BENHA UNIVERSITY
FACULTY OF ENGINEERING AT SHOUBRA

ECE-291
Electronic Engineering

Part II,
Lecture #1
Electronics Applications & Diodes

Instructor:
Dr. Ahmad El-Banna

SPRING 2015

Agenda

- Part II Objectives
- Part II Information
- Lectures List
- Electronics Fundamentals
- Electronics Applications
- Intro. to Diodes

Part II Objectives

Remember:
Part I: Electric Circuits
Part II: Electronic Circuits

- ***Understand the fundamentals of electronics and know its applications.***
- ***Being familiar with diodes and regulator circuits.***
- ***Know the different types of transistors and analyze their circuits.***
- ***Understand Modulation Circuits.***
- ***Understand the Logic and digital circuits and study some of their applications.***

Part II Information

Instructor:	Dr. Ahmad El-Banna http://bu.edu.eg/staff/ahmad.elbanna Office: Room # SB-205 Email: ahmad.elbanna@feng.bu.edu.eg
Lectures:	Thursday: 12:30-15:30
Office Hours:	Saturday, Sunday, Wednesday (14:00~16:30) Thursday (11:00 ~12:30)
T.A.:	Eng. Mohamed El-Sayed
Texts/Notes:	• Lectures slides, available by each lecture, and found online at http://bu.edu.eg/staff/ahmad.elbanna-courses/12136 • T. Floyd, **Electronic devices** - Conventional Current Version, 9th edition, Prentice Hall.
Course Credit:	150 Marks (**75** mark/part)
Part II Grading:	▪ **45 Marks** • Final Exam (Closed-Book) ▪ **30 Marks** • Mid Term Exam (Open-Book!) (10) • Oral Exam (8) • Project (7) • Tutorials Activities (5)

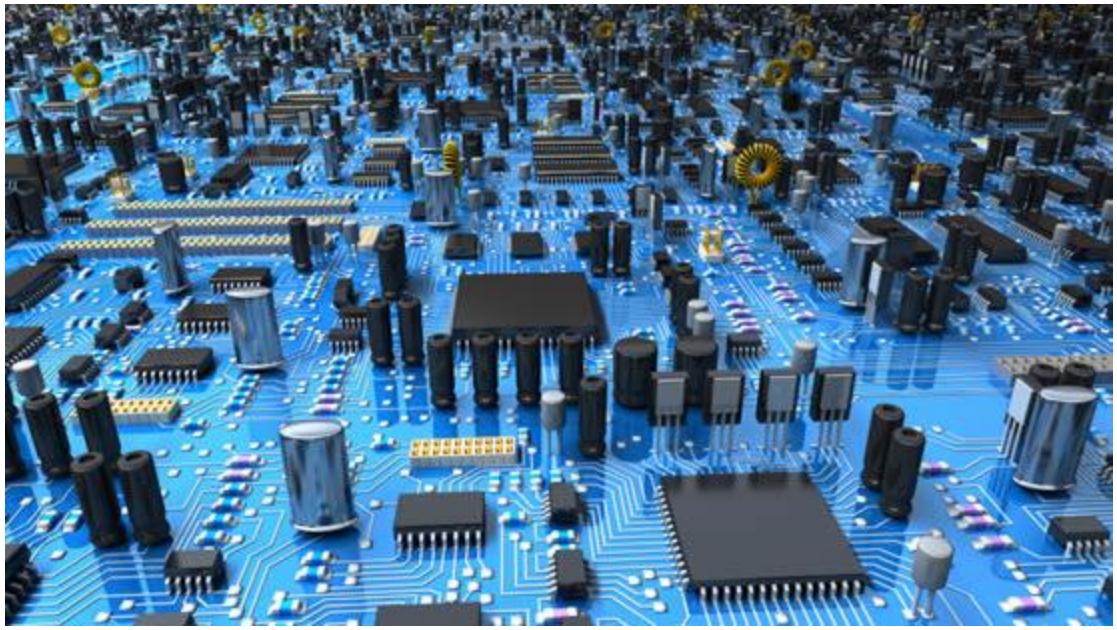
Lectures List

- Week#1 • Introduction and Electronics Applications
- Week#2 • Diodes and Regulation Circuits
- Week#3 • Basics of Transistors
- Week#4 • Transistor circuits analysis & Applications
- Week#5 • Modulation Circuits
- Week#6 • Logic and Digital Circuits
- Week#7 • M.T. Exam & Project Delivery

