

# Diodes

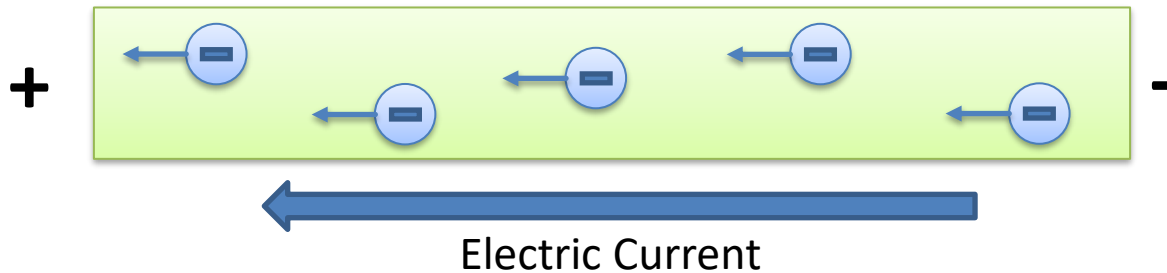
Networks and Embedded Software

First Grade Level

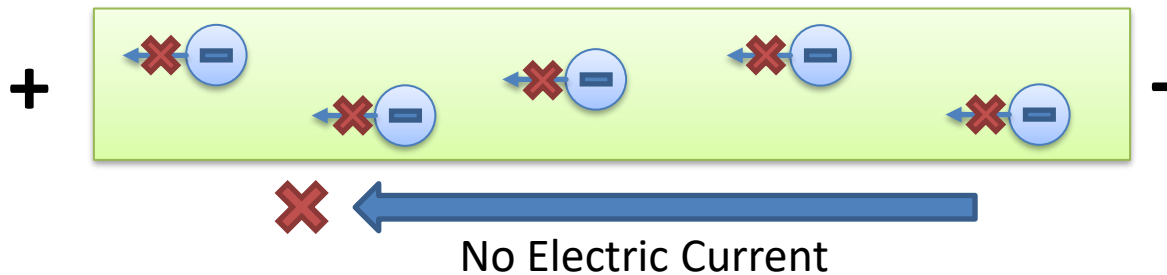
by Wolfgang Neff

# Semiconductors (1)

- Conductor

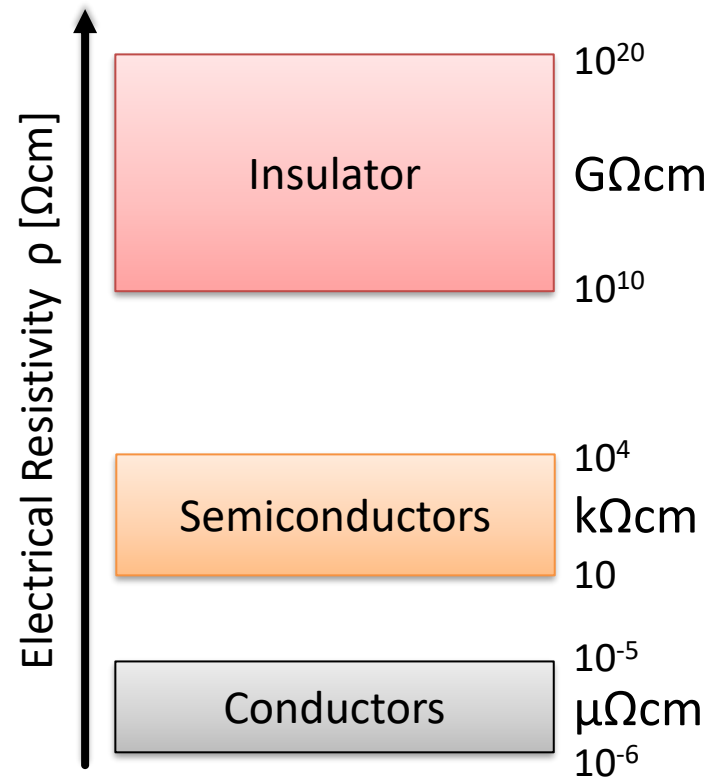


- Insulator



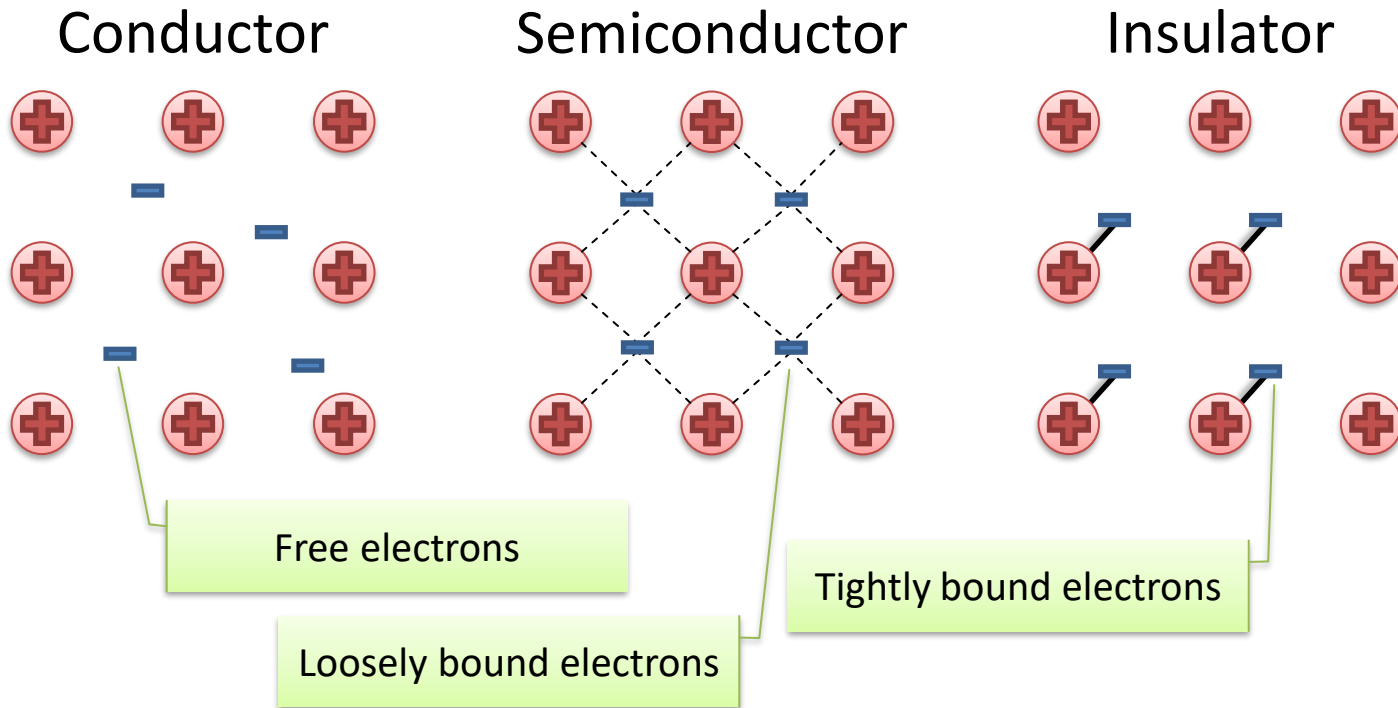
# Semiconductors (2)

- Classification
  - Conductor
    - Silver, copper
    - High conductivity
  - Insulator
    - Porcelain, plastics
    - High resistivity
  - Semiconductor
    - Silicon, germanium



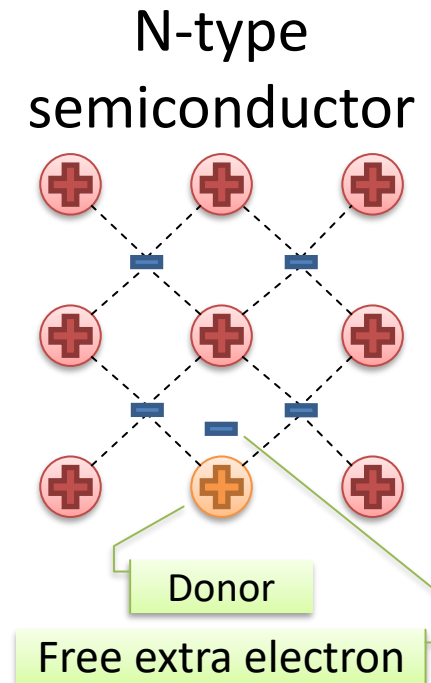
# Semiconductors (3)

