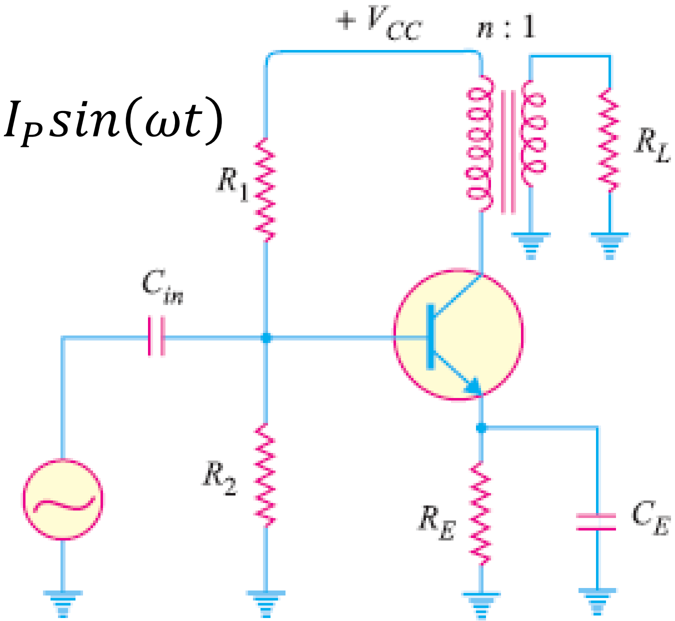
Transformer-Coupled Load CE Amplifier

❖ The effective load resistance R_L' referred to the primary side: $R'_L = \left(\frac{N_P}{N_S}\right)^2 R_L$





Transformer-Coupled Load CE Amplifier



❖ **The collector current:** $i_C = I_{CQ} + i_c = \frac{V_{CC}}{R'_L} + I_P sin(\omega t)$

❖ **The load current:** $i_L = I_P \frac{N_P}{N_S} sin(\omega t)$

❖ **Supplied power:** $P_{CC} = V_{CC} I_{CQ} \simeq \frac{V_{CC}^2}{R'_L}$

❖ **Power transferred to load:** $P_L = \frac{R'_L I_P^2}{2}$

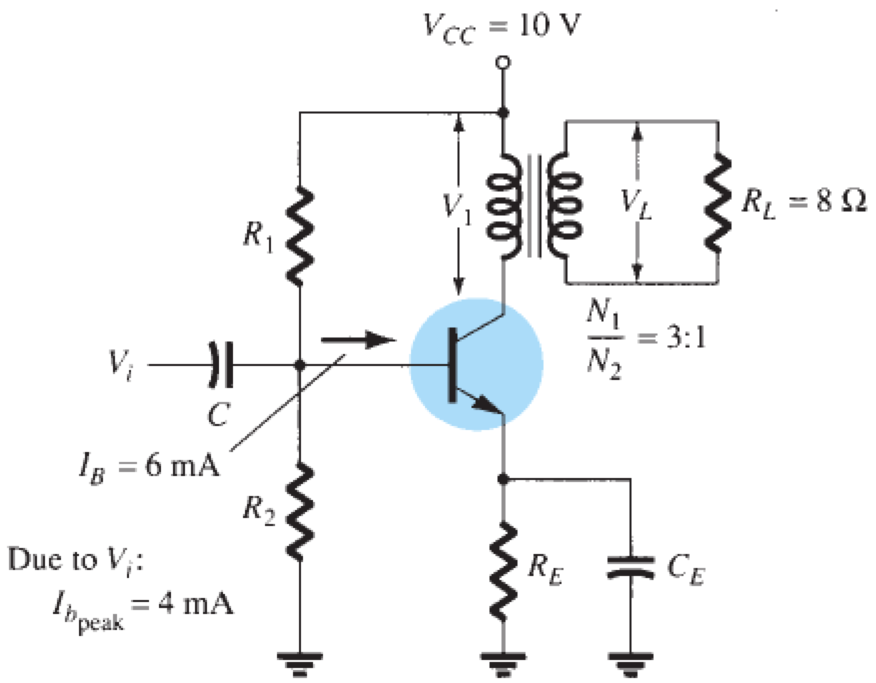
- The **maximum average** power dissipated by the load: $P_{L,max} = \frac{R'_L I_{CQ}^2}{2} = \frac{V_{CC}}{2R'_L}$

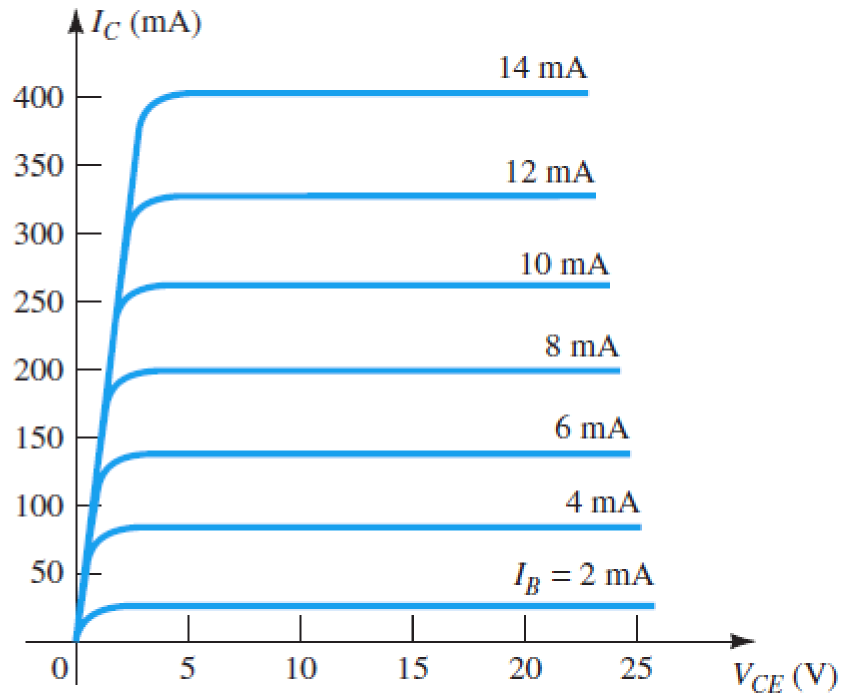
❖ **Power dissipated by the collector:** $P_C = P_{CC} - P_L = \frac{V_{CC}^2}{R'_L} - \frac{R'_L I_P^2}{2}$