ELECTRONICS APPLICATIONS

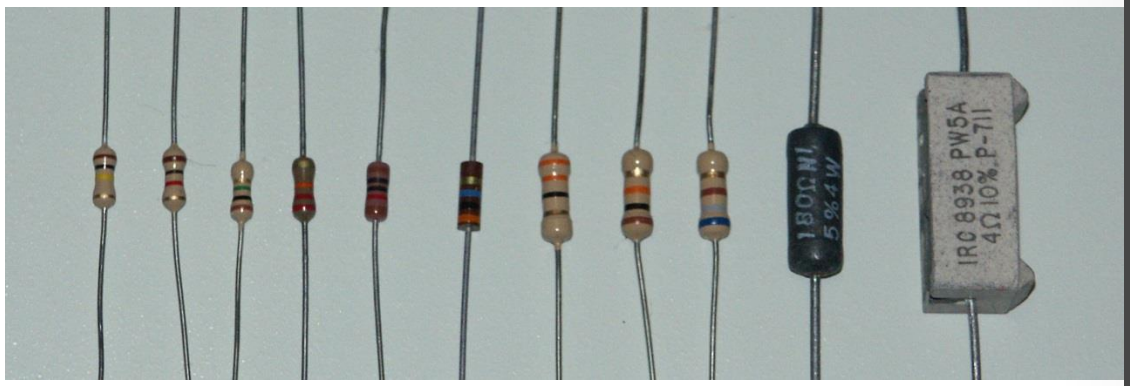
Meaning of Electronics

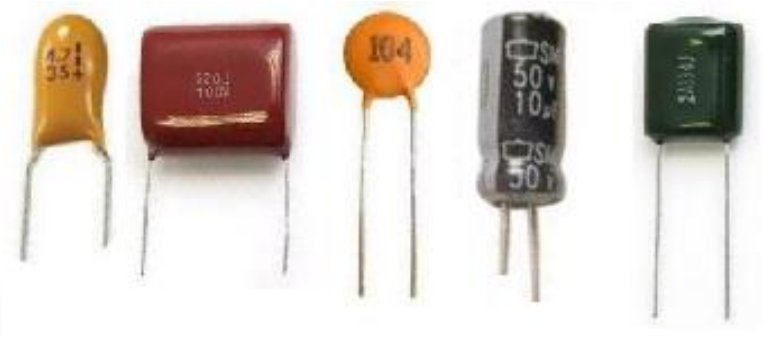
- Electronics means study of flow of electrons in electrical circuits.
- All electronic circuits contain few basic components.
- That are three passive components and two active components.
- An Integrated circuit may comprise of thousands of transistors, few capacitors on a small chip.

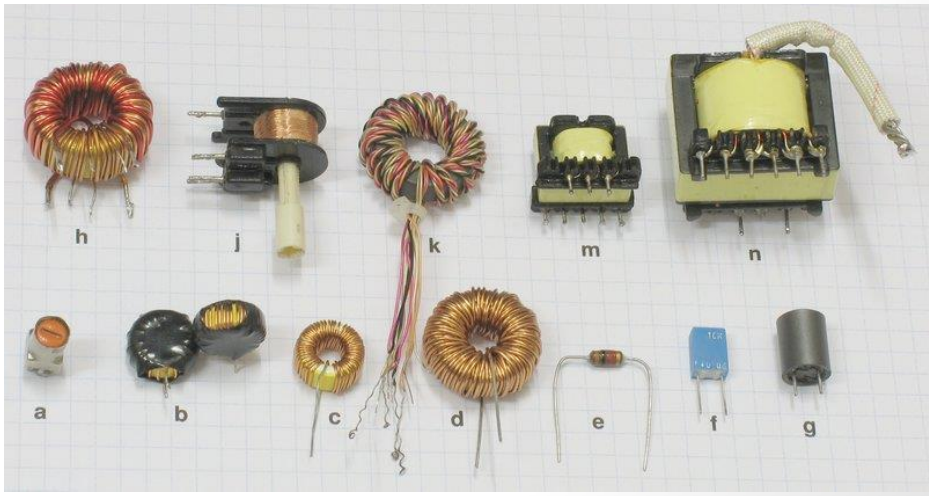


Types of Electronic Components..

