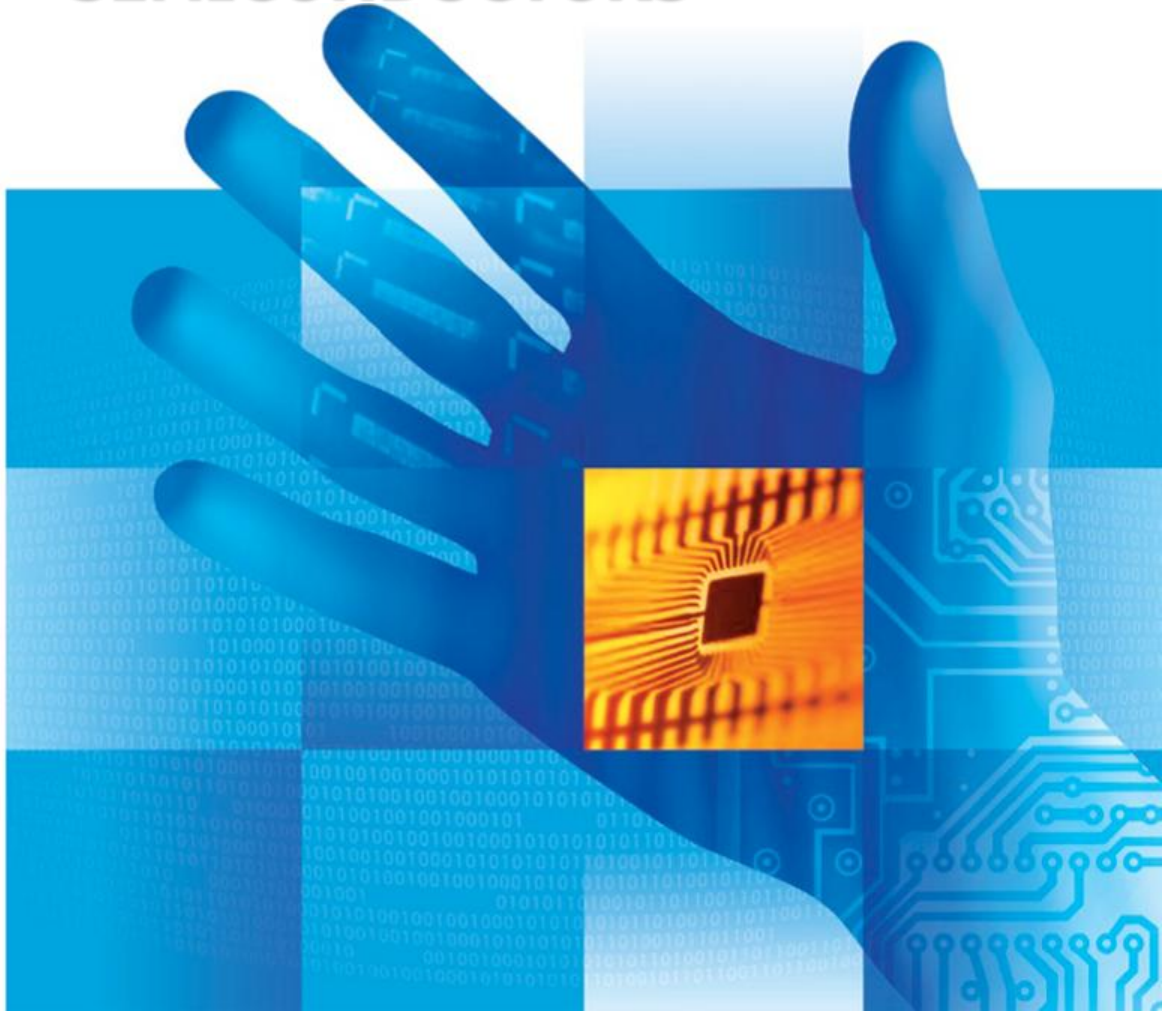
EVROPSKÁ UNIE
Evropské strukturální a investiční fondy
Operační program Výzkum, vývoj a vzdělávání

MINISTERSTVO ŠKOLSTVÍ, MLÁDEŽE A TĚLOVÝCHOVY

5. FUNDAMENTALS OF SEMICONDUCTORS



Doc. Ing. Stanislav Kocman, Ph.D.

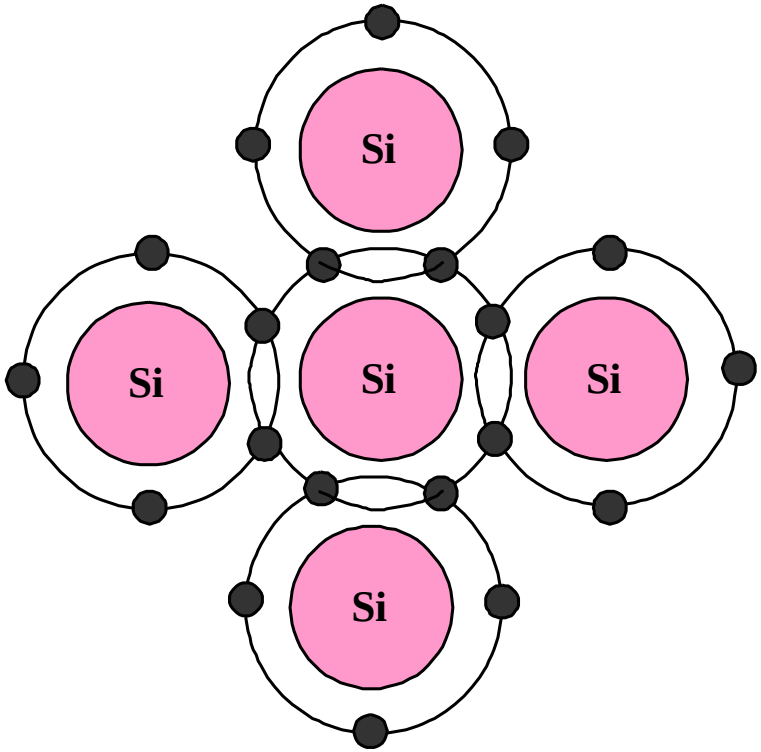
12. 1. 2018, Ostrava

LECTURE PLAN

- basics of semiconductor physics, PN junction
- semiconductor diodes
- bipolar transistor, thyristor, triac
- basic applications in electrical devices

