دارات الكترونية
عملي - /1/المحاضرة

الدكتور السموءل صالح
المهندس جبران خليل
المهندسة ايه خيربك

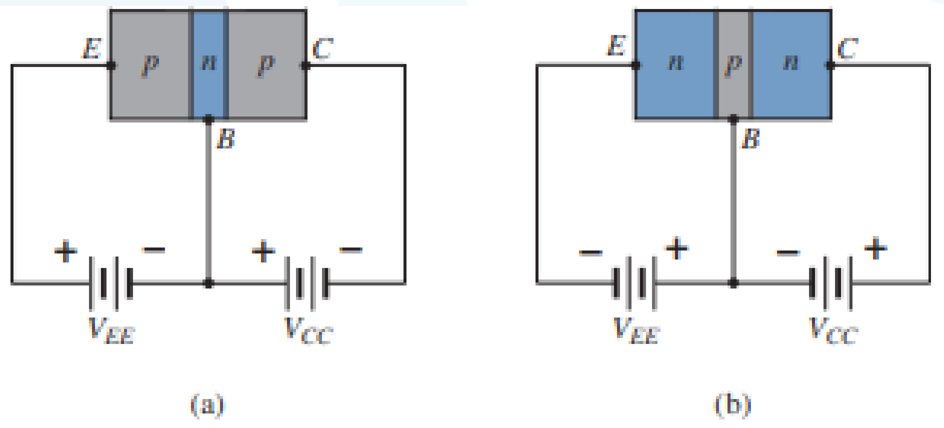
مراجعة

BJT (Bipolar Junction Transistors) ترانزستورات

- The transistor is *a three-layer semiconductor* device consisting of either two n- and one p-type layers of material or two p- and one n-type layers of material.

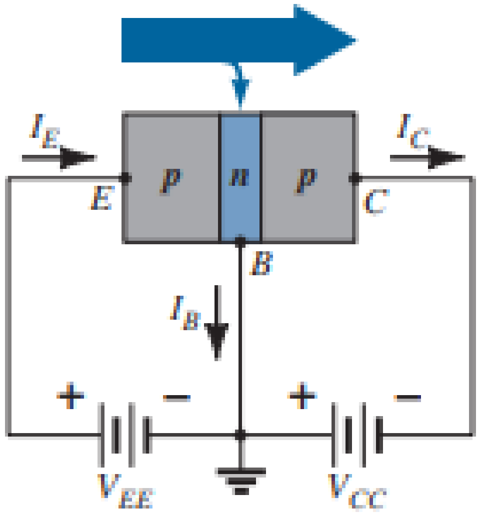
- The former is called an npn transistor, and the latter is called a pnp transistor.

- For the biasing shown in Figure the terminals have been indicated by the capital letters E for *emitter*, C for *collector*, and B for *base*.

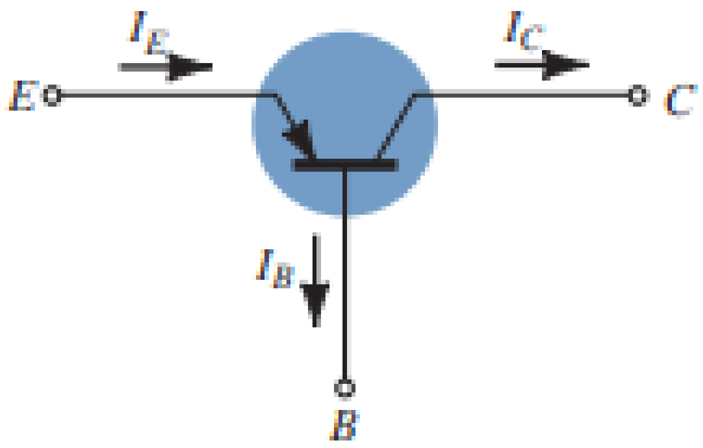


BJT (Bipolar Junction Transistors) ترانزستورات

- Applying Kirchhoff's current law to the transistor of Figure as if it were a single node, we obtain