- *Passive Components*
  - *Resistors*
  - Capacitors
  - Inductors

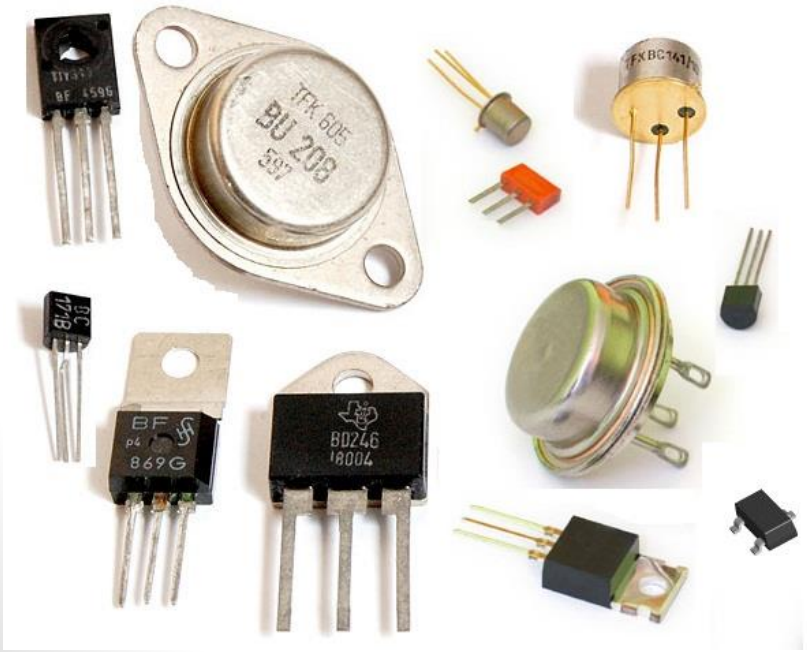


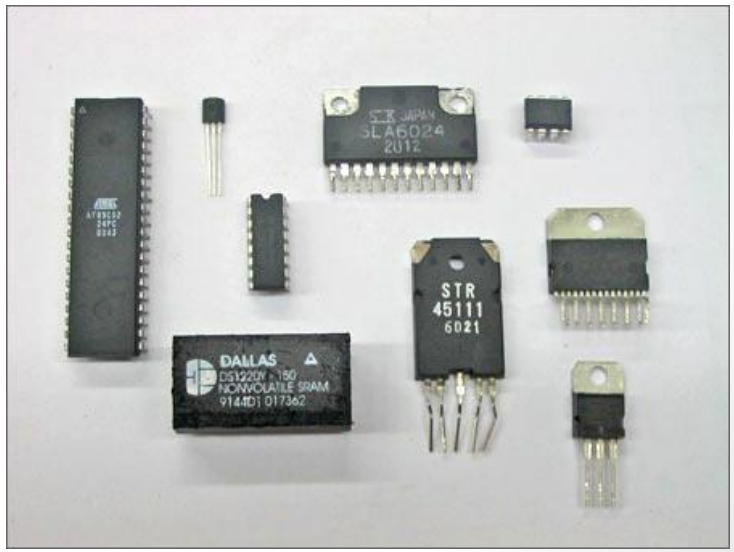




Types of Electronic Components

- *Active Components*
  - Tube devices
  - Semiconductor devices



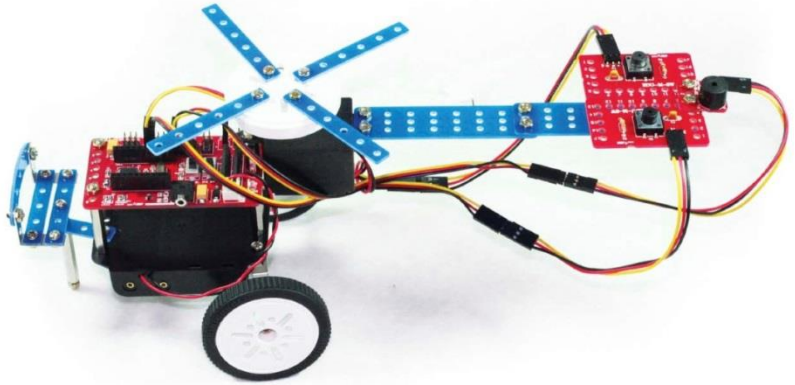


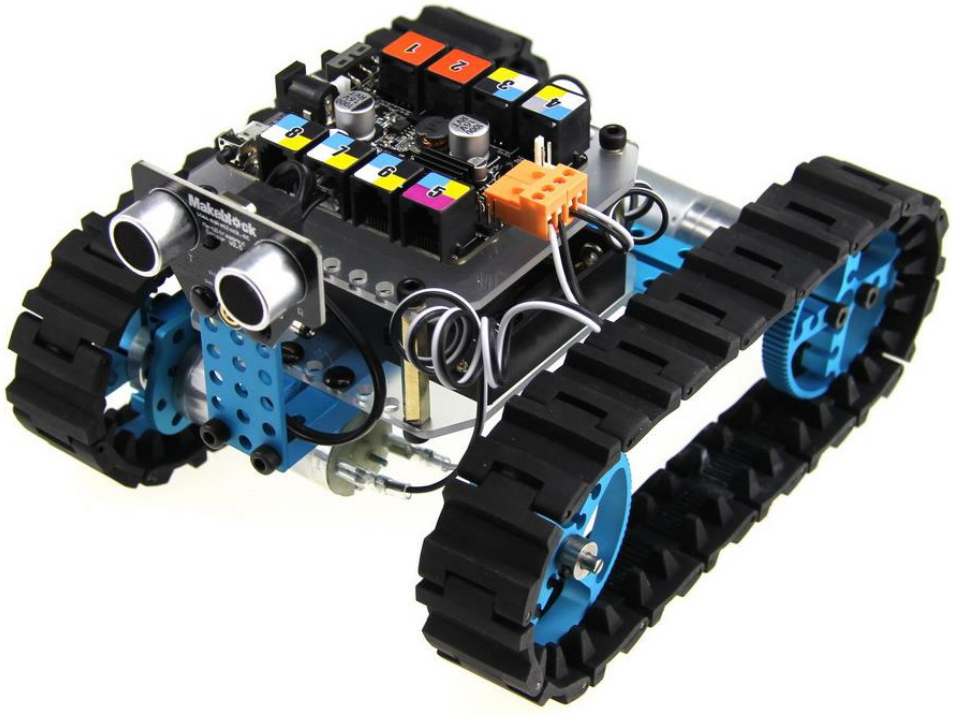
Electronics Applications

- Look around you !
- You will find it everywhere

Electronics Applications..

Electronics Applications...





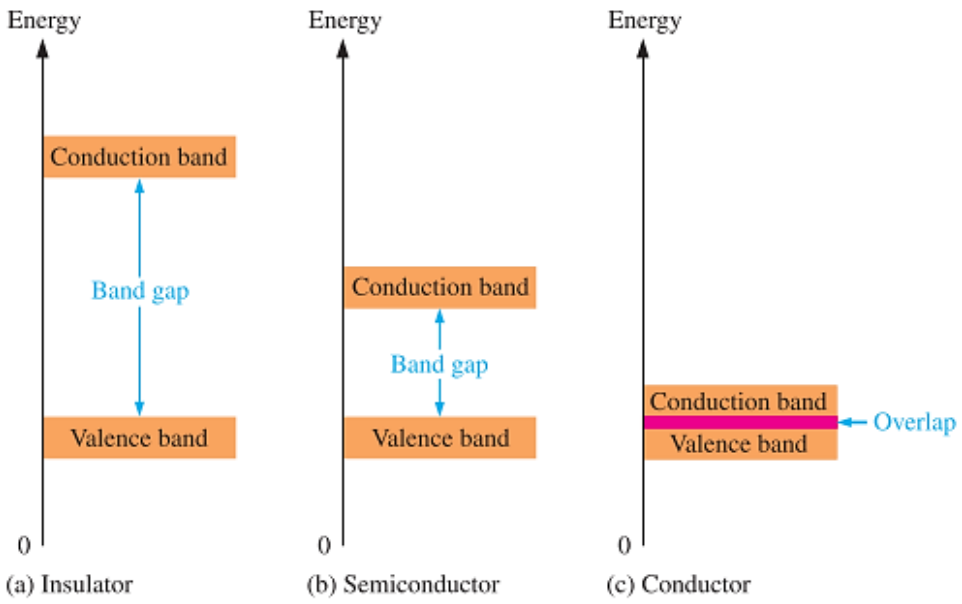
Electronics Applications....