❖ **Efficiency:** $\eta = \frac{P_L}{P_{CC}} = \frac{\frac{R'_L I_P^2}{2}}{V_{CC} I_{CQ}} = \frac{1}{2}\frac{I_P^2}{I_{CQ}^2}$ $\eta_{max} = 50\%$

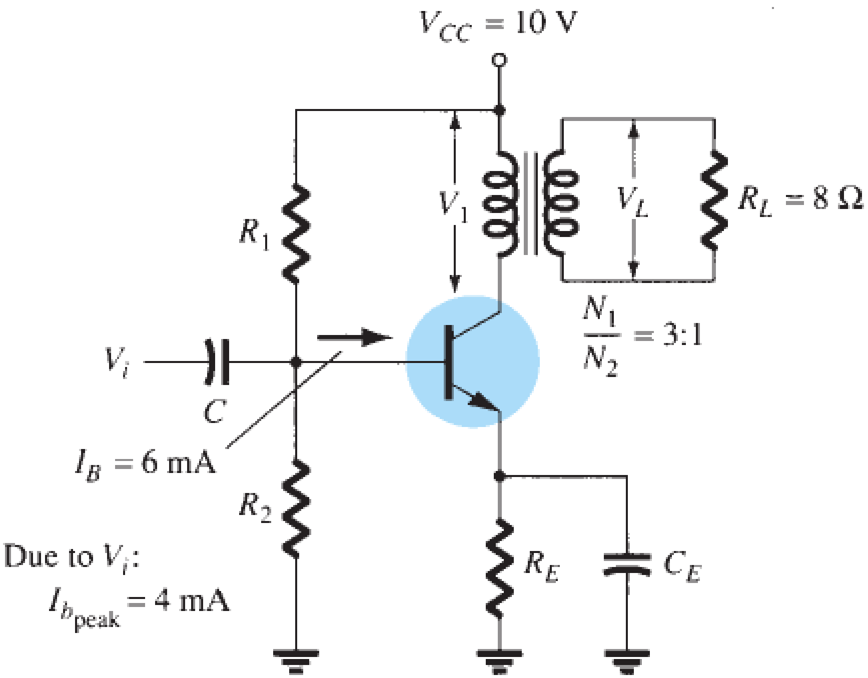
Transformer-Coupled Load CE Amplifier

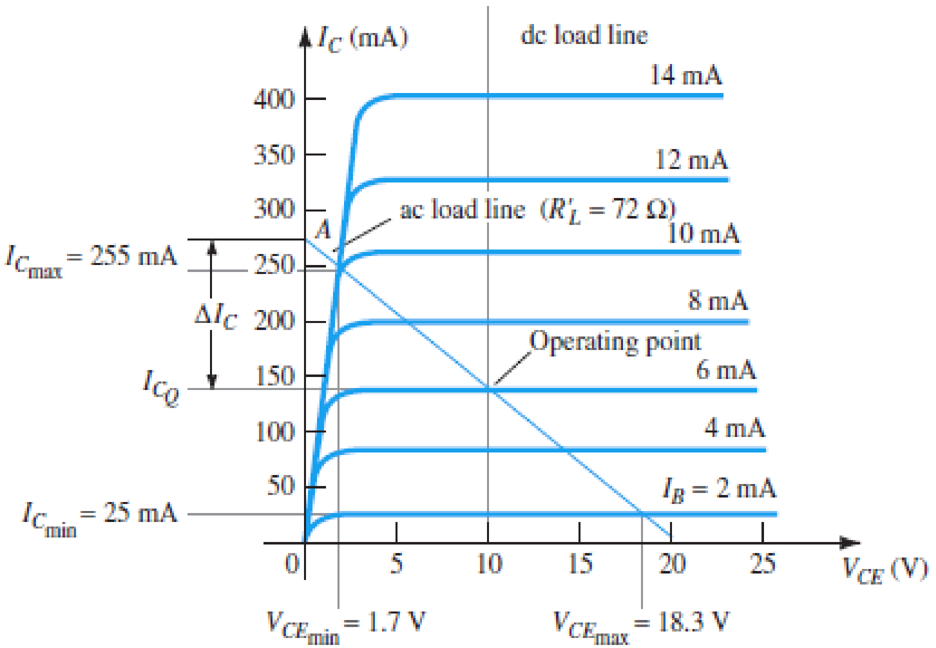
Example 5: Calculate the ac power delivered to 8 ohm speaker for the circuit shown below. The circuit component values result in a dc base current of 6mA, and the input signal *vi* results in a peak base current swing of 4mA.