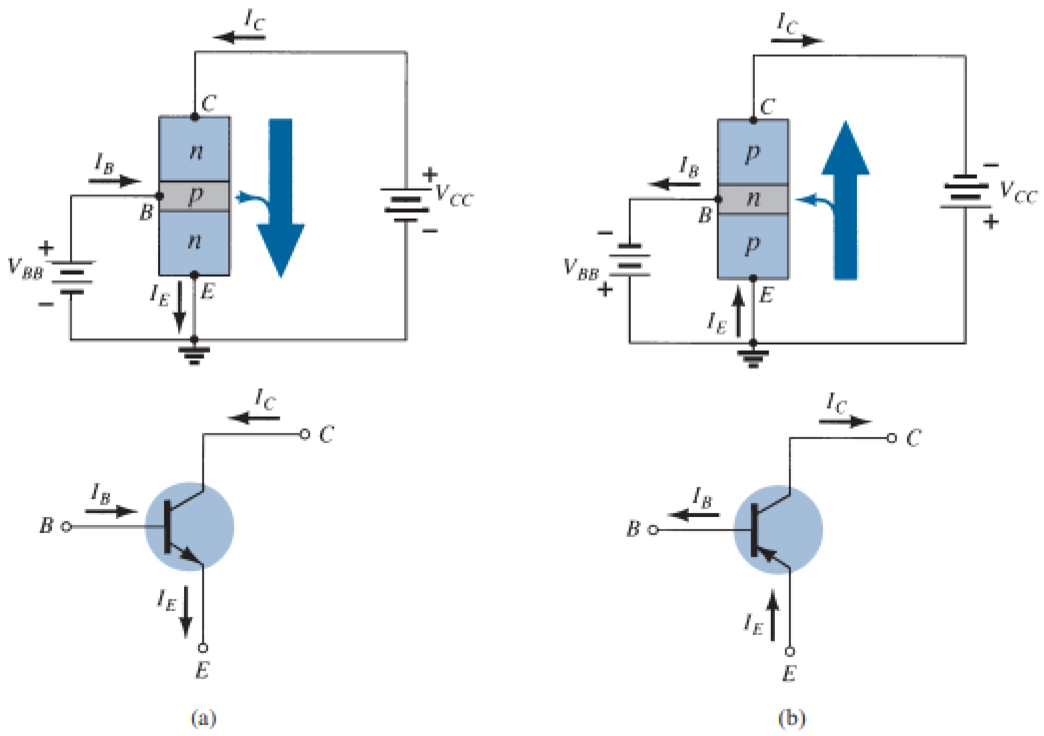
IE = IC + IB



BJT (Bipolar Junction Transistors) ترانزستورات

- **Common-emitter Configuration**

It is called the common-emitter configuration because the emitter is common to both the input and output terminals