Basics of semiconductor physics

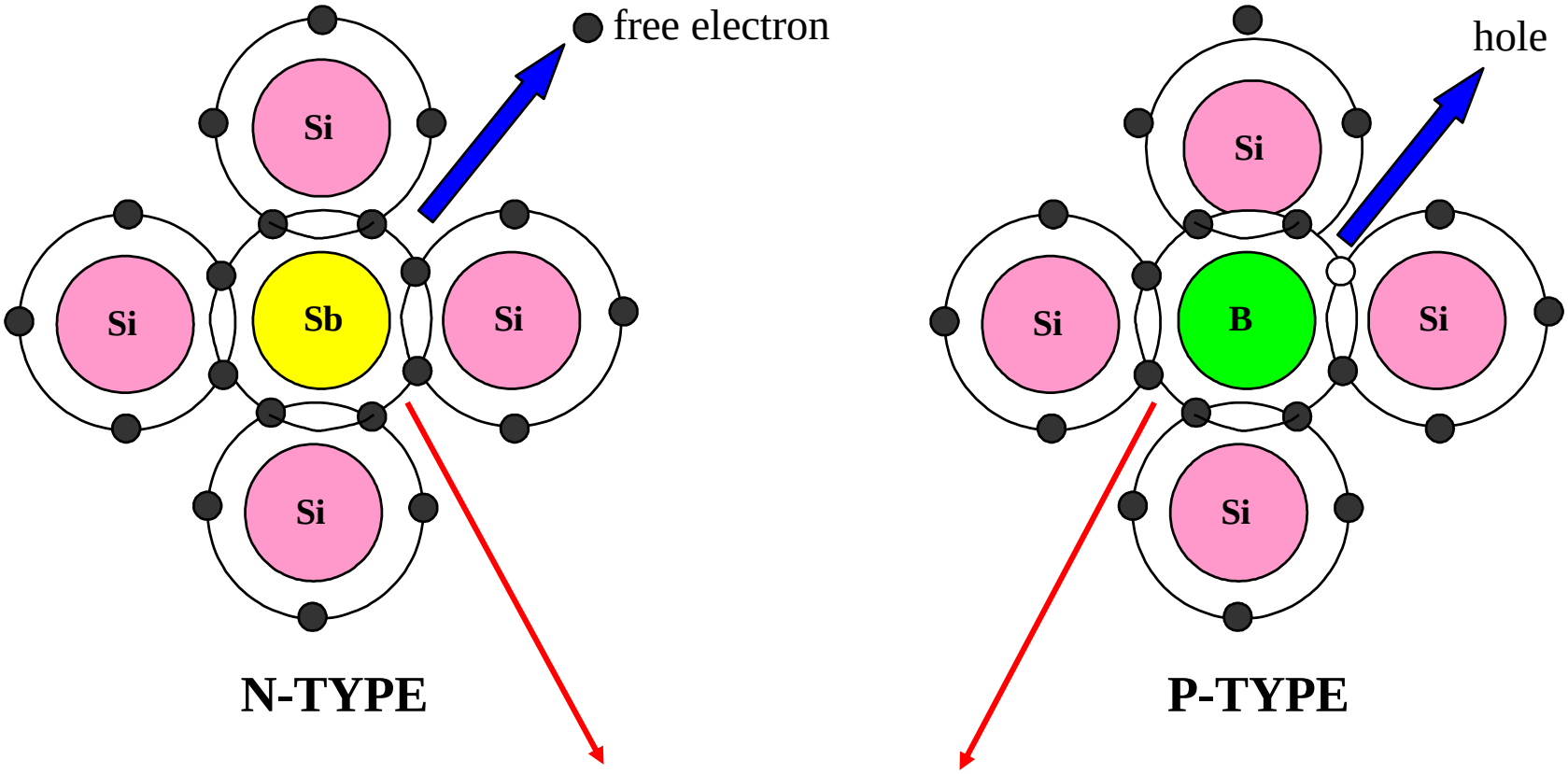
Intrinsic semiconductor



structure of silicon with four valence electrons

very low conduction

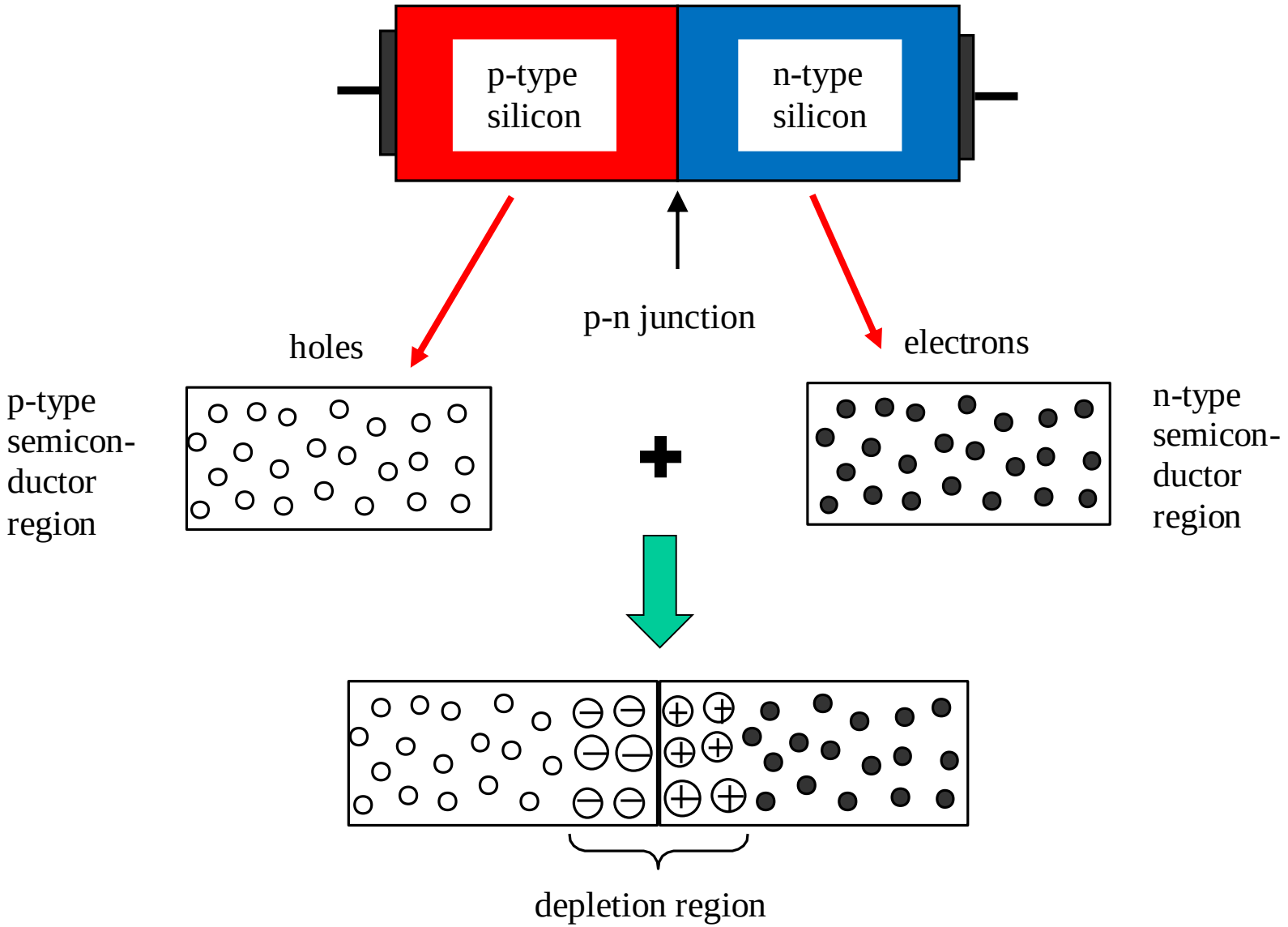
Doped semiconductors



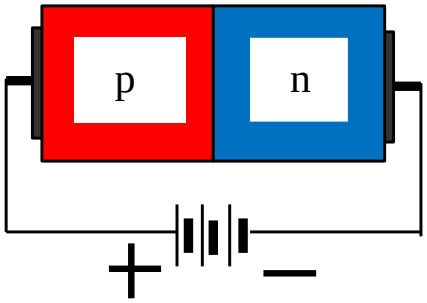
donor impurity acceptor impurity