Transformer-Coupled Load CE Amplifier



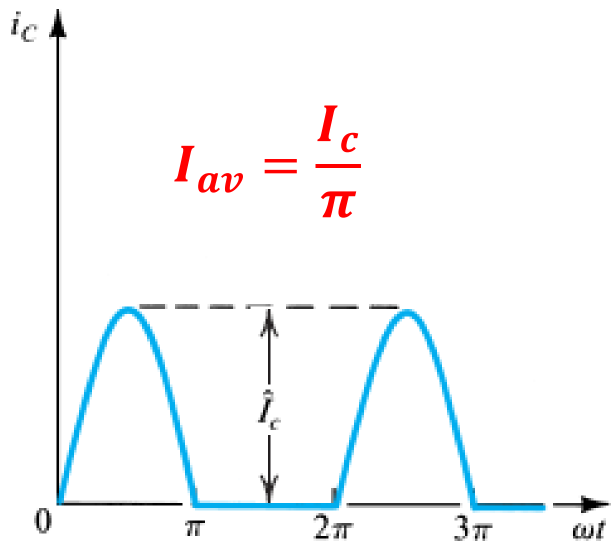


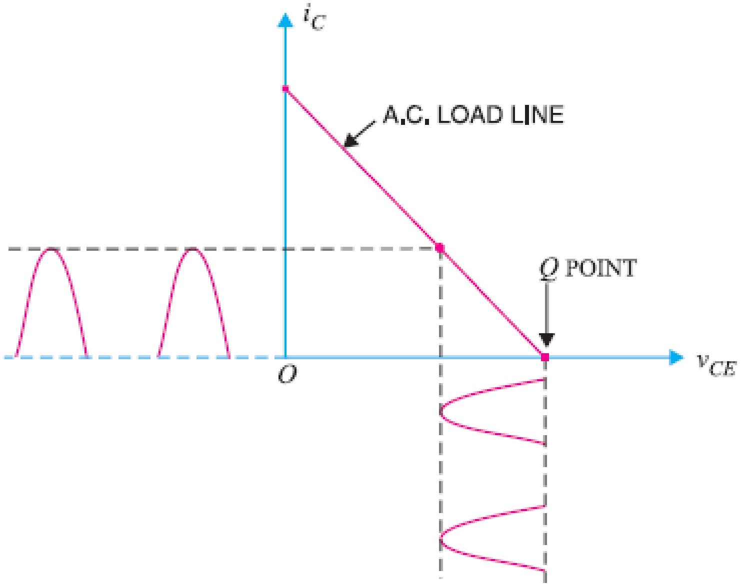
$P_L = 0.477W \qquad P_{CC} = 1.4W \qquad \eta = 34.1\%$

Class B Amplifier

❖ **Class B power amplifier**: *If the collector current flows only during the positive half-cycle of the input signal, it is called a* **class B power amplifier**.

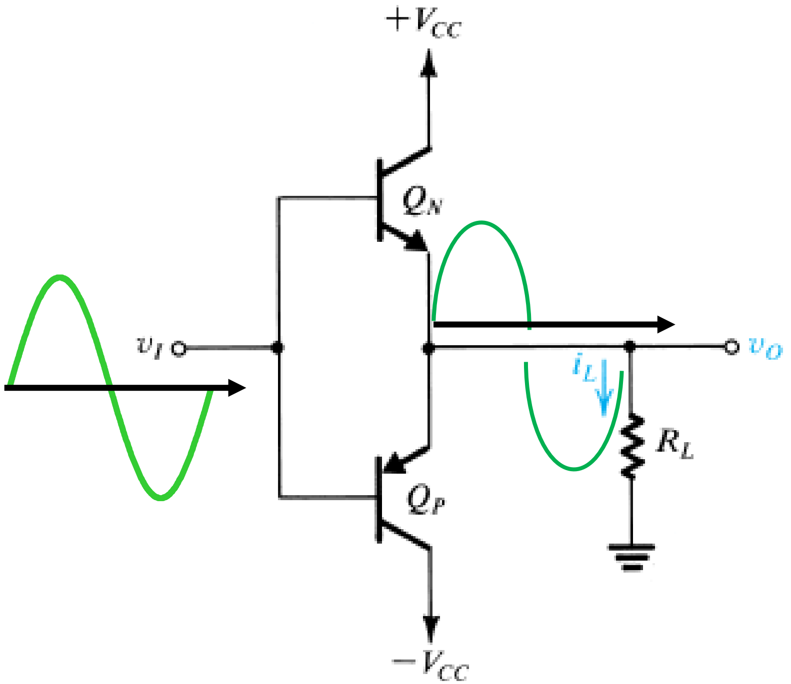
- No biasing circuit is needed at all.
- The operating point *Q* is located at collector cut-off voltage.
- Severe distortion occurs.
- Provide higher power output and collector efficiency $(50 - 60\%)$.