- Conductivity



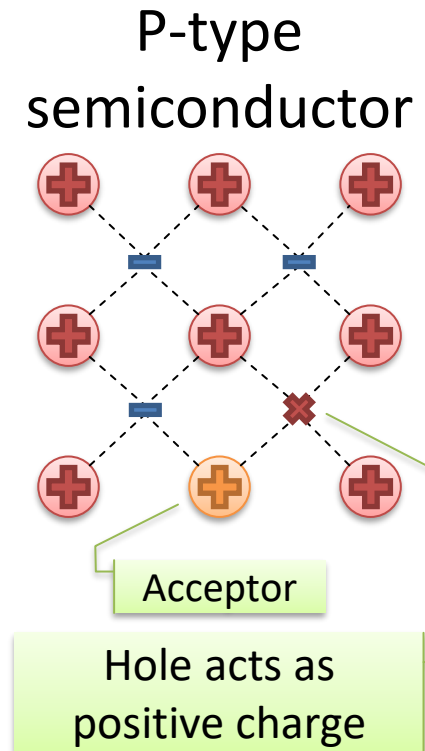
# Semiconductors (4)

- Doping: donors
  - Some atoms are replaced by donors
  - Extra electrons
  - Better conductivity
  - N-type doping



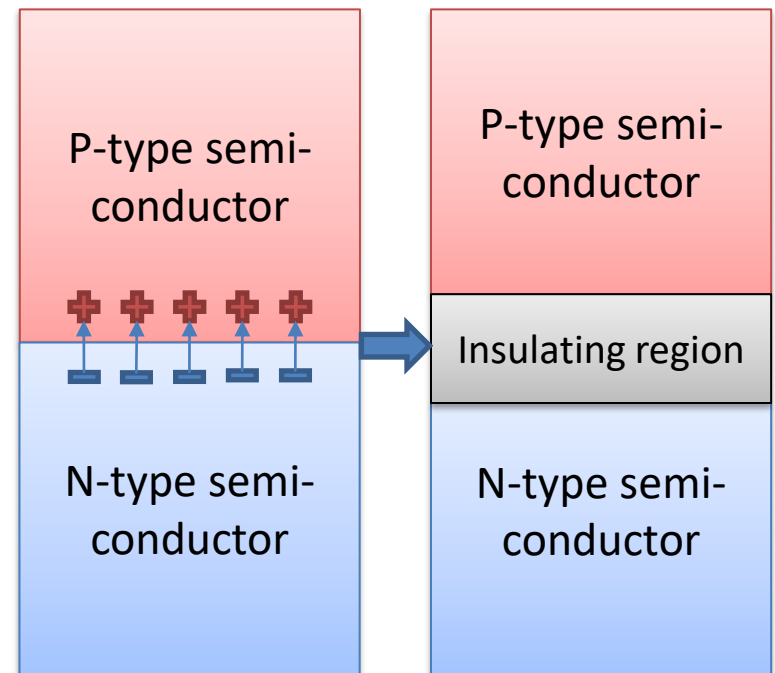
# Semiconductors (5)

- Doping: acceptors
  - Some atoms are replaced by acceptors
  - Lack of electrons
  - Better conductivity
  - P-type doping



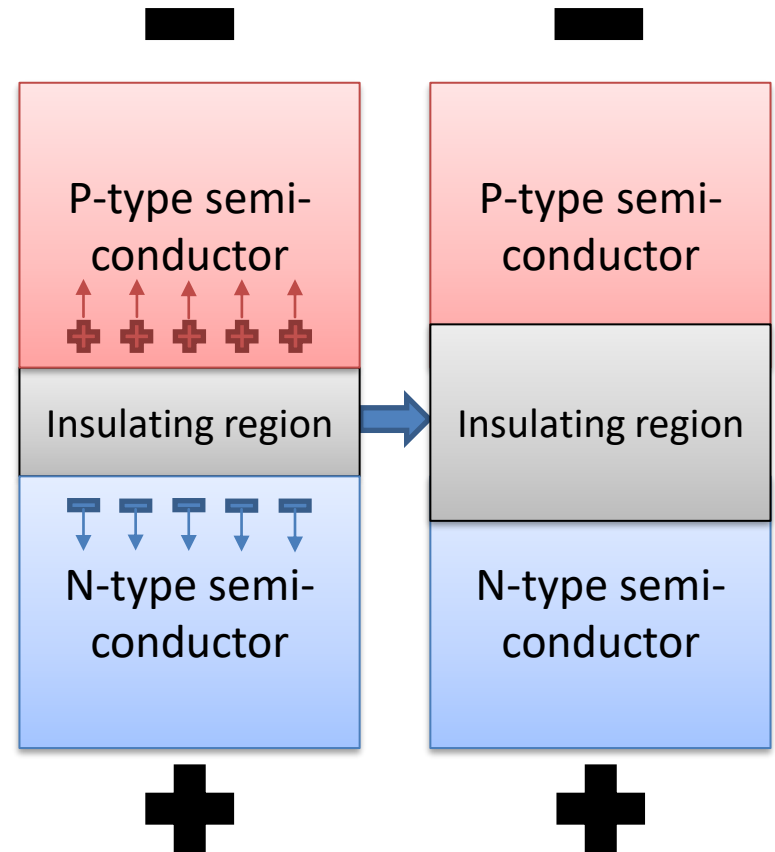
# Semiconductors (6)