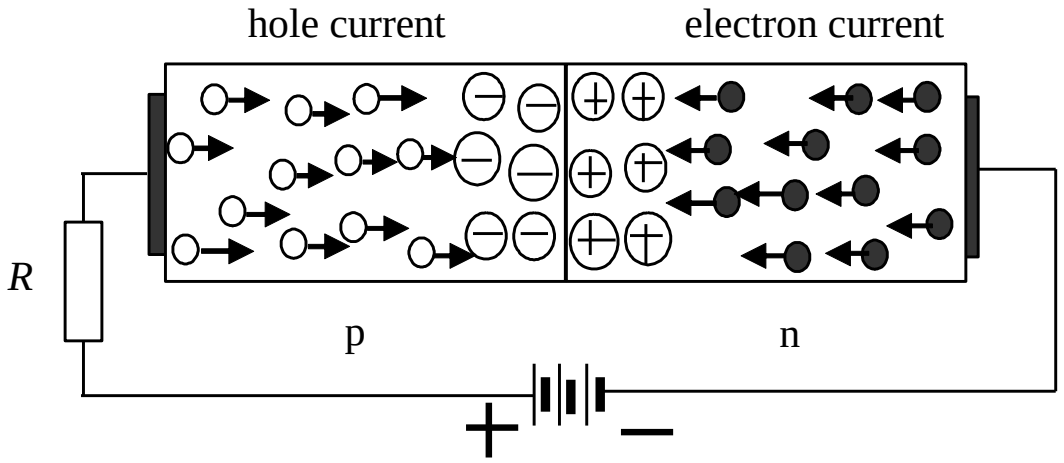
high conduction

PN junction

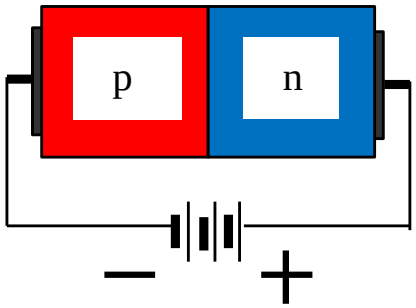

p-type silicon
n-type silicon
p-n junction
holes
electrons
p-type semicon-ductor region
n-type semicon-ductor region
depletion region
⊖ negative ion from filled hole
⊕ positive ion from removed electron