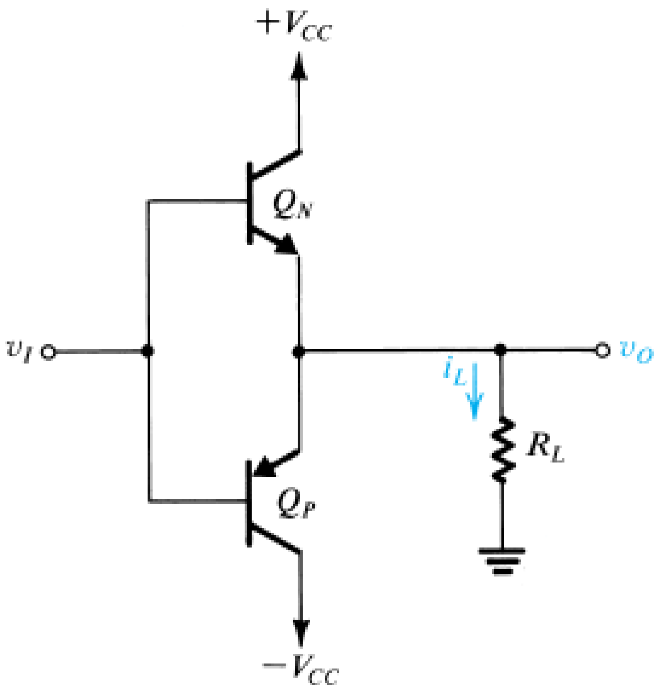


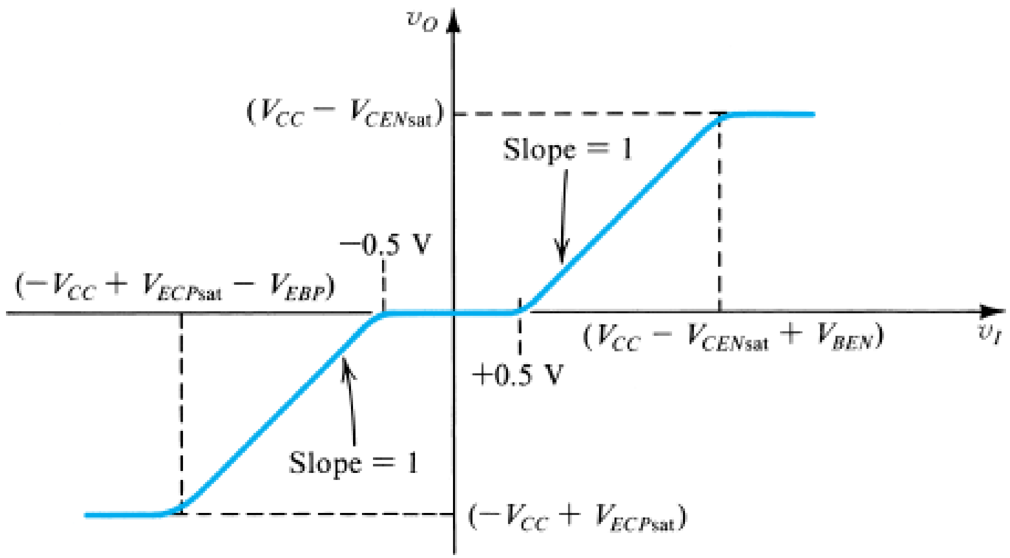
Class B Amplifier

- In Class B, transistor is biased just off. The AC signal turns the transistor ON.
- The transistor only conduct when it is turned on by one-half of the AC cycle.
- In order to get a full AC cycle out of class B, two transistors are required:
  - An npn transistor that provide the positive half of the AC cycle.
  - An pnp transistor that provide the negative half of the AC cycle.



Class B Amplifier





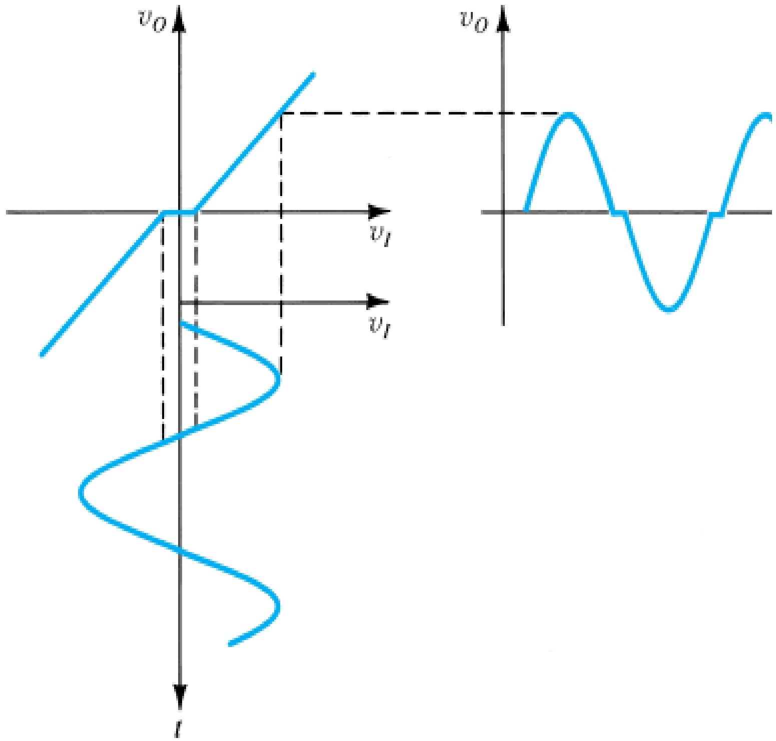
- $V_{BE,on} < v_I < V_{CC} - V_{CE,sat}$: Q_N ON, Q_P OFF

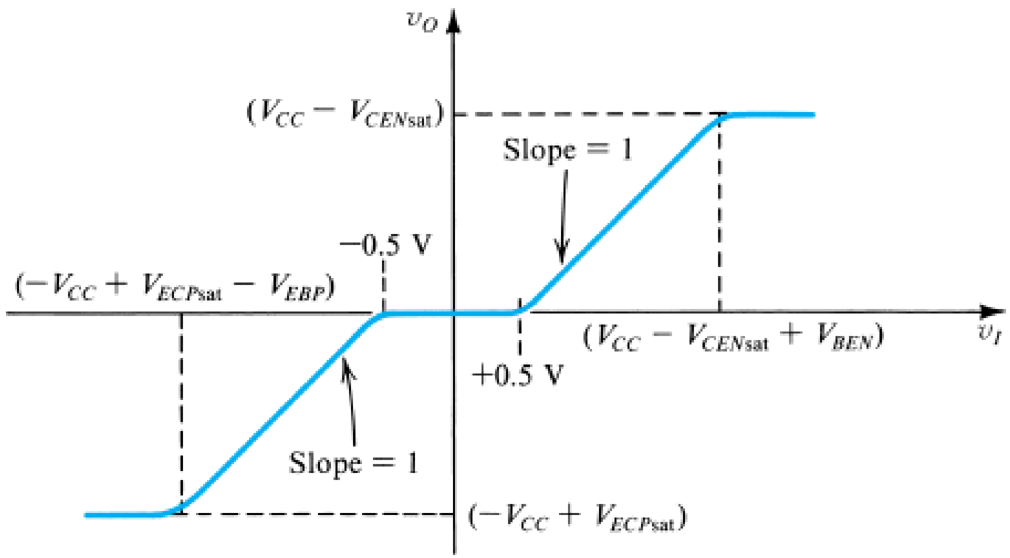
  $v_o = v_I - v_{BE,ON}$ $\qquad$ $i_L = i_{CN}\ (PUSH)$