- P–n junction
  - Electrons jump into the holes
  - There are no longer free charges
  - There is an insulating region



# Semiconductors (7)

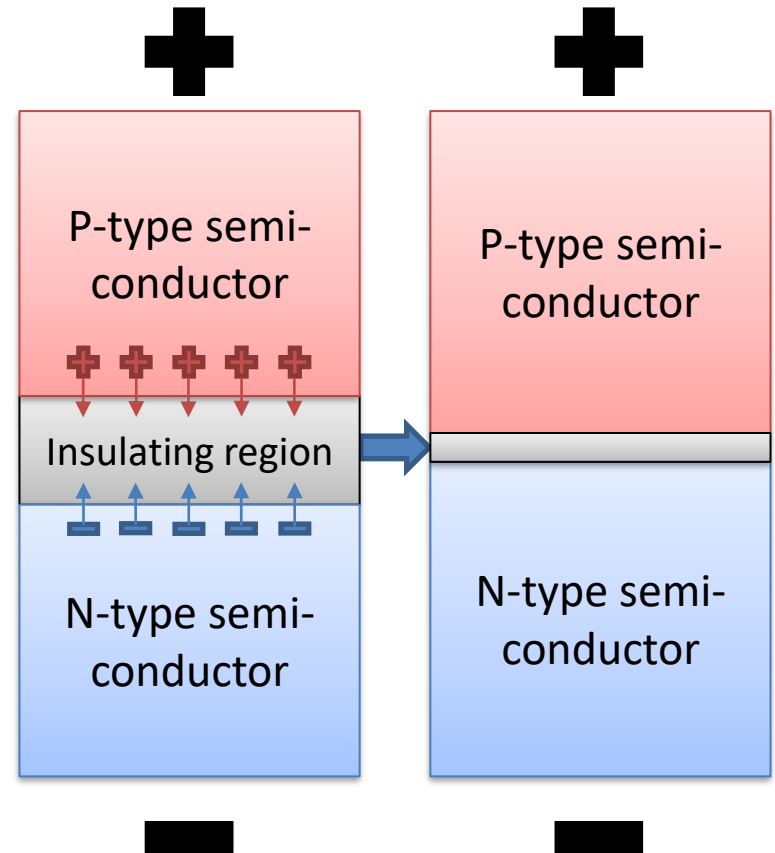
- P–n junction (continued)
- Power supply
  - P-type side: –
  - N-type side: +
- Insulating region gets even larger





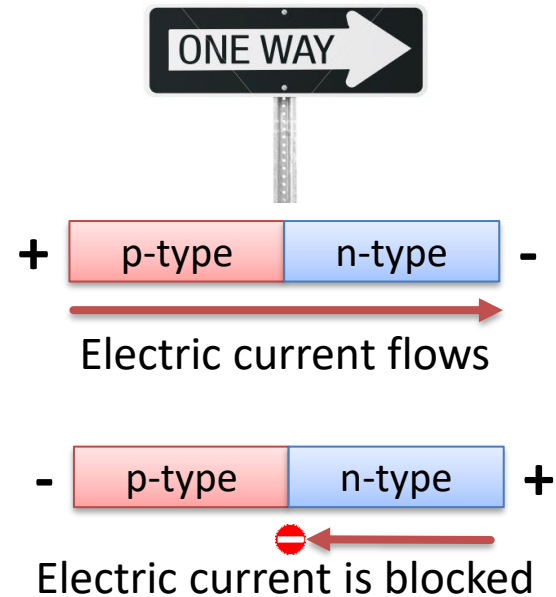
# Semiconductors (8)