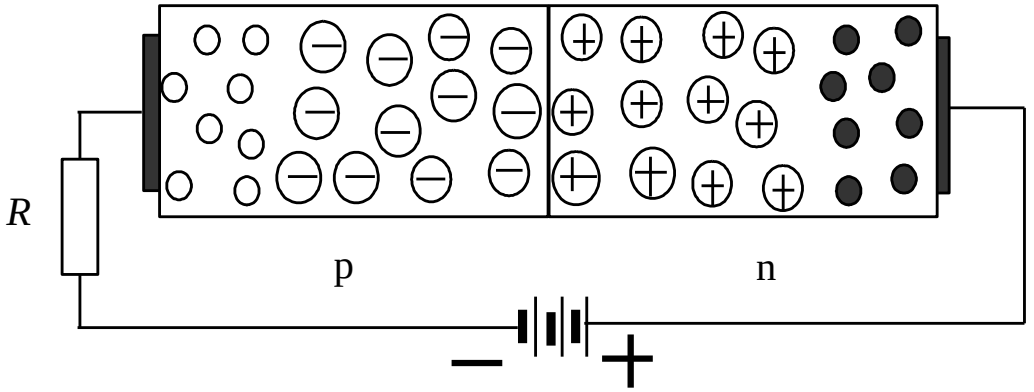
Forward biasing of the P-N Junction





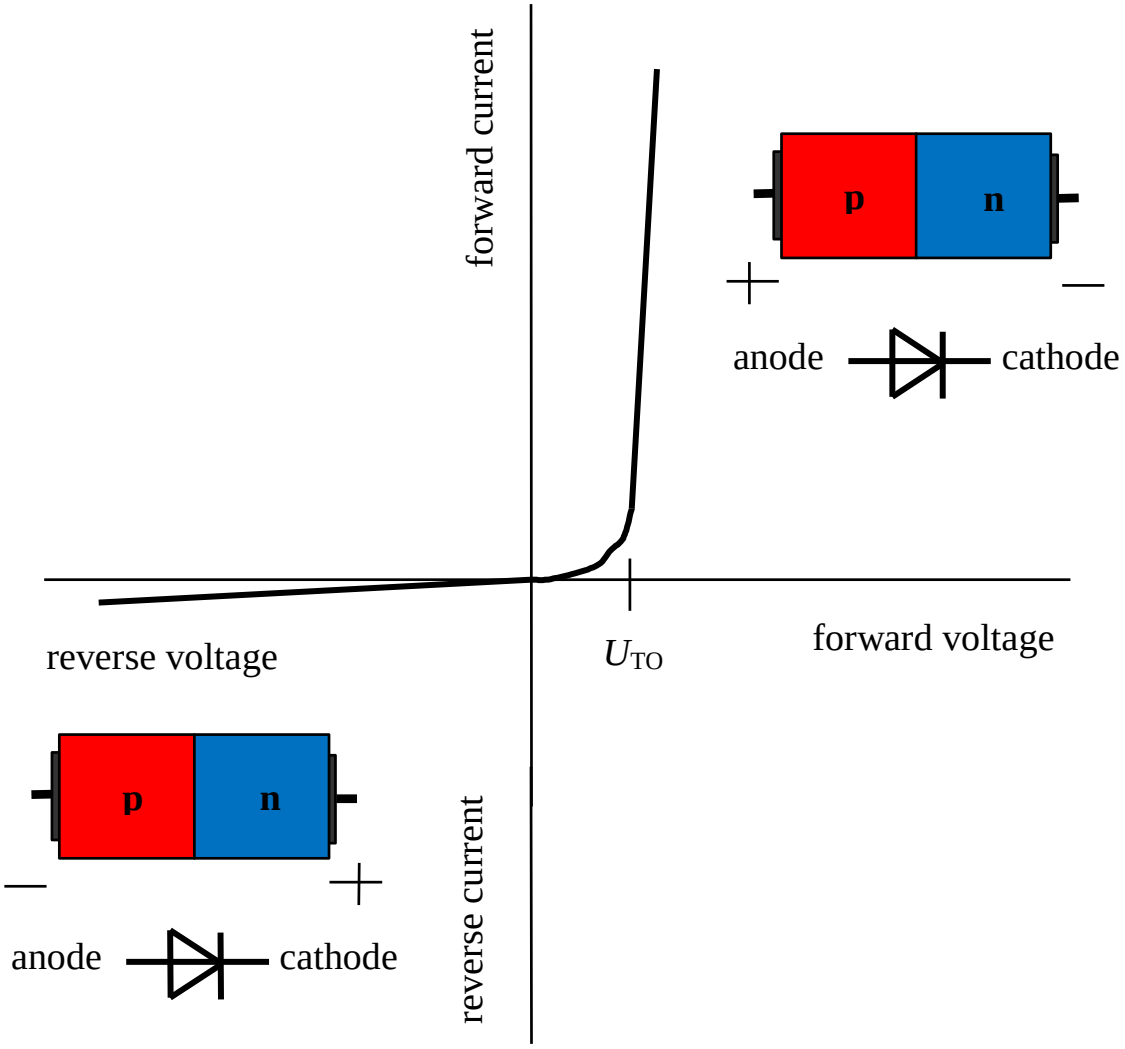
Reverse biasing of the P-N Junction





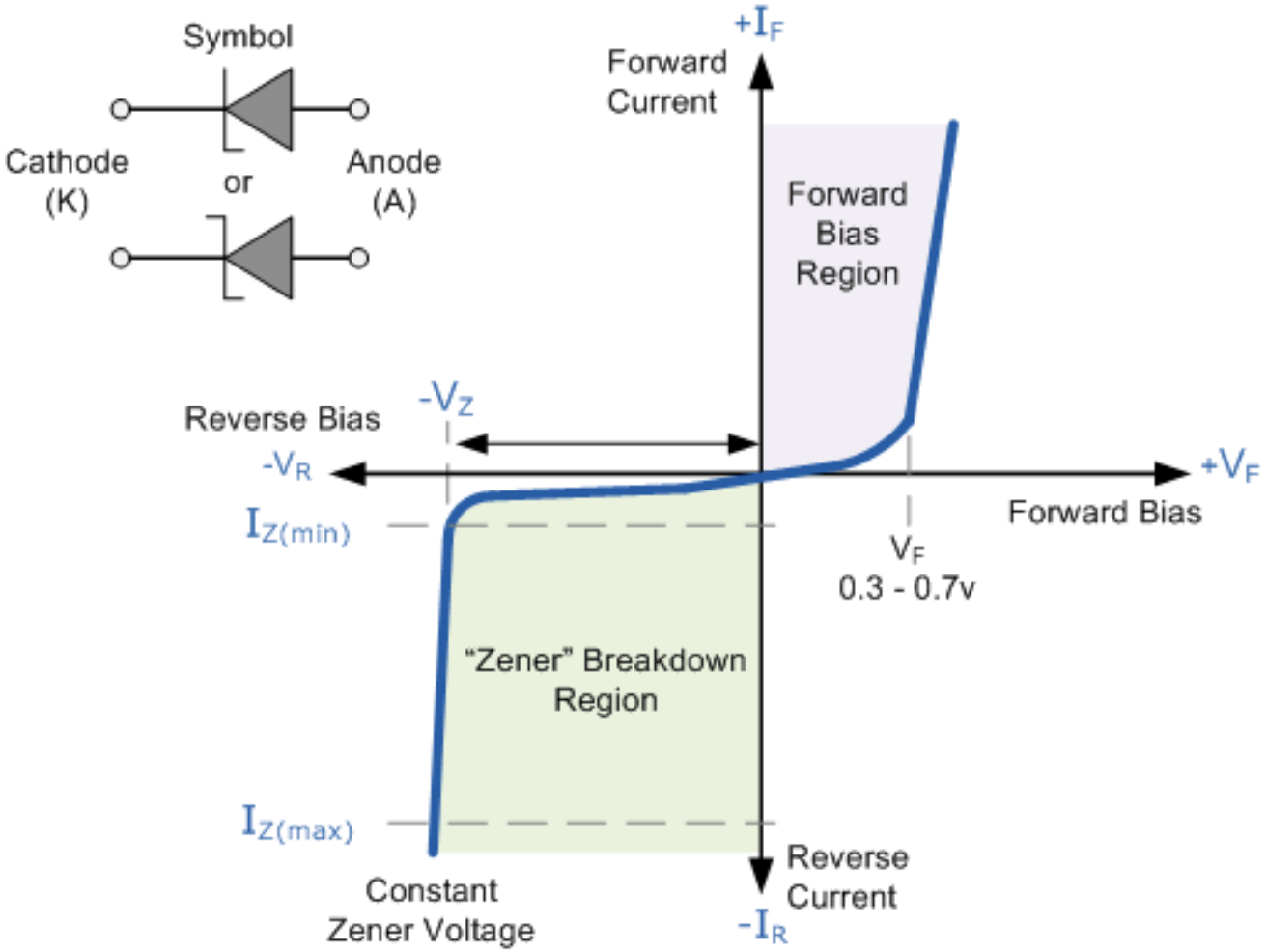
Semiconductor (p-n junction) diode

Characteristic curve



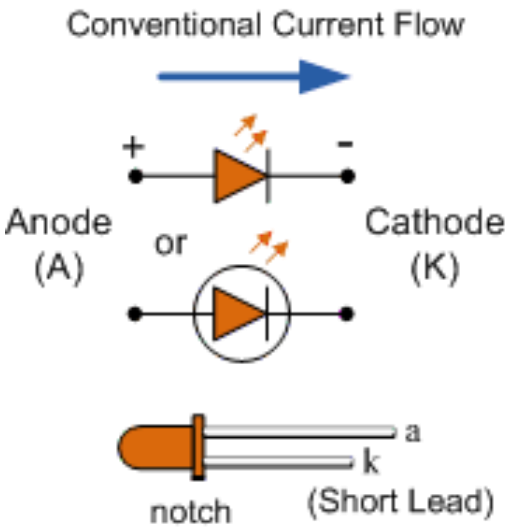
Some other types of diodes

- **Zener diode: conducts in reverse bias**
  - **parallel connection to the load**
  - **to stabilize the voltage across load**