and more and more ☺

ELECTRONICS FUNDAMENTALS

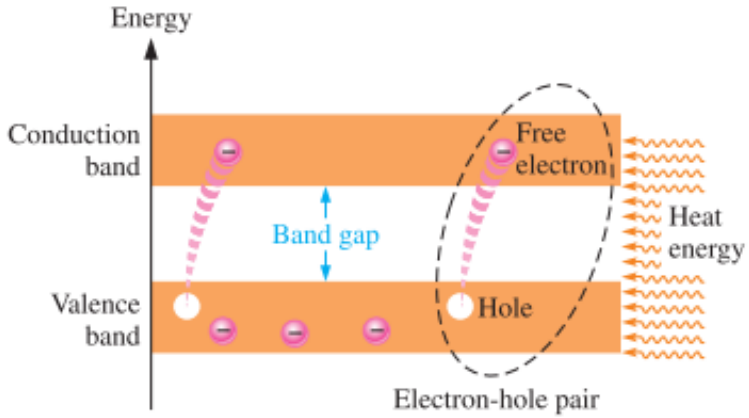
MATERIALS USED IN ELECTRONICS

- Insulators
  - An insulator is a material that does not conduct electrical current under normal conditions.
- Conductors
  - A conductor is a material that easily conducts electrical current.
  - Most metals are good conductors.
- Semiconductors
  - A semiconductor is a material that is between conductors and insulators in its ability to conduct electrical current.

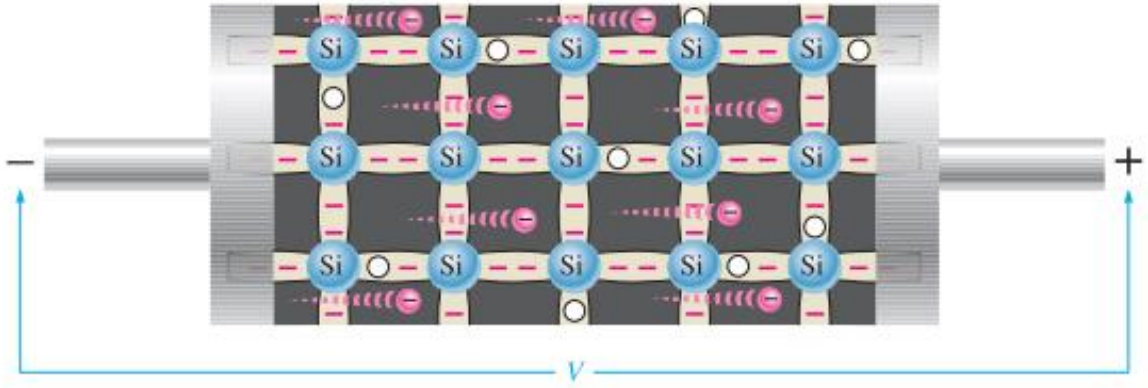


CURRENT IN SEMICONDUCTORS

- Creation of electron-hole pairs in a silicon crystal.
- Electrons in the conduction band are free electrons.

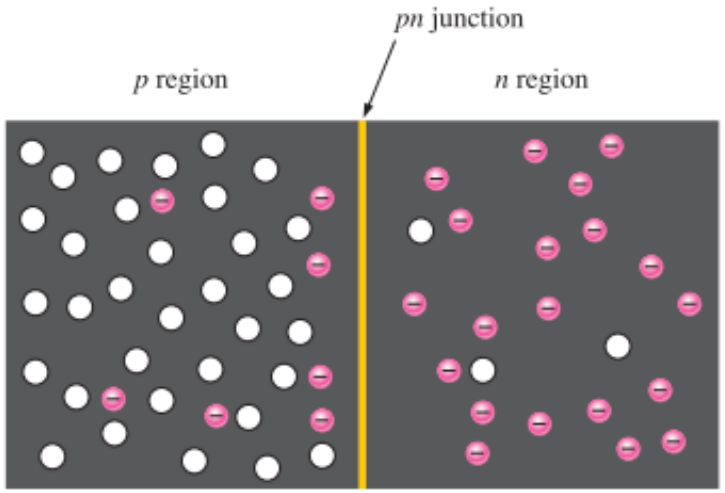


- Electron current in intrinsic silicon is produced by the movement of thermally generated free electrons.