- P–n junction (*finished*)
- Power supply
  - P-type side: +
  - N-type side: -
- Insulating region gets smaller



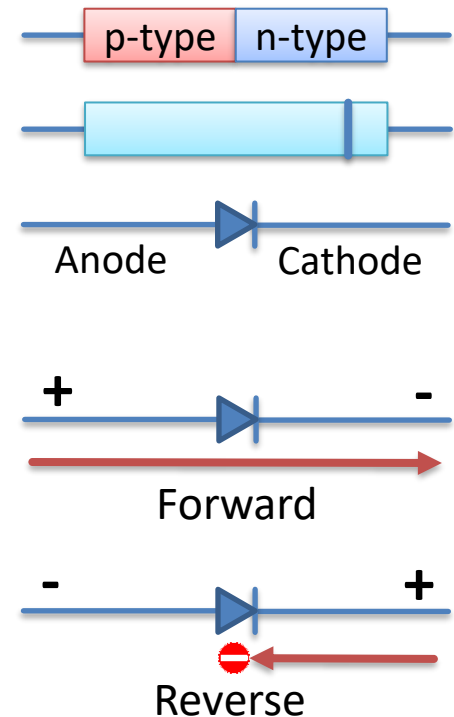
# Diodes (1)

- P–n junctions are diodes
  - Flow Control Valve
    - One-Way Road
  - Forward
    - P-type: +, n-type: -
    - Current flows
  - Reverse
    - P-type: -, n-type: +
    - Current gets blocked



# Diodes (2)

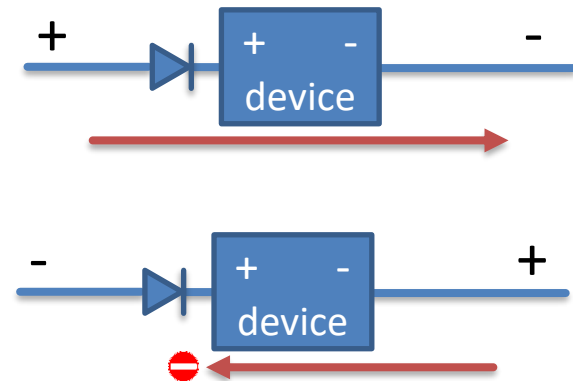
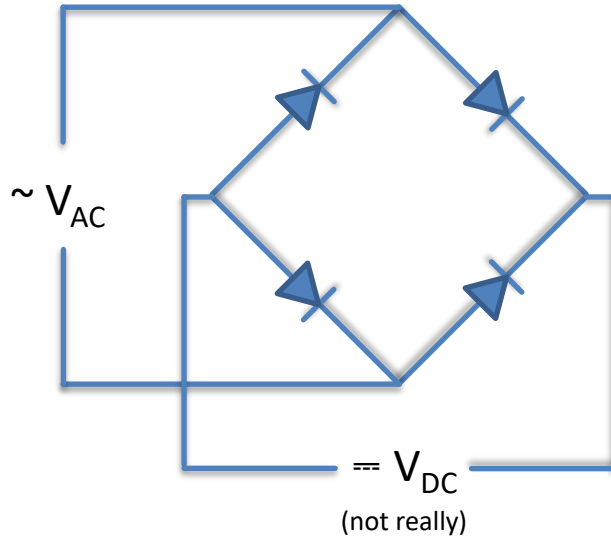
- Example: 1N4148
  - Maximum forward current
    - $I_F = 300 \text{ mA}$
  - Maximum reverse voltage
    - $V_R = 100 \text{ V}$
  - Reverse Leakage
    - $I_R = 0.025 \text{ } \mu\text{A}$  ( $V_R = 20 \text{ V}$ )
    - $I_R = 5.0 \text{ } \mu\text{A}$  ( $V_R = 70 \text{ V}$ )



# Diodes (3)

- Applications

- Reverse voltage protection
- Rectifier (e. g. mobile phone charger)