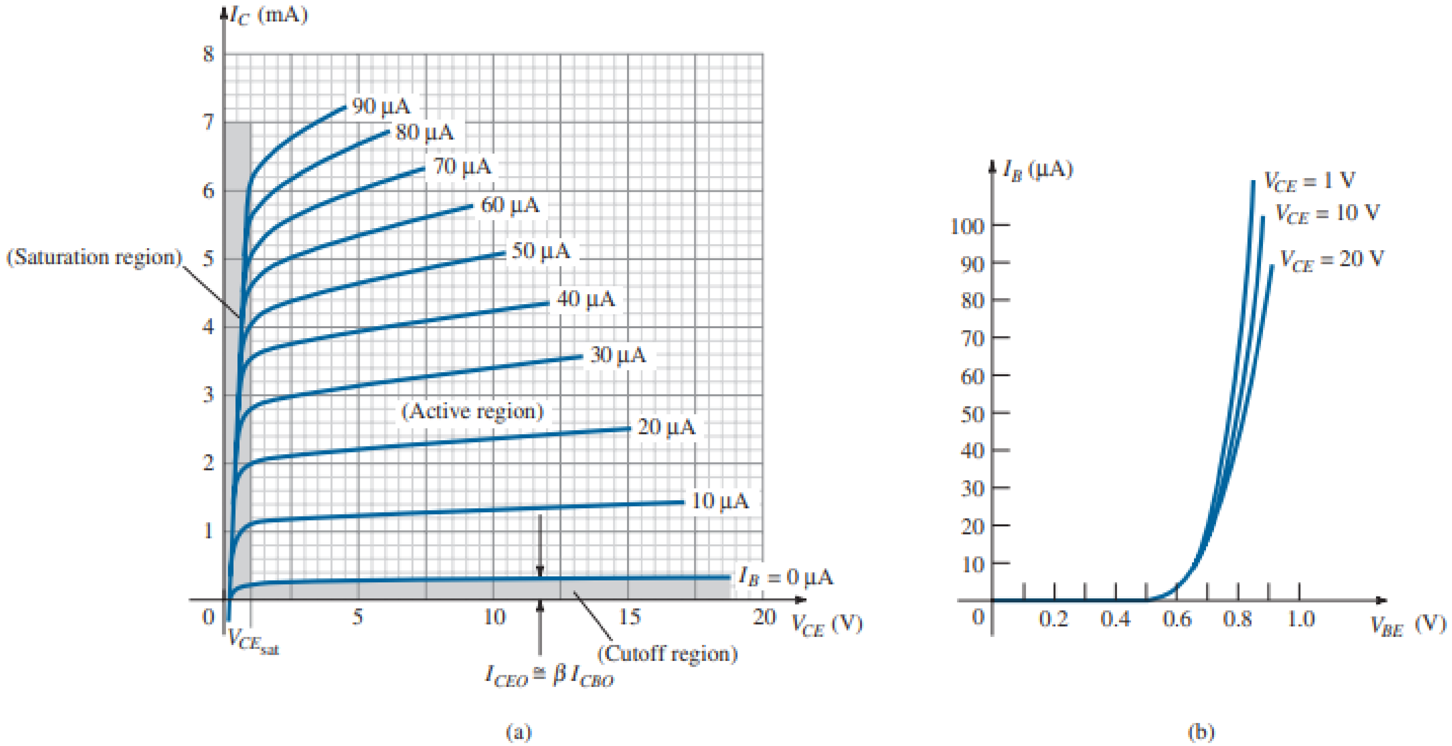


Notation and symbols used with the common-emitter configuration: (a) npn transistor; (b) pnp transistor.

BJT (Bipolar Junction Transistors) ترانزستورات

- Common-emitter Configuration

For the common-emitter configuration the output characteristics are a plot of the output current (IC) versus output voltage (VCE) for a range of values of input current (IB). The input characteristics are a plot of the input current (IB) versus the input voltage (VBE) for a range of values of output voltage (VCE)



Characteristics of a silicon transistor in the common-emitter configuration: (a) collector characteristics; (b) base characteristics.

BJT (Bipolar Junction Transistors) ترانزستورات

- Common-emitter Configuration

beta (β)

DC mode:

In the dc mode the levels of IC and IB are related by a quantity called **beta** and defined by the following equation:

$$\beta_{dc} = \frac{I_C}{I_B}$$

where IC and IB are determined at a particular operating point on the characteristics. For practical devices the level of β typically ranges from about 50 to over 400, with most in the midrange. The parameter β reveals the relative magnitude of one current with respect to the other. For a device with a β of 200, the collector current is 200 times the magnitude of the base current.

BJT (Bipolar Junction Transistors) ترانزستورات

- **Uses of BJT**

- BJTs are versatile semiconductor devices used for signal amplification in electronic circuits.
- They serve as electronic switches in digital applications, controlling current flow.
- BJTs play a role in signal modulation for communication systems.
- Oscillator circuits utilize BJTs to generate continuous waveforms, crucial in RF applications.
- They find use in voltage regulation, stabilizing output in power supply circuits.
- BJTs are also employed in audio amplifiers, RF amplifiers, photodetection, and temperature sensing.

BJT (Bipolar Junction Transistors) ترانزستورات

-Advantages & Disadvantages

Advantages of BJTs:

- High current gain for effective signal amplification.
- Fast switching speed, suitable for certain high-speed applications.
- Simple drive circuit compared to some other transistor types.
- Good linearity in amplification applications, making them suitable for audio amplifiers.
- Lower saturation voltage in the ON state compared to some alternatives.
- Well-established technology with a long history of reliable use.
- Cost-effective for many applications.

BJT (Bipolar Junction Transistors) ترانزستورات

-Advantages & Disadvantages

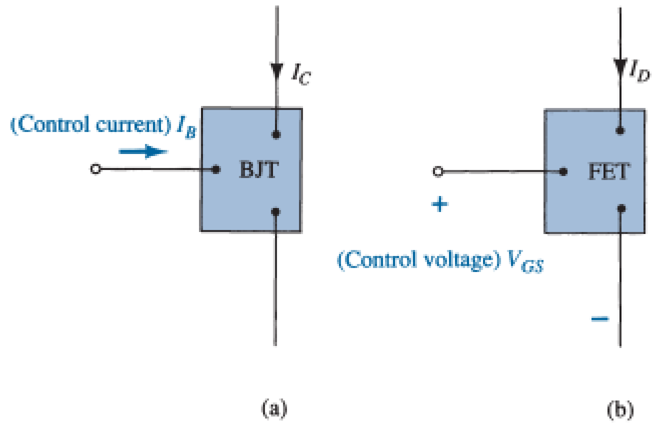
Disadvantages of BJTs:

- Higher power consumption, especially in the ON state.
- Larger physical size compared to some alternatives, limiting use in integrated circuits.
- Temperature-sensitive characteristics that can impact performance.
- Lower input impedance compared to some alternatives.
- Potential for more noise in electronic circuits.
- Complexity in high-frequency designs due to parasitic capacitances.