- $-V_{CC} + V_{CE,sat} < v_I < -V_{BE,on}$: Q_N OFF, Q_P ON

  $v_o = v_I + v_{BE,ON}$ $\qquad$ $i_L = -i_{CP}\ (PULL)$

Class B Amplifier





- $-V_{BE,on} < v_I < V_{BE,on}$: Q_N OFF, Q_P ON

  $v_o = 0$

- **Crossover distortion on input & output waveforms**
- **Crossover distortion in audio power amplifiers produce unpleasant sounds.**

Class B – Output Power and Efficiency

- The average collector current of a transistor: $$\boxed{I_C = \frac{1}{T}\int_0^{T/2} i_c\,(t)dt = \frac{I_P}{\pi}}$$

- The average current draw from the DC supply source by transistors Q_N and Q_P

$$\boxed{I_{dc} = 2I_C = \frac{2I_P}{\pi}}$$

- The average input power supplied from the DC source:

$$\boxed{P_{CC} = V_{CC}I_{dc} = 2V_{CC}I_C}$$

- The output power:

$$\boxed{P_L = \frac{R_L I_P^2}{2}}$$

- The power efficiency: $$\eta = \frac{P_L}{P_{DC}} = \frac{\pi}{4}\frac{V_P}{V_{CC}}$$

$$\eta = 50\%@V_P = {}^{2V_{CC}}/_{\pi}$$

$$\eta = 78.5\%@V_P = V_{CC}$$

Class B – Output Power and Efficiency

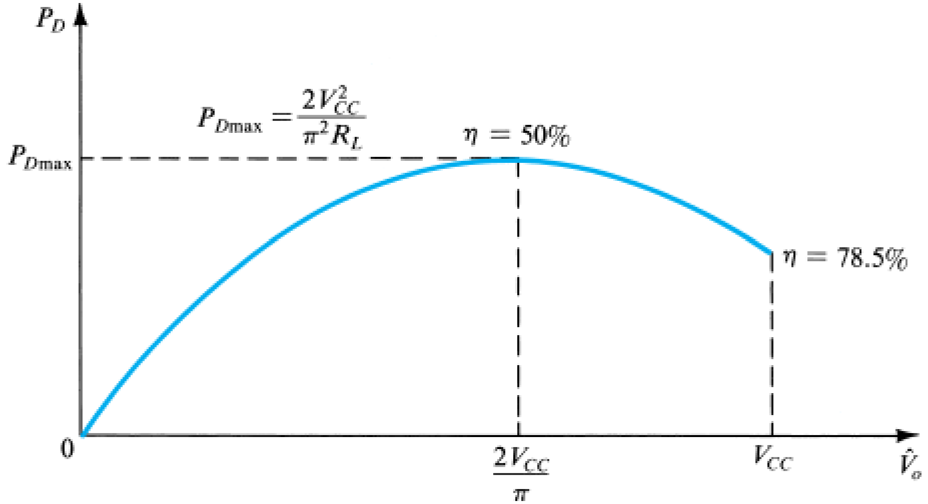
- *The average* power dissipated in the class B stage is given by:

$$\boxed{P_D = P_S - P_L = 2V_{CC}\frac{I_P}{\pi} - \frac{R_L I_P^2}{2}}$$

- The maximum collector power at $\frac{\partial P_D}{\partial I_P} = 0 \rightarrow I_{P,max} = \frac{2V_{CC}}{\pi R_L}$

$$\boxed{V_{P,max} = {}^{2V_{CC}}/_{\pi}}$$

$$\frac{P_D}{P_{D,max}} = \frac{\pi V_P}{V_{CC}} - \frac{\pi^2 V_P^2}{4V_{CC}^2}$$



Class B – Output Power and Efficiency

Example 6: For a class B amplifier using a supply of $V_{CC} = 30$ and driving a load of 16Ω, determine the maximum input power P_{CCmax}, output power P_{Lmax}, the maximum efficiency $\eta_{\max}$, and power dissipation of each transistor, P_{Cmax}?

$P_{Lmax} = 28.125W$ $P_{CCmax} = 35.8W$ $\eta_{max} = 78.54\%$ $P_{Cmax} = 5.7W$

Example 7: Calculate the efficiency of a class B amplifier for a supply voltage of V_{CC}=24V with peak output voltages of:

a. $V_P = 22V$
b. $V_P = 6V$

a. $\eta = 72\%$ b. $\eta = 19.6\%$

Class B – Output Power and Efficiency

Example 8: For a class B amplifier providing a 20V peak signal to a 16Ω load (speaker) and a power supply of $V_{CC} = 30V$, determine the input power, output power, and circuit efficiency?