# Diodes (4)

- Light-emitting diodes

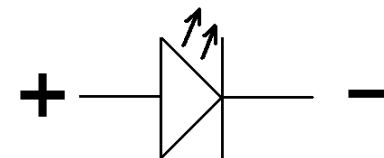
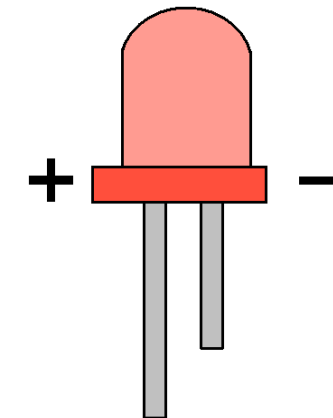
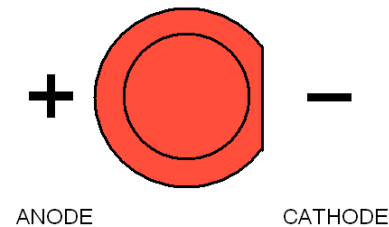
- They emit light

- They have different colors



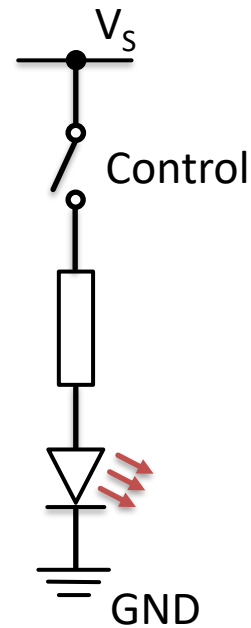
- They have two leads

- Long one: anode (+)
    - Short one: cathode (-)

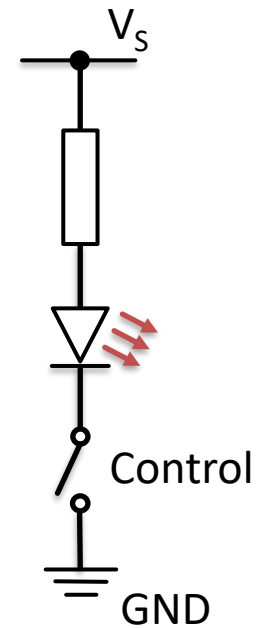


# Diodes (5)

- Control of LED
  - They can be switched on or off
  - There are two ways
    - Active high (on = 1)
    - Active low (on = 0)



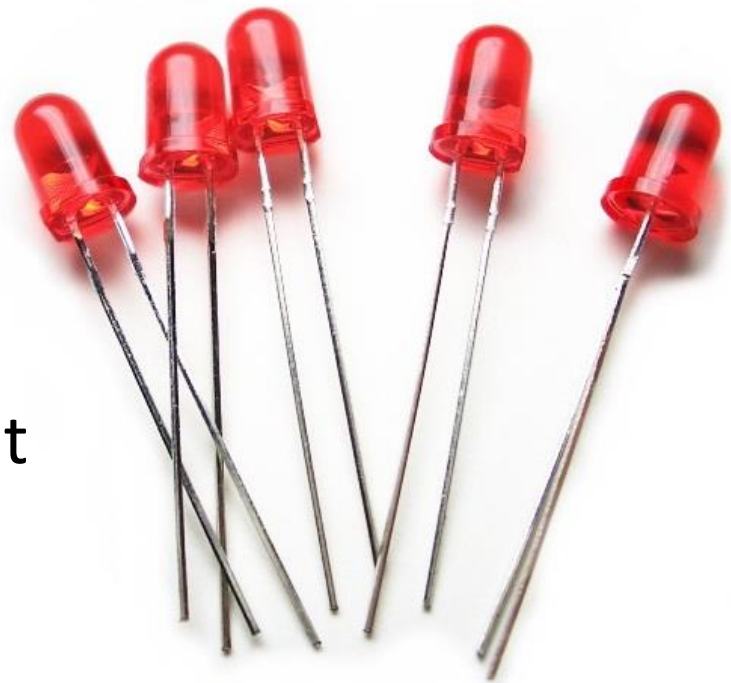
Active High LED



Active Low LED

# Diodes (6)

- Example: L-63ID
  - Typical wavelength
    - $\lambda = 627 \text{ nm}$  (red)
  - Typical forward voltage
    - $V_F = 1.9 \text{ V}$
  - Maximum forward current
    - $I_F = 30 \text{ mA}$



# Diodes (7)

- Series resistor

$$- I_R = I_F$$

$$- V_R = V_S - V_F$$

$$- R = \frac{V_R}{I_R} = \frac{V_S - V_F}{I_F}$$

$$- R = \frac{5\text{ V} - 1.9\text{ V}}{20\text{ mA}} = \frac{3.1\text{ V}}{0.02\text{ A}}$$

$$- R = 155\ \Omega \rightarrow 180\ \Omega$$

E12 Series of Resistors