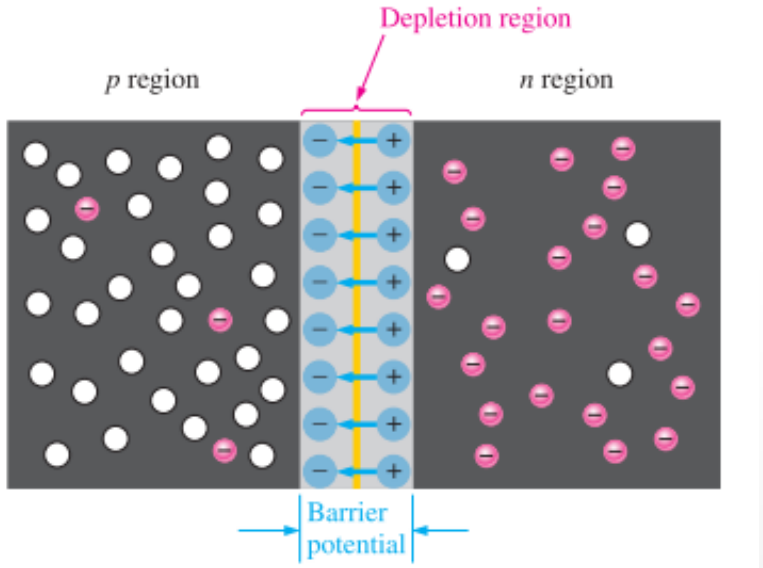


PN Junction

- N-Type Semiconductor
  - The electrons are the majority carriers and the holes are the minority. This is done by doping process.
- P-Type Semiconductor
  - The holes are the majority carriers and the electrons are the minority.



- The basic silicon structure at the instant of junction formation showing only the majority and minority carriers.

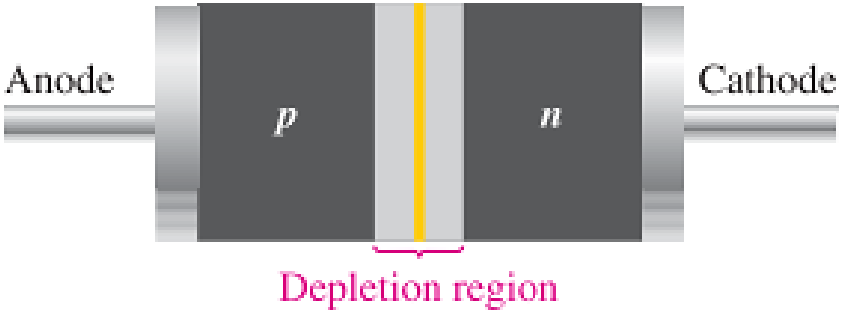


- electrons diffuse and a depletion region is formulated.

DIODES

Diodes

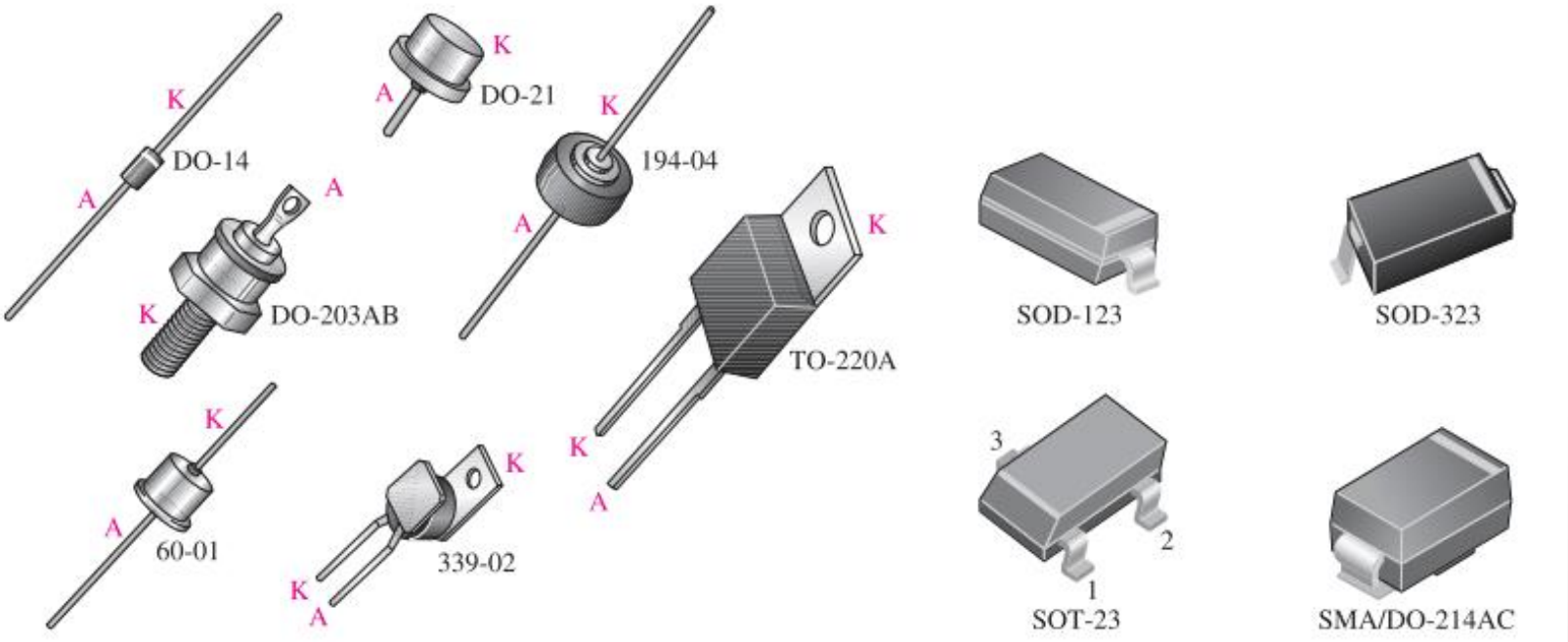
- A diode is made from a small piece of semiconductor material, usually silicon, in which half is doped as a ***p*** region and half is doped as an ***n*** region with a ***pn*** junction and depletion region in between.