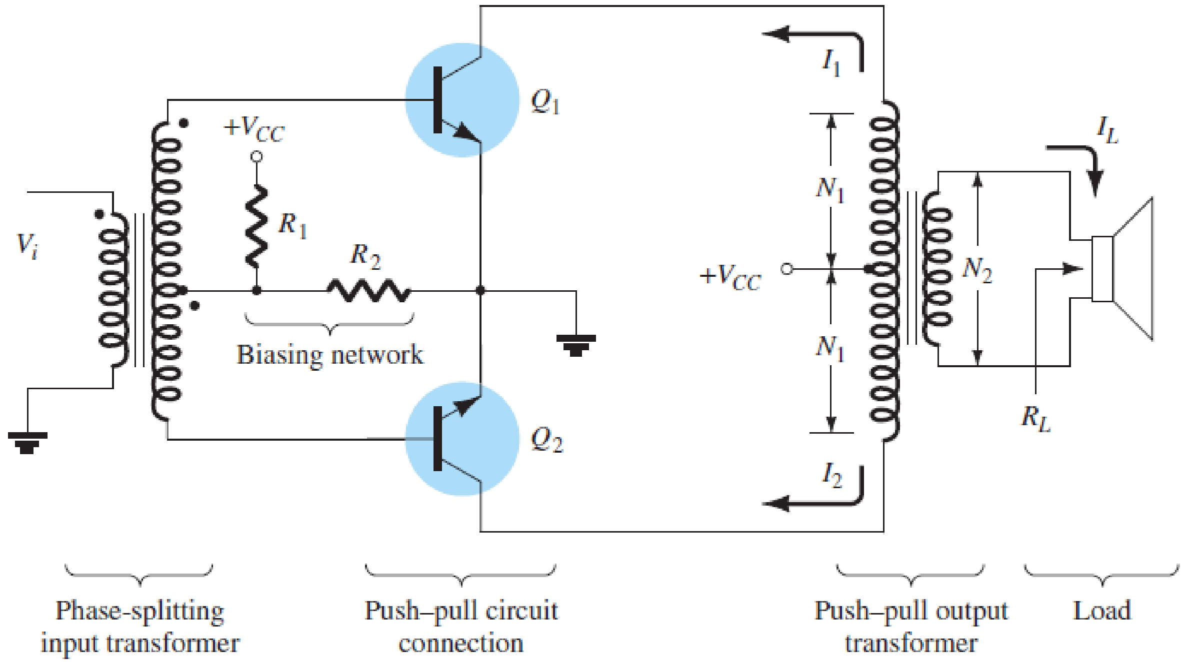
$P_L = 12.5W$ $P_{CC} = 23.9W$ $\eta \quad = 52.3\%$

Transformer-Coupled Push Pull Circuit

- *The circuit uses a center-tapped input transformer to produce opposite polarity signals to the two transistor inputs and an output transformer to drive the load in a push-pull mode of operation.*

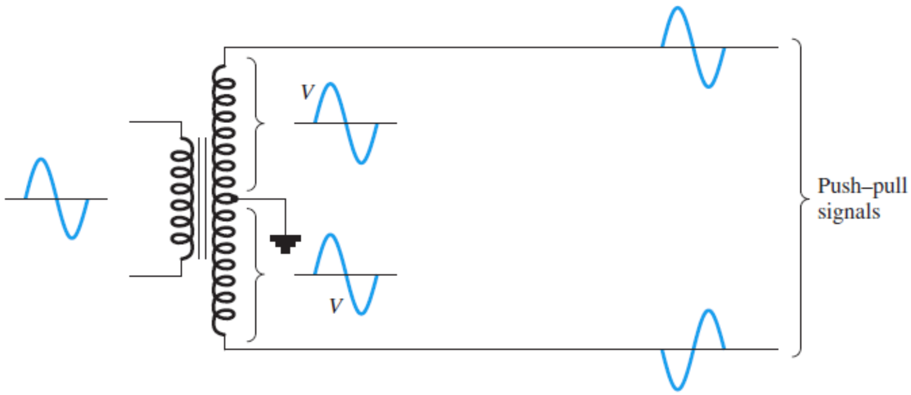
- *During the first half-cycle of operation, transistor Q1 is driven into conduction whereas transistor Q2 is driven off.*

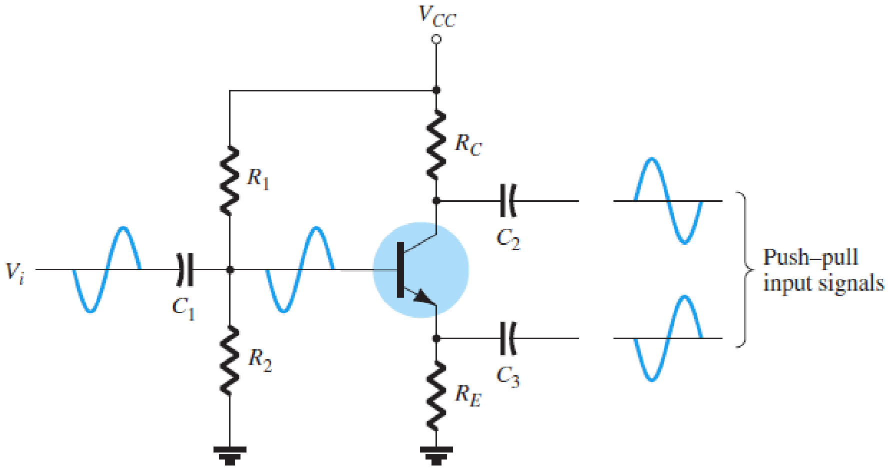
- *During the second half-cycle of the input signal. Q2 conducts whereas Q1 stays off.*

