Analog Electronics

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1st **semester**

Chapter 5

Amplifiers

Lec. 12

The Common-Emitter Amplifier

Three amplifier configurations are the **common-emitter**, the **common-base,** and the **common-collector**.

In the common-emitter (CE) amplifier, the **input signal** is applied to the **base** and the **inverted output** is **taken** from the **collector**. The emitter is common to AC signals.

Figure 4 shows a common-emitter amplifier with voltage-divider bias and coupling capacitors C_1 and C_3 on the input and output and a bypass capacitor, C_2, from the emitter to the ground.

The input signal V_{in} is capacitive coupled to the base terminal, and the output signal **V_{out}** is capacitively coupled from the collector to the load.

The A_{CE} amplifier has **high voltage**, **current**, and **power gains** **but** a relatively low input resistance.

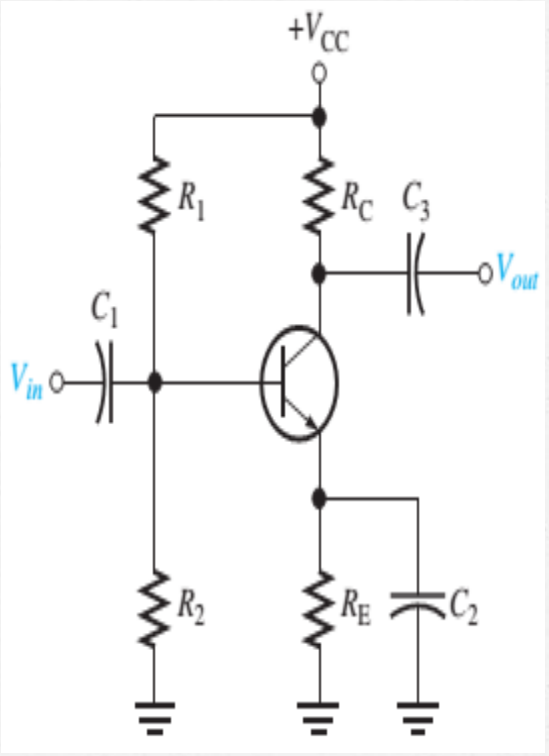


Figure 4: A common-emitter amplifier.

The Common-Base Amplifier

The common-base (CB) amplifier **provides** **high voltage gain** with a **maximum current gain** **of 1**. Since it has a low input resistance, the CB amplifier is the most appropriate type for certain applications where sources tend to have **very low-resistance outputs.**

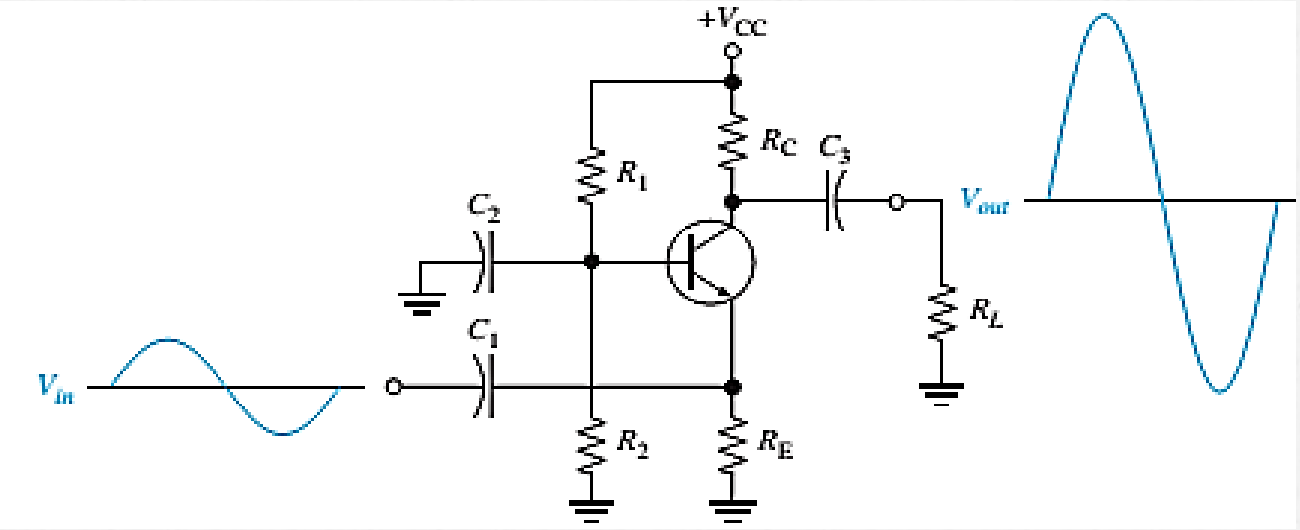


Figure 6: Common-base amplifier with voltage-divider bias.