Basic structure

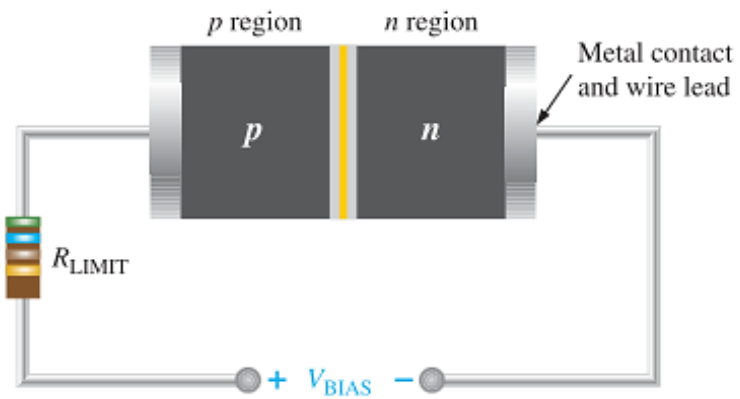
Symbol

Diode Packages

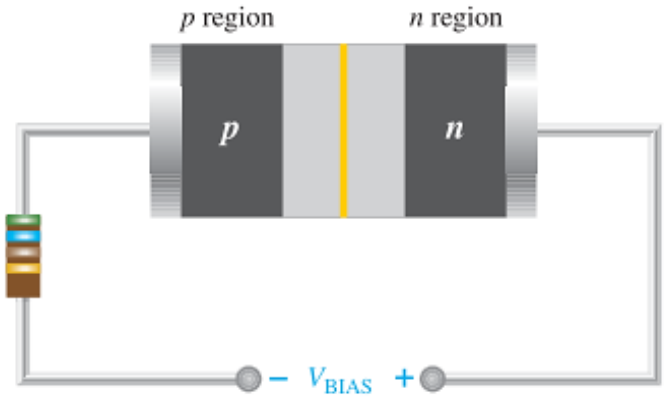


Forward & Reverse Bias

- To **bias** a diode, you apply a dc voltage across it.
- **Forward bias** is the condition that **allows current** through the pn junction.
- **Reverse bias** is the condition that essentially **prevents current** through the diode.



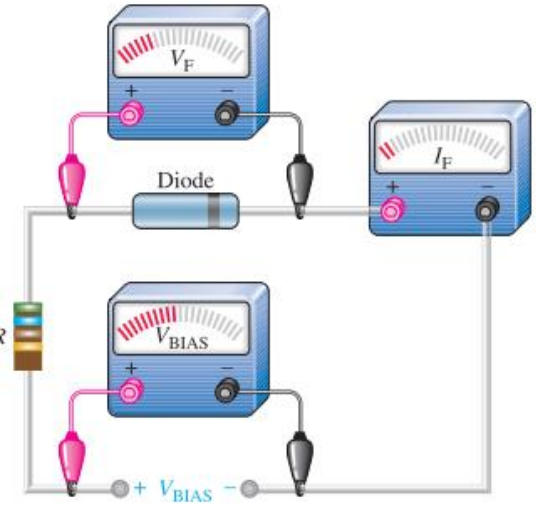
Forward bias



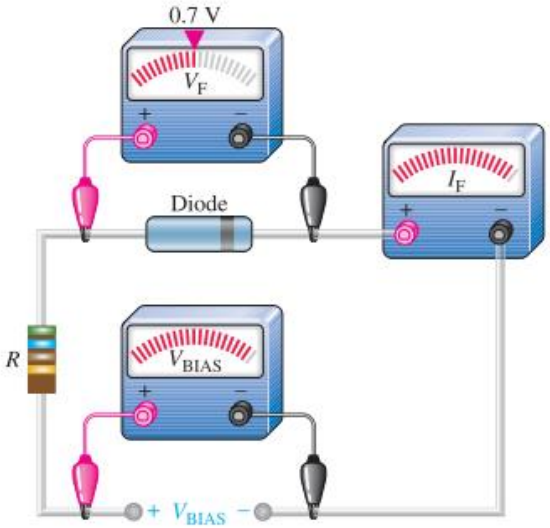
Reverse bias

VOLTAGE-CURRENT CHARACTERISTIC OF A DIODE

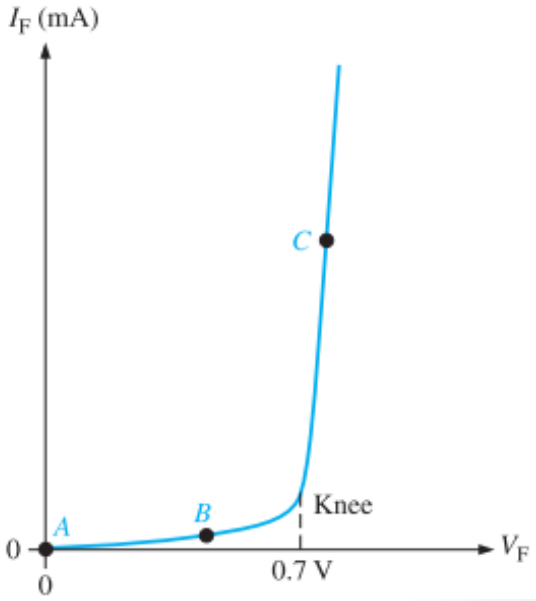
- **V-I Characteristic for Forward Bias**



(a) Small forward-bias voltage ($V_F < 0.7$ V), very small forward current.

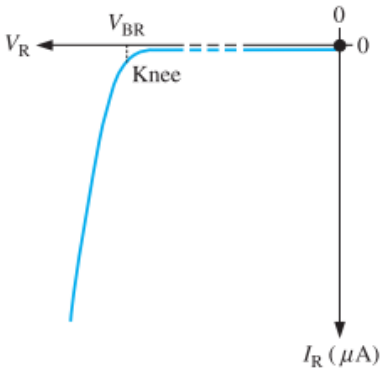


(b) Forward voltage reaches and remains nearly constant at approximately 0.7 V. Forward current continues to increase as the bias voltage is increased.