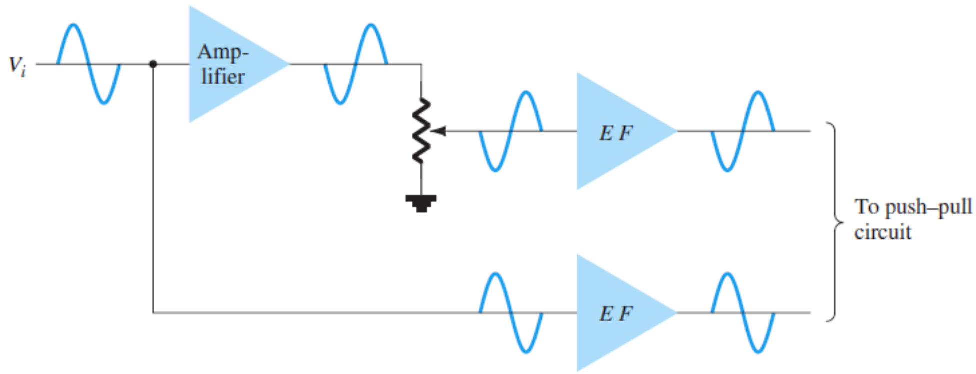


Transformer-Coupled Push Pull Circuit

❖ *Different ways to obtain phase-shifter circuits*

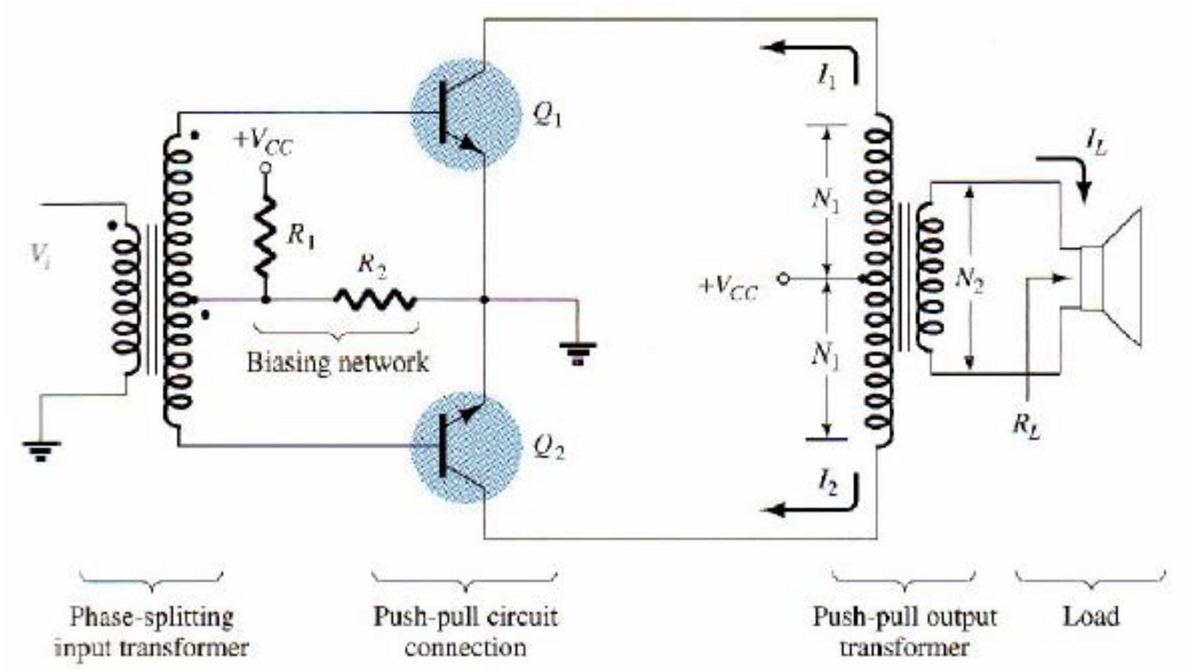






Transformer-Coupled Push Pull Circuit

Example 8: Design a transformer-coupled class B push-pull amplifier, as shown in figure below, to supply a maximum output power of $P_{L(\max)} = 10W$ at a load resistance of $R_L = 4\Omega$. Assume a DC supply voltage of 15V and transistors of $\beta = 100$ and $V_{BE} = 0.7V$.