FET (field-effect transistor) ترانزستورات

The field-effect transistor (FET) is a three-terminal device used for a variety of applications that match, to a large extent, those of the BJT transistor. Although there are important differences.

The **BJT** transistor is a ***current-controlled*** device as depicted in Figure (a), whereas the **JFET** transistor is a ***voltage-controlled*** device as shown in Figure (b).



(a) Current-controlled and (b) voltage-controlled amplifiers.

JFET (Junction field-effect transistor) ترانزستورات

The **basic construction** of the n-channel JFET is shown in previous figure. The *major* part of the structure is the n-type material, which forms the channel between the embedded layers of p-type material.

The top of the n-type channel is connected through an ohmic contact to a terminal referred to as the ***drain (D),*** whereas the lower end of the same material is connected through an ohmic contact to a terminal referred to as the ***source (S)***. The two p-type materials are connected together and to the ***gate (G)*** terminal.

In essence, therefore, the drain and the source are connected to the ends of the n-type channel and the gate to the two lavers of p-type material

JFET (Junction field-effect transistor) ترانزستورات

Advantages of JFETs:

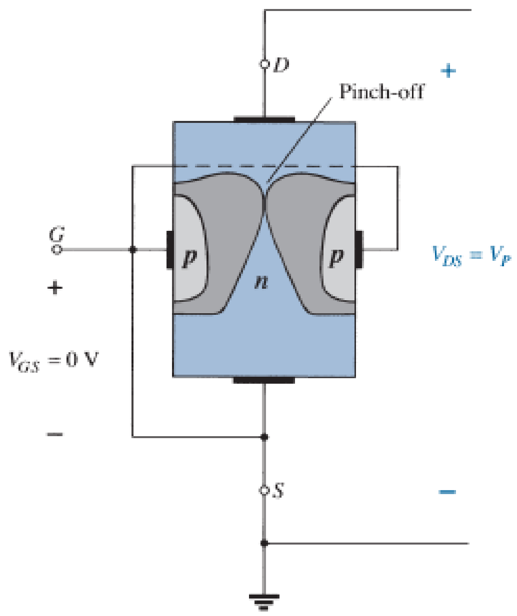
- High input impedance, beneficial for circuits requiring minimal loading.
- Low noise characteristics make them suitable for applications like audio amplifiers.
- Simple biasing requirements ease integration into electronic circuits.
- Good linearity in signal amplification for faithful signal reproduction.
- No gate current, potentially leading to lower power consumption.
- High-temperature stability makes them suitable for challenging environments.
- Well-suited for low-power applications due to their low power requirements.

JFET (Junction field-effect transistor) ترانزستورات

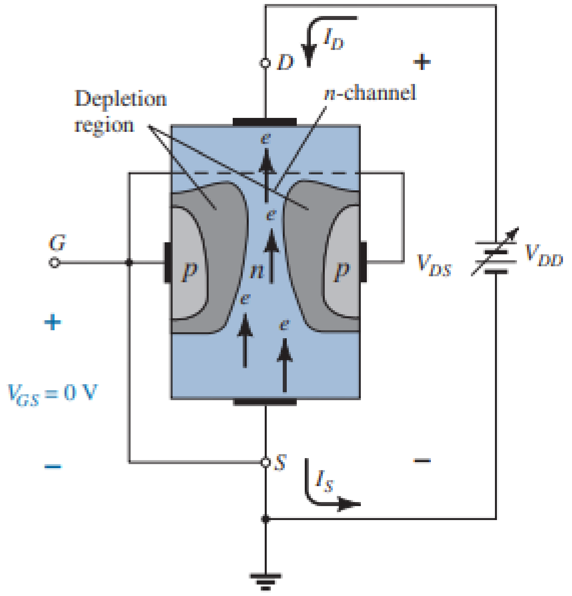
Advantages of JFETs Over BJTs:

- **High Input Impedance:** JFETs offer significantly higher input impedance, minimizing loading effects on preceding circuits.
- **Low Noise:** JFETs exhibit lower noise characteristics, making them ideal for applications where signal clarity is crucial, such as in audio amplifiers.
- **Simpler Biasing:** JFETs have simpler biasing requirements, streamlining circuit design compared to BJTs.
- **No Gate Current:** JFETs have no gate current, potentially leading to lower power consumption in specific applications.
- **Temperature Stability:** JFETs are often less sensitive to temperature changes, providing more stable performance in varying environments.
- **High-Frequency Performance:** JFETs perform well at higher frequencies, making them more suitable for certain high-frequency applications.
- **Suitability for High-Impedance Circuits:** The high input impedance of JFETs makes them well-suited for applications where high-impedance circuits are essential, such as in sensor interfaces.