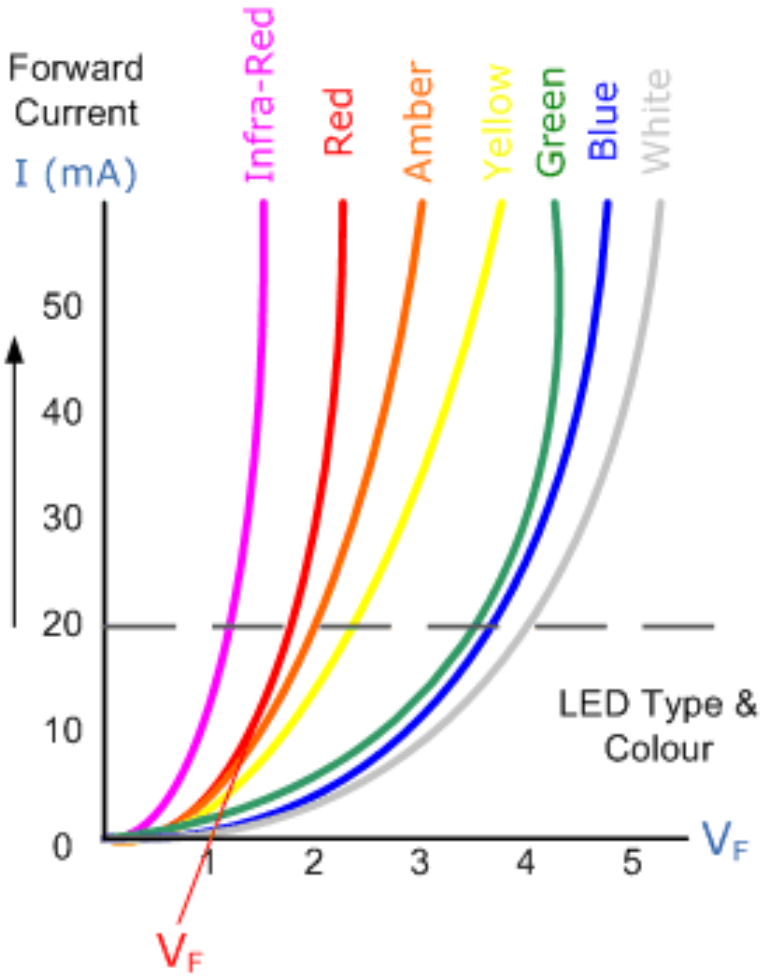


Some other types of diodes

- **Light-emitting diode (LED): charges emit photons**
  - **series connection into circuit**
  - **semiconductor light source of various colors**

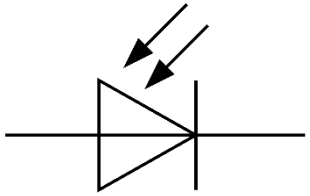


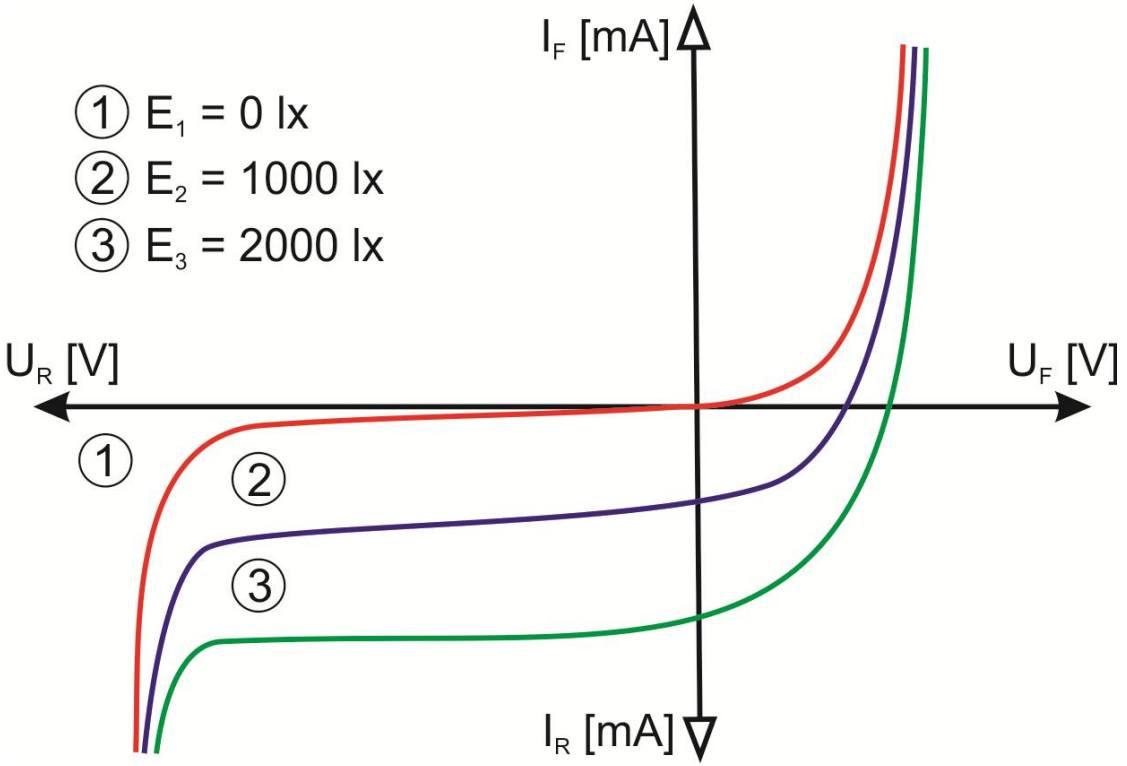
LED and its
I-V Characteristics

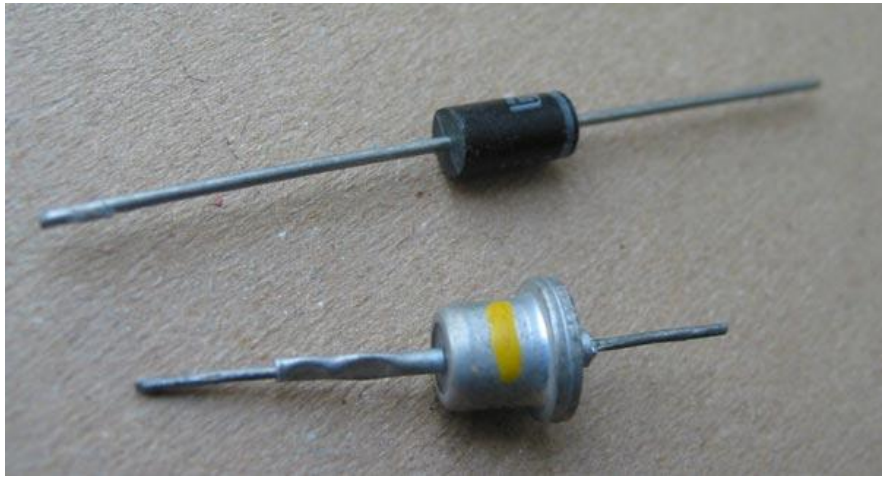


Some other types of diodes

- **Photodiode: converts light into electrical current**
  - **in photovoltaic cells, in optical communication**