$R'_L = 11.25\Omega$

$N_P/N_S = 1.68$

$R_B = 8.25\Omega$

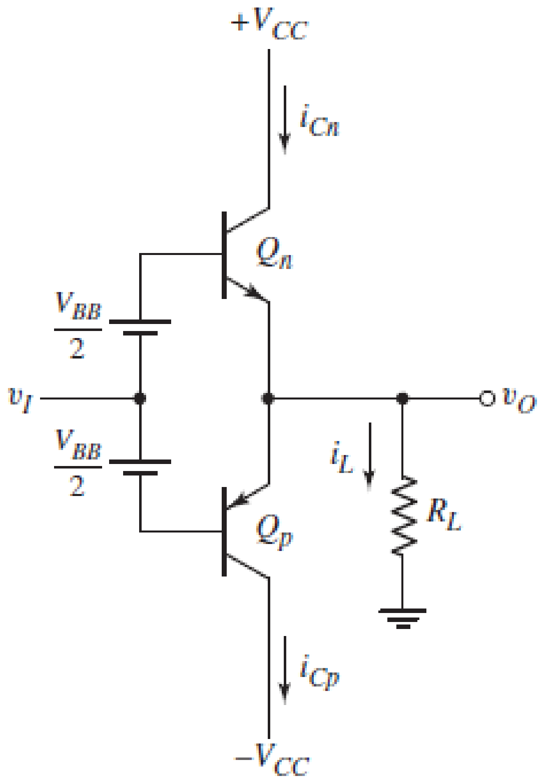
$V_{BB} = 0.77V$

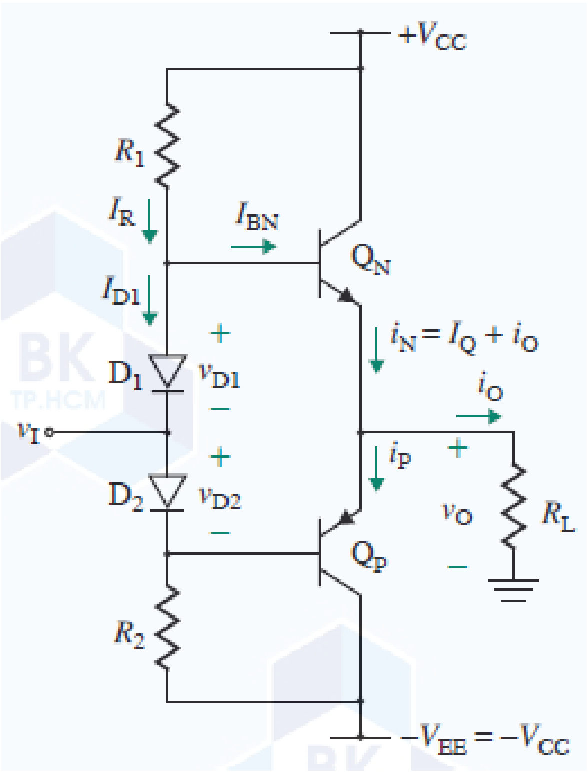
$R_1 = 8.7\Omega$

$R_2 = 161\Omega$

Class AB Amplifier

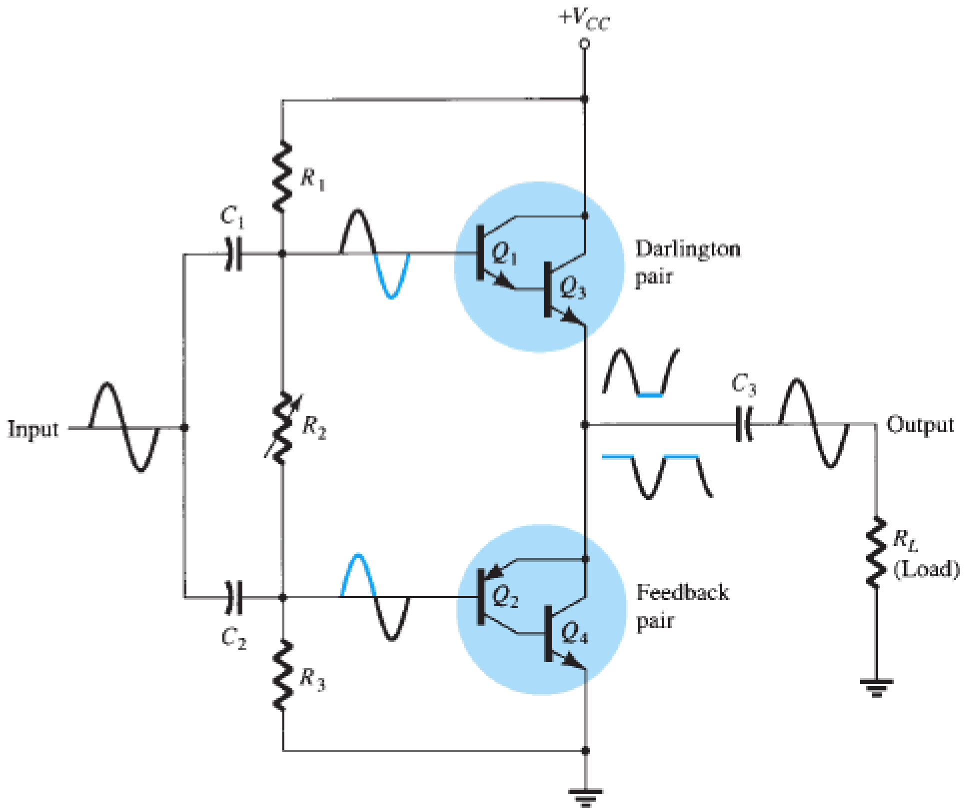
❖ Crossover distortion can be virtually eliminated by applying a small quiescent bias on each output transistor, for a zero input signal. This is called a class-AB output stage.





Class AB Amplifier

- Resistor R_2 can be adjusted to minimize crossover distortion by adjusting the dc bias condition



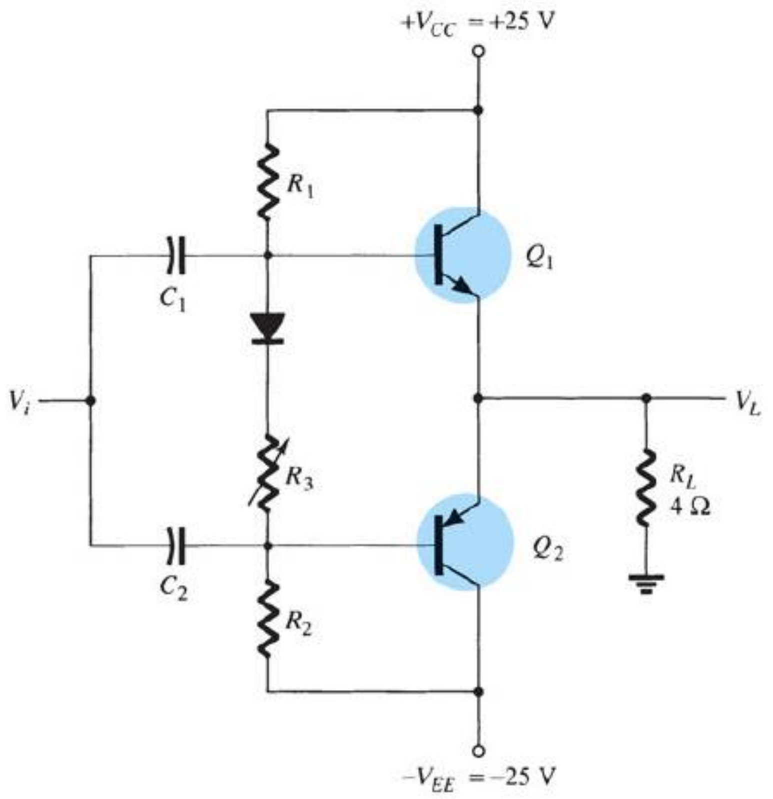
Class AB Amplifier

Example 9: For the circuit of following figure, calculate:

a. Input power, output power, and power handled by each output transistor and the circuit efficiency for an input of 12 V rms.

b. Maximum input power, maximum output power, input voltage for maximum power operation, and power dissipated by the output transistors at this voltage.

c. Determine the maximum power dissipated by the output transistors and the input voltage at which this occurs.



Q&A