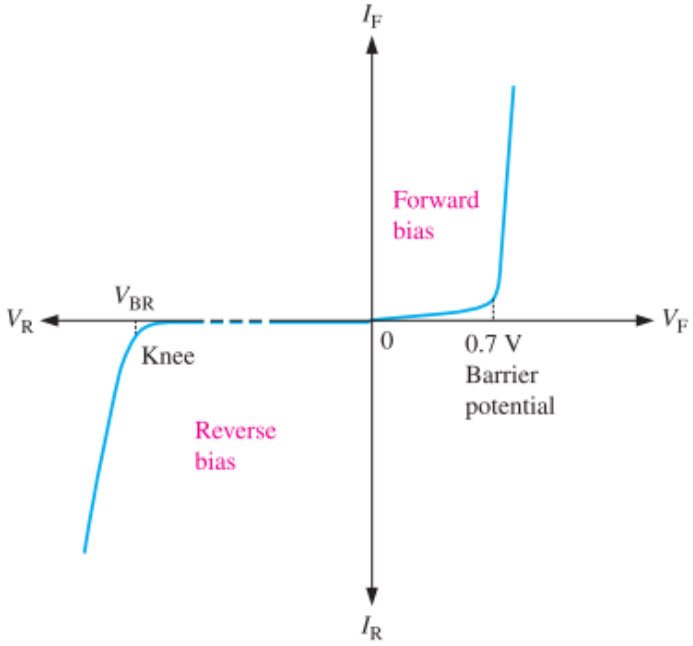


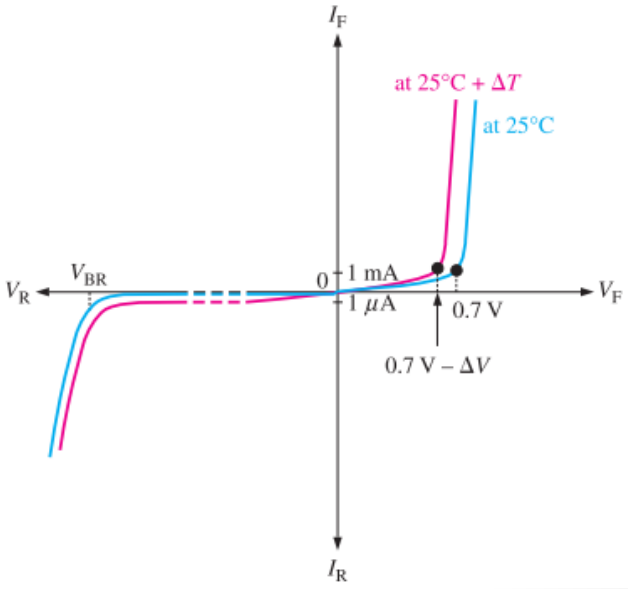
V-I CHARACTERISTIC OF A DIODE ..