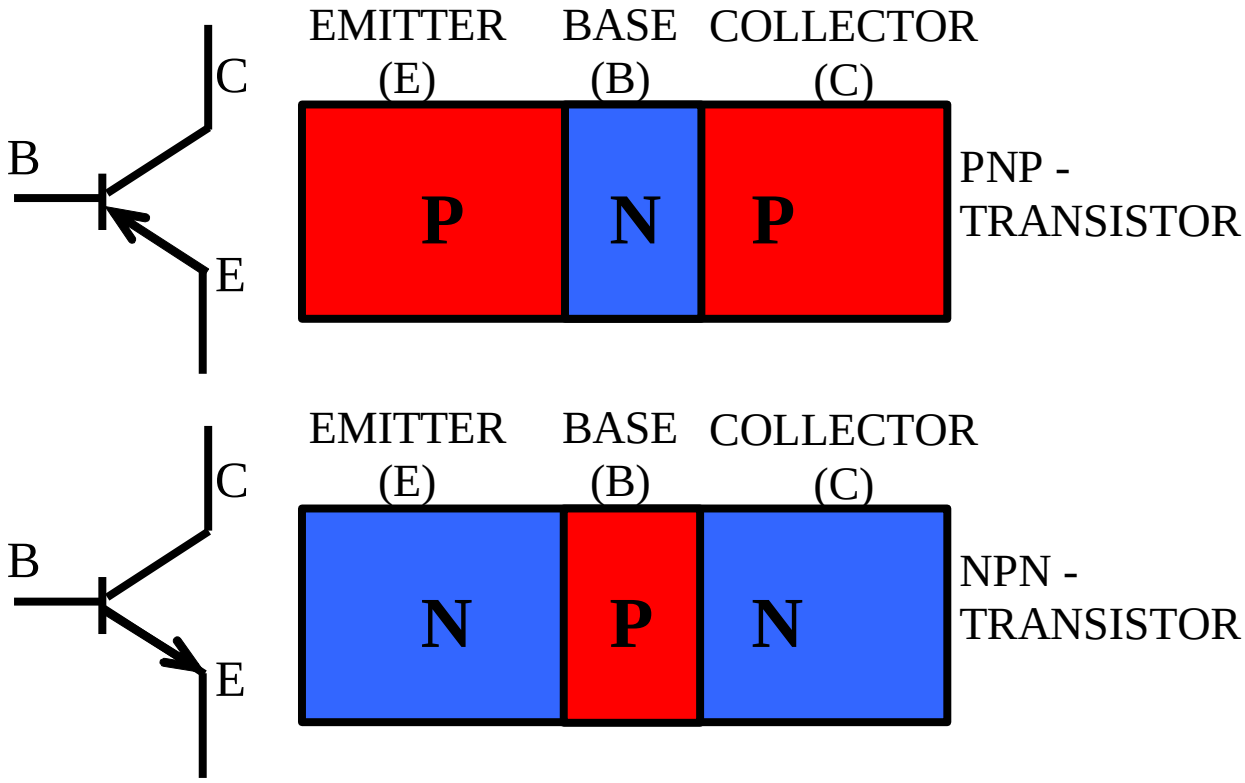





2982
1N2982

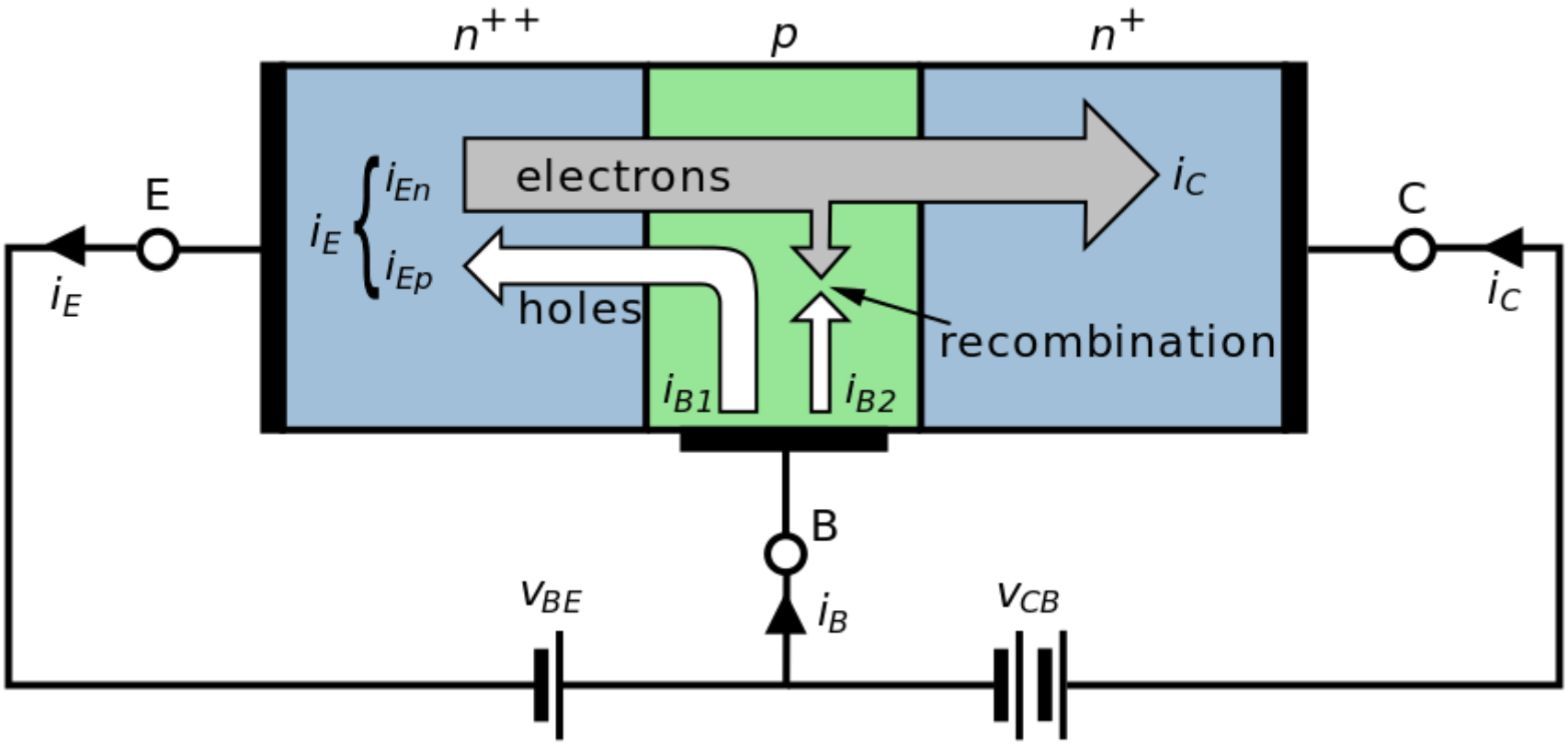


Bipolar transistor



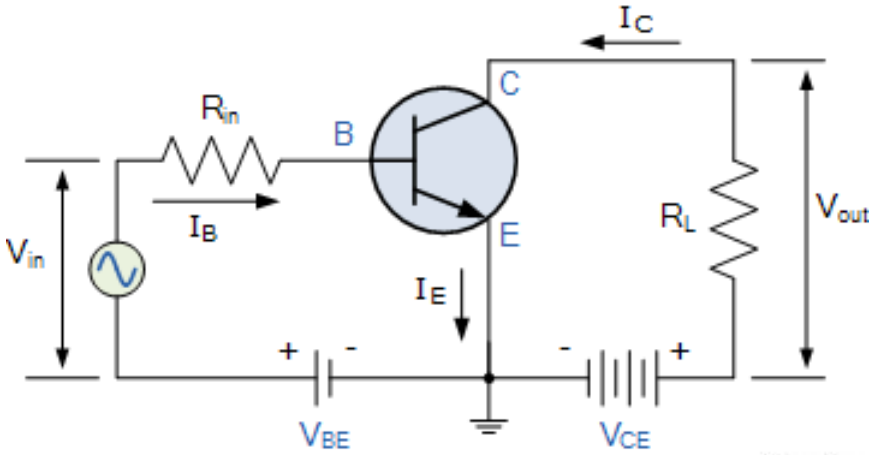
Bipolar transistor

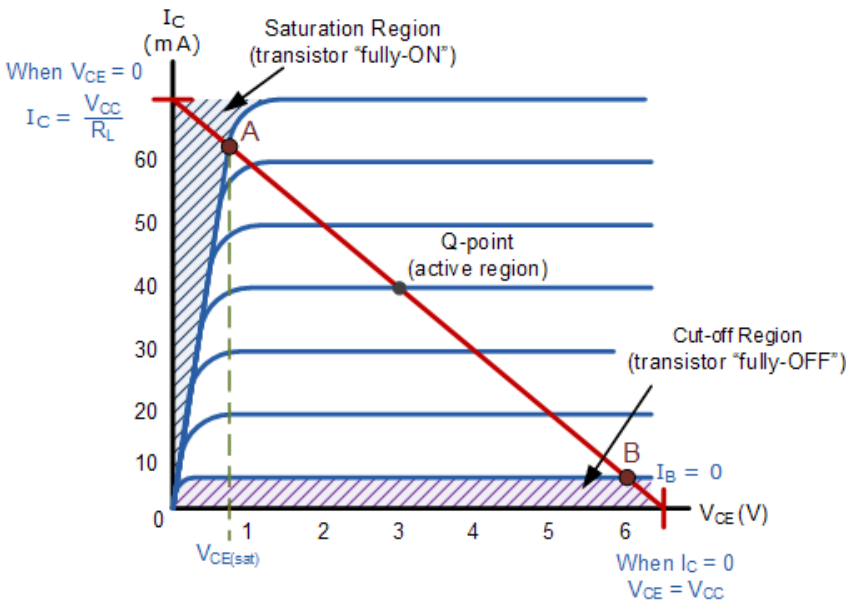
Function of NPN transistor