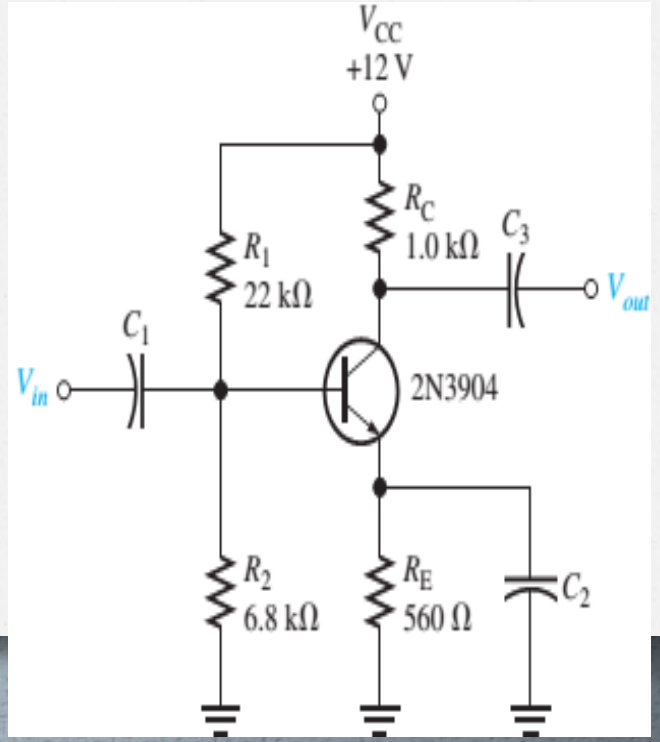
Capacitors in Amplifier

Coupling capacitors are **used** to transmit an AC signal from one node to another. Coupling capacitors **provide** DC isolation between two nodes.

Bypass capacitor is **used** to short-circuit AC signals to the ground (while not affecting the DC operation of the circuit).

The **value** of the bypass capacitor **must** be large enough so that its reactance over the frequency range of the amplifier is very small (ideally) compared to R_E.

The **capacitive reactance, X_C**, of the bypass capacitor should be **at least 10 times smaller than R_E at** the **minimum frequency** for which the amplifier must operate (**$10X_C \leq R_E$**).



Transistors as a Small Signal Amplifier

There are **two analysis**; **DC Analysis and AC Analysis**.

The purpose of DC analysis is to determine the **initial operating values** of IC, IB and VCE (Q-point).

The goal is to set the Q-point such that it does not go into saturation or cutoff **when** an AC signal is applied.

If the Q-point is in active region, the transistor can operate **as an amplifier**. The purpose of **AC analysis** is to obtain the gain.

An amplifier is a system that has a gaining ability to amplify where a small electrical signal will be converted into a strong one. Amplifiers are classified as small signal amplifiers (preamplifiers) and strong signal amplifiers (power amplifiers).

Amplifiers are able to amplify current, voltage and/or power. In other words, **only amplifiers** are able to produce power gain where as other devices such as **transformer** are **only** able to produce **voltage and current gain.**

Small signal amplification **causes** **small** current changes and **small** output voltage change surrounding operation point (Q-point from DC analysis). These small changes are small enough for us to disregard any influence it may have on the transistor's parameter values such as **α** and **β**.

There are 4 basic categories of small signal amplifiers:

– Voltage amplifier.

– Current Amplifier

– Trans-conductance Amplifier (converts voltage to current)

– Trans-resistance Amplifier (converts current to voltage)

Gain

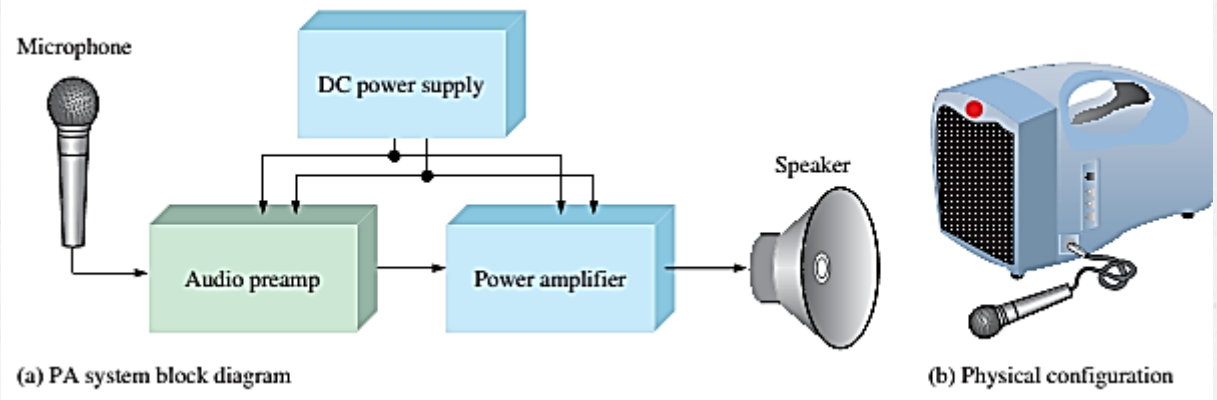
The **gain of an amplifier** is the ratio of an output parameter to an input parameter.

An amplifier with a current gain of 100–during normal use, the output current is **a hundred times greater** than the input current. There are three types of gain:

$$\text{Current gain} \quad A_i = \frac{i_o}{i_i}$$

$$\text{Voltage gain} \quad A_v = \frac{v_o}{v_i}$$

$$\text{Power gain} \quad A_p = \frac{P_o}{P_i} = A_v A_i$$



H.W

H.W.: Give examples of other amplifiers.