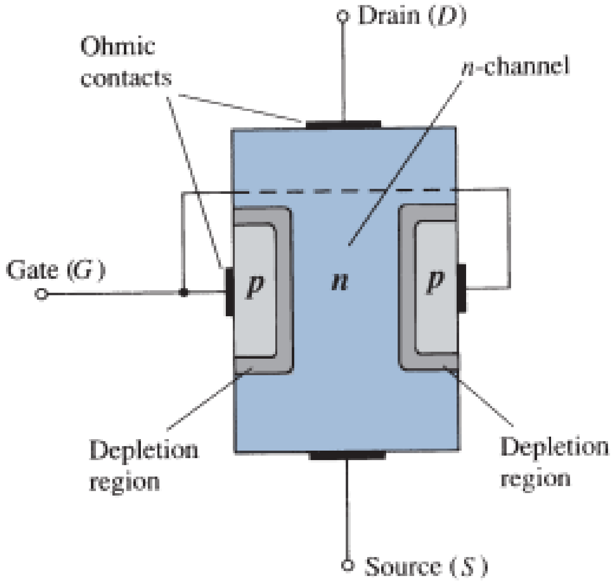
JFET (Junction field-effect transistor) ترانزستورات



Pinch-off ($V_{GS} = 0$ V, $V_{DS} = V_P$).

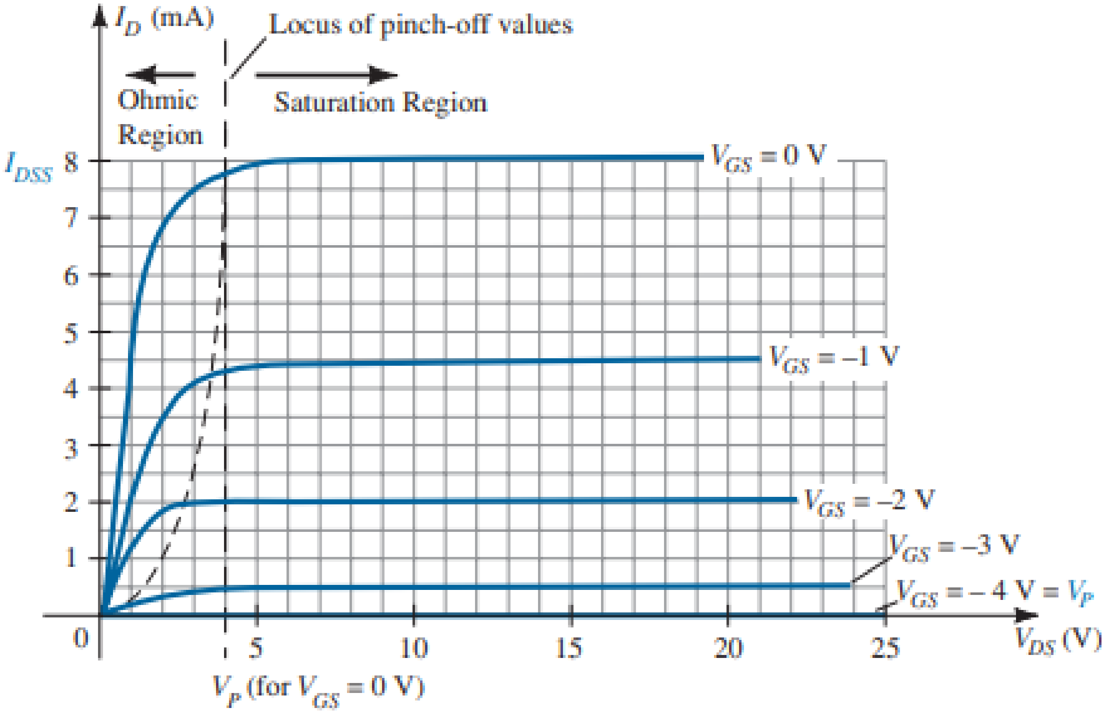


JFET at $V_{GS} = 0$ V and $V_{DS} > 0$ V.



Junction field-effect transistor (JFET).

JFET (Junction field-effect transistor) ترانزستورات



n-Channel JFET characteristics with $I_{DSS} = 8$ mA and $V_P = -4$ V.