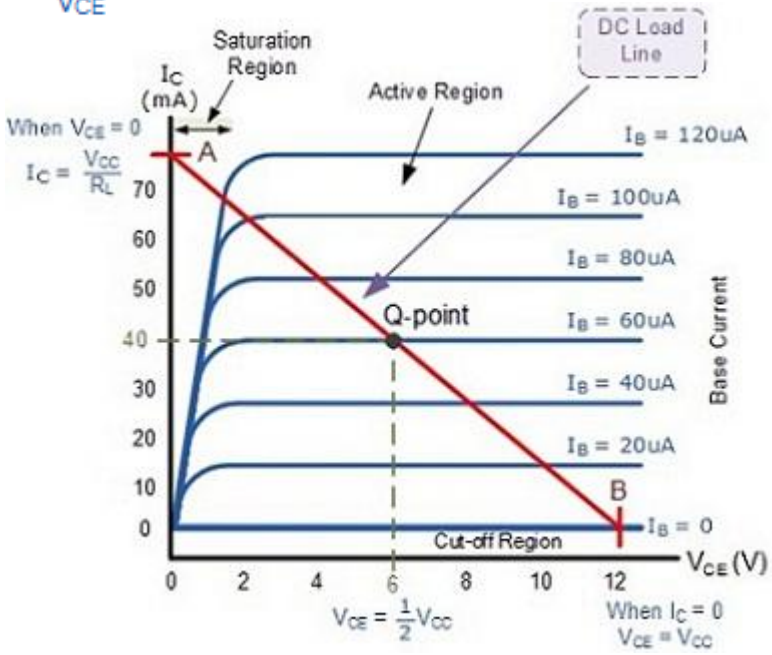


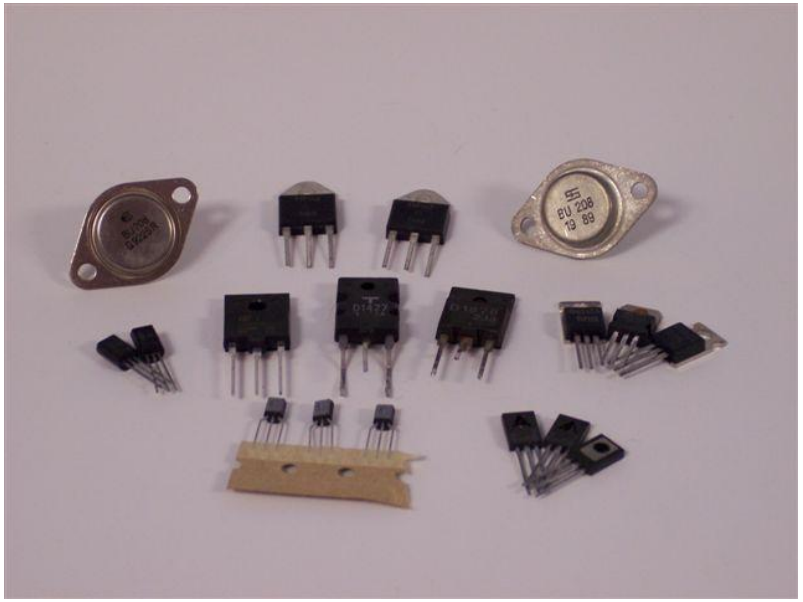
NPN transistor (connection of common emitter)

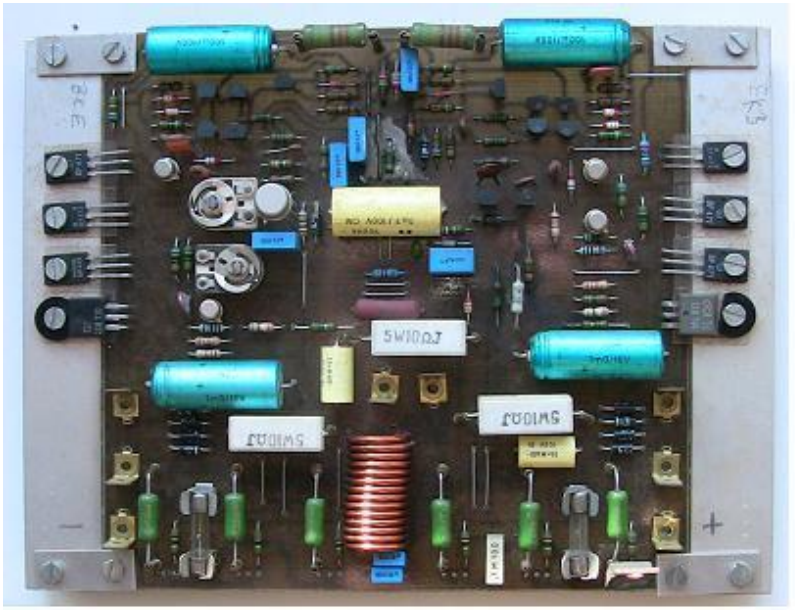
- ❑ as an amplifier (in active region, point Q)
- ❑ as a switch (in point A ON, in point B OFF)