- **V-I Characteristic for Reverse Bias**



- **Complete V-I Characteristic**

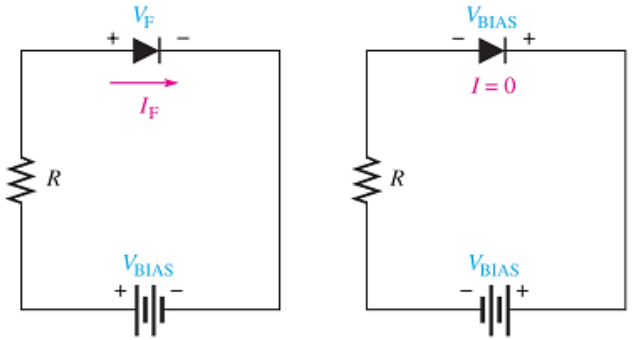




Temperature Effect

DIODE MODELS

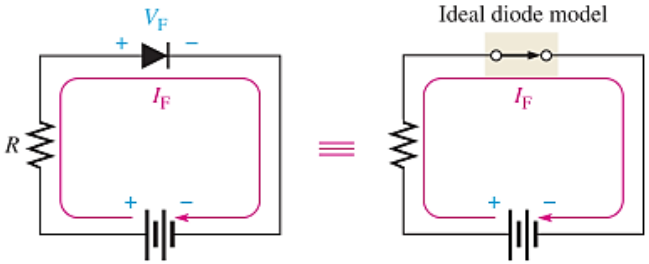
- **Bias Connections**



(a) Forward bias (b) Reverse bias

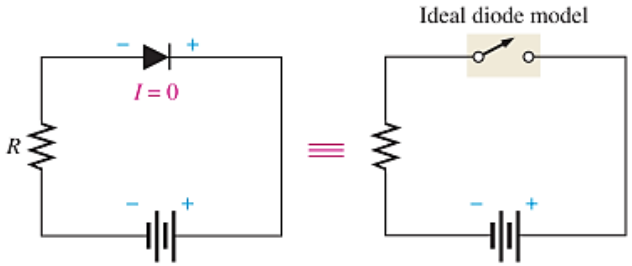
1. The Ideal Diode Model

$$V_F = 0\,V \qquad I_F = \frac{V_{BIAS}}{R_{LIMIT}}$$

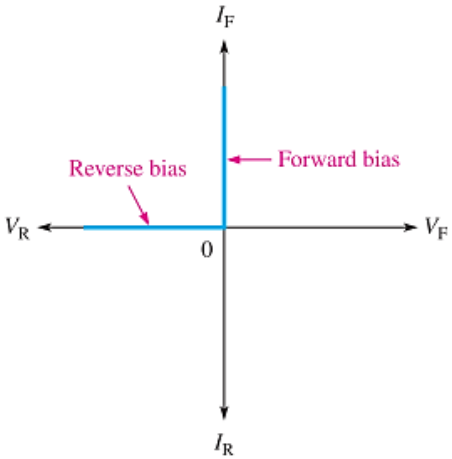


(a) Forward bias

$$I_R = 0\,A \qquad V_R = V_{BIAS}$$



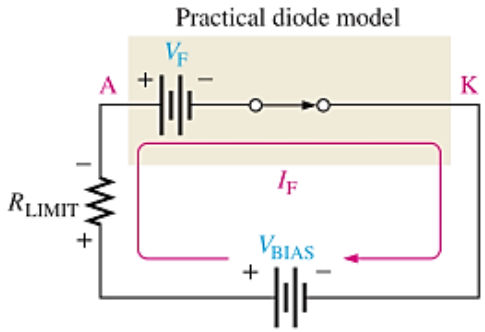
(b) Reverse bias



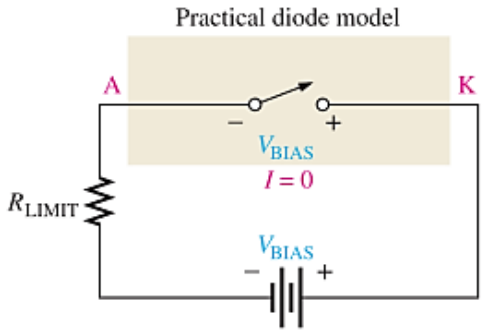
(c) Ideal *V-I* characteristic curve (blue)

DIODE MODELS..

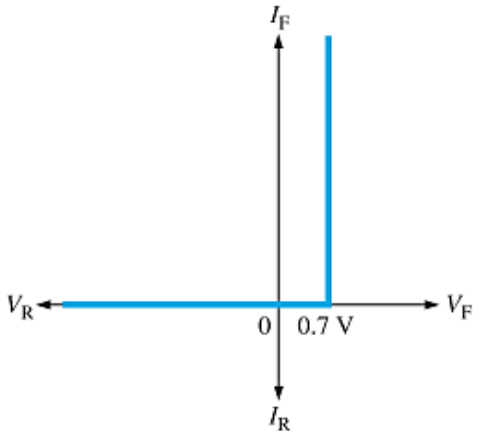
2. The Practical Diode Model



(a) Forward bias



(b) Reverse bias



(c) Characteristic curve (silicon)

$$V_F = 0.7\,\text{V}$$

$$V_{BIAS} - V_F - V_{R_{LIMIT}} = 0$$

$$V_{R_{LIMIT}} = I_F R_{LIMIT}$$

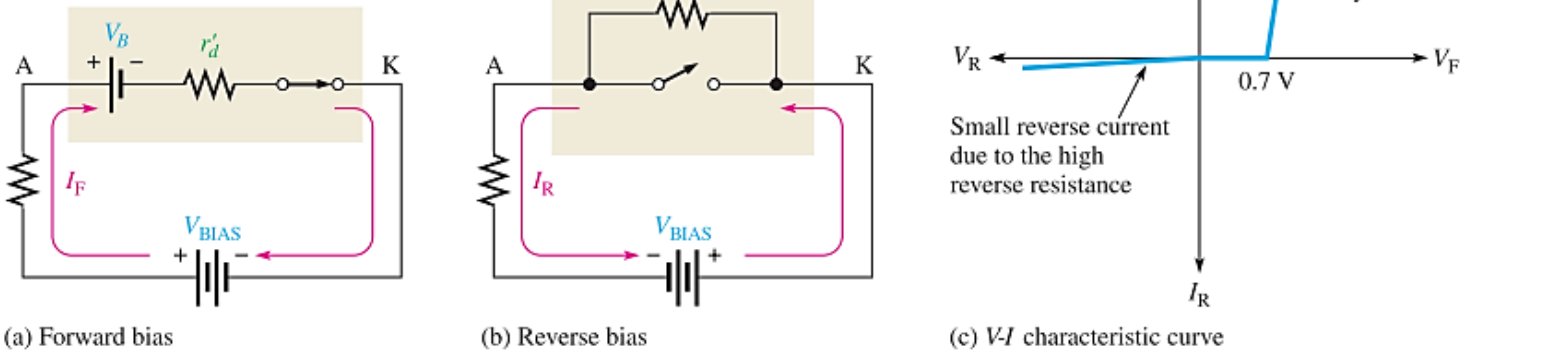
$$I_R = 0\,\text{A}$$

$$V_R = V_{BIAS}$$

$$I_F = \frac{V_{BIAS} - V_F}{R_{LIMIT}}$$

DIODE MODELS..

3. The Complete Diode Model



$$V_F = 0.7\,\text{V} + I_F r'_d$$

$$I_F = \frac{V_{BIAS} - 0.7\,\text{V}}{R_{LIMIT} + r'_d}$$

I_R : Reverse (leakage) current → diode datasheet

$V_R = I_R\, r'_R$

- For more details, refer to:
  - Chapter 1&2, T. Floyd, **Electronic Devices and Circuit Theory**, 11th edition, Prentice Hall.
- The lecture is available online at:
  - *http://bu.edu.eg/staff/ahmad.elbanna-courses/12136*
- For inquires, send to:
  - ahmad.elbanna@feng.bu.edu.eg