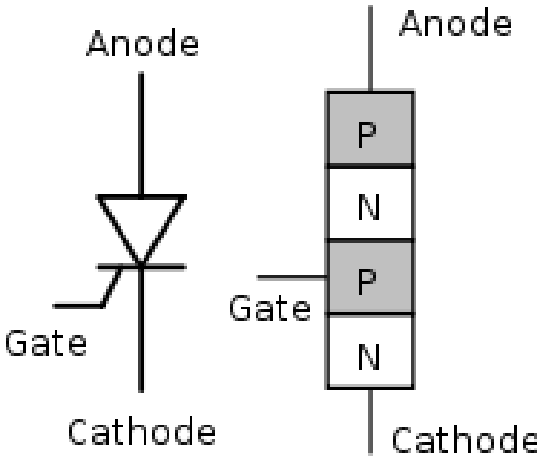


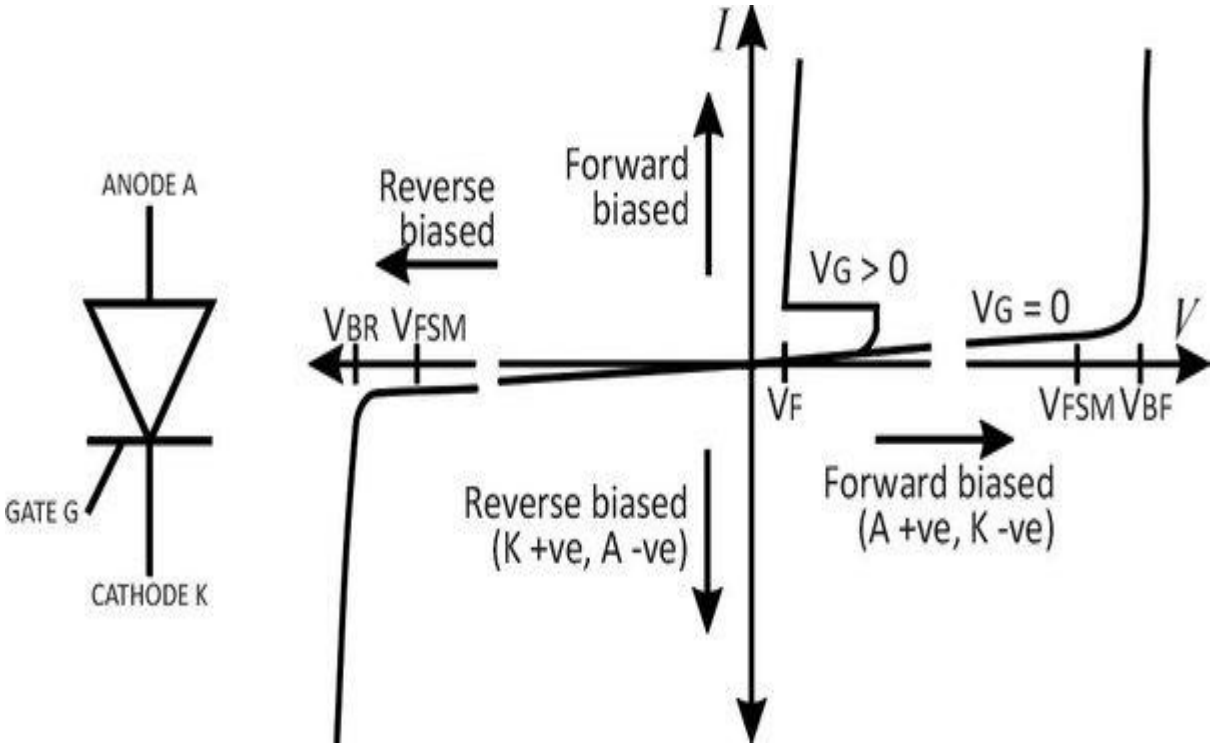




Thyristor

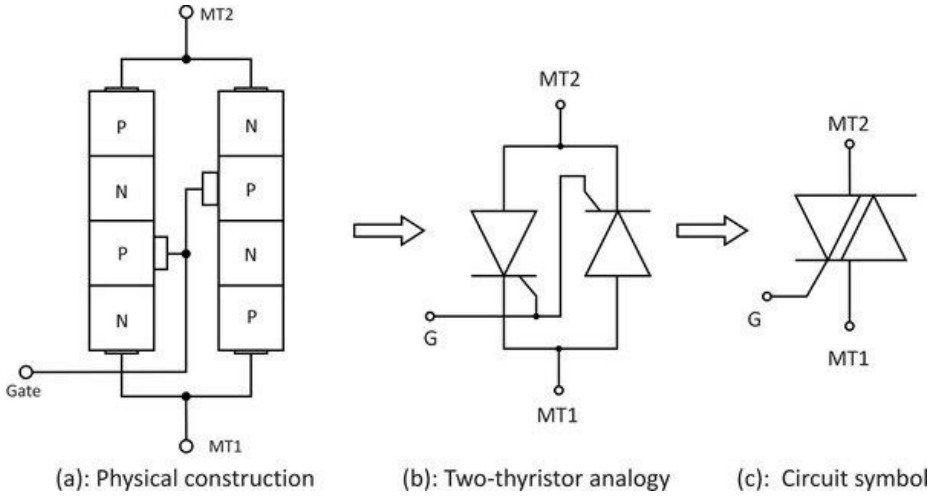
Characteristic curve



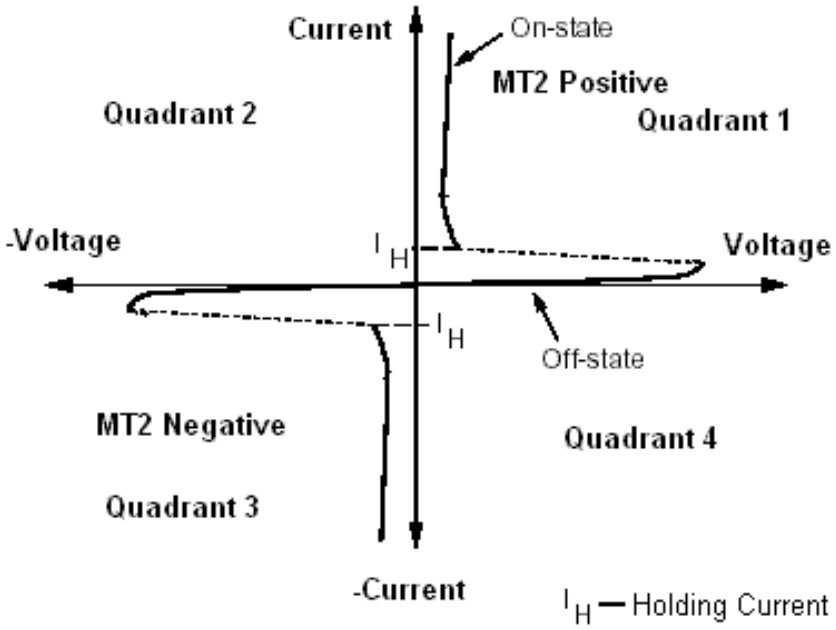


Triac

Characteristic curve



(a): Physical construction (b): Two-thyristor analogy (c): Circuit symbol



Triac Ampere-Voltage Characteristic Curve

Basic applications in electrical devices

- ❑ rectifiers (to convert AC current into DC current)
- ❑ amplifiers (to magnify signals)
- ❑ switches (as contactless switch)
- ❑ voltage regulators
- ❑ voltage stabilizers
- ❑ in photovoltaic power stations
- ❑ in electrical drives

