# VASAVI COLLEGE OF ENGINEERING (AUTONOMOUS)
## DEPARTMENT OF PHYSICS
## PHYSICS OE TRACKS (B.E-III Semester)
## MATERIALS SCIENCE FOR ENGINEERS
## FUNDAMENTALS OF MATERIALS SCIENCE

| L : T : P | Credits | CIE | | SEE | | Course Code |
|---|---|---|---|---|---|---|
| | | Marks | Exam Duration | Marks | Exam Duration | |
| 02 :0 :0 | 2 | 30 | 90 min | 60 | 3hours | U24OE330PH |
| CIE | Assignments (02) | | Quizzes (02) | Internal Exams(01) | | Total CIE Marks |
| Ave. Marks | 5 | | 5 | 30 | | 40 |

**UNIT I: Atomic structure and Chemical Bonding (8 hours)**

Structure of the atom, The quantum states, Forces between atoms, Ionization potential, Electron affinity and electronegativity. Bond energy, Bond type and Bond length. Types of Bonds-Ionic, Covalent, Metallic bonding, Hydrogen bond, Vanderwalls bond, Cohesive energy of ionic crystals, Madelung constant.

**UNIT II: Atomic Packing (6 hours)**

Simple crystal structures, Classification of close packings 2-D & 3-D, Voids in closed packings, size and coordination of voids, significance of voids, axial ratio and lattice constants, effect of radius ratio, representation of closed packing, Paulings rule, Applications of Paulings rule to actual structures, examples of closed packed structures. Line and surface density of atoms.

**UNIT III: Diffusion in Solids(8 hours)**

Solid state diffusion, Diffusion mechanisms, Self-diffusion, Impurity diffusion coefficient, Fick's laws, Diffusion coefficient, determination of diffusion coefficient, Random walk diffusion, Diffusion in a simple cubic structure, Diffusion under external field, Kirkendall shift, Ionic conductivity, Ionic conductivity of alkali halides.

**UNIT-IV: Strengthening Mechanisms (6 hours)**

Solidification of metals and alloys, cooling curves, concepts of nucleation and growth, Heat transfer associated in nucleation and growth, Homogeneous and Heterogeneous nucleation, Structure of metal ingots, Construction of binary alloys, Formation of alloy phases, viz. Solid solutions – substitutional and interstitial, intermetallic compounds.

**References:**


1. A.J.Dekker, Solid State Physics, Macmillan India Ltd., 2008.
2. V Raghavan, Materials Science and Engineering, PHI, 6thEdn, 2015
3. W.D. Callister Jr & David G. Rethwich, Materials Science and Engineering an Introduction-, John Wiley, 10thEdn, 2018.
4. M. A. Wahab, Solid State Physics, Narosa. 2015.
5. J. P. Srivastava, Elements of Solid State Physics, PHI, 2014.


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**VASAVI COLLEGE OF ENGINEERING (AUTONOMOUS)**
**DEPARTMENT OF PHYSICS**
**PHYSICS OE TRACKS (B.E-IV Semester)**
**MATERIALS SCIENCE FOR ENGINEERS**

## SYNTHESIS AND PROPERTIES OF MATERIALS

| L : T : P | Credits | CIE | | SEE | | Course Code |
|---|---|---|---|---|---|---|
| | | Marks | Exam Duration | Marks | Exam Duration | |
| 03 :0 :0 | 3 | 30 | 90 min | 60 | 3hours | U24OE420PH |
| CIE | Assignments (03) | | Quizzes (03) | Internal Exams(01) | | Total CIE Marks |
| Ave. Marks | 5 | | 5 | 30 | | 40 |

**UNIT I: SYNTHESIS OF MATERIALS-PHYSICAL METHODS (10 hours)**
Solid state reaction, diffusion, melt quenching, vapor deposition, Chemical vapor deposition, physical vapor deposition, sputtering, mechanical milling, electron beam deposition.

**UNIT II: SYNTHESIS OF MATERIALS-CHEMICAL METHODS (8 hours)**
Introduction, slow evaporation at room temperature, high-temperature solution growth, Sol-gel process, Aerosol method, Hydro-thermal process, Solvo-thermal synthesis, Photo-chemical synthesis.

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**UNIT III: Electrical Properties of Materials (8 hours)**
The Boltzmann transport equation, Electrical conductivity, electrical conductivity at low temperatures, Matheissen's rule, Thermal conductivity, Widemann-Franz law, Hall-effect, Temperature variation of electrical conductivity

**UNIT-IV:Physical properties of Materials(10 hours)**
Fundamentals of magnetism, different types of magnetism, Permeability, Magnetic Hysteresis, Coercive force.
Young's modulus, Bulk modulus, Modulus of rigidity, tensile testing and tensile strength, breaking strength, plastic deformation, failure analysis, hardness-testing, Brinell's, Viker's impact testing – toughness, resilience, scratch test.

**UNIT-V:Optical and Thermal Properties of Materials (10 hours)**
Optical properties: photoconductivity, optical absorption & transmission, energy band gap determination, photoluminescence, phosphorescence, electroluminescence.
Thermal properties: concept of phonons, thermal conductivity, specific heat, exothermic & endothermic processes.

**References:**


1. A.J.Dekker, Solid State Physics, Macmillan India Ltd., 2008.
2. V Raghavan, Materials Science and Engineering, PHI, 6$^{th}$Edn, 2015
3. W.D. Callister Jr & David G. Rethwich, Materials Science and Engineering an Introduction-, John Wiley, 10$^{th}$Edn, 2018.
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**VASAVI COLLEGE OF ENGINEERING (AUTONOMOUS)**
**DEPARTMENT OF PHYSICS**
**PHYSICS OE TRACKS (B.E-III Semester)**
**Semiconductor Physics and Device Applications**
**ESSENTIALS OF SEMICONDUCTOR PHYSICS**

| L : T : P | Credits | CIE | | SEE | | Course Code |
|---|---|---|---|---|---|---|
| | | Marks | Exam Duration | Marks | Exam Duration | |
| 02 :0 :0 | 2 | 30 | 90 min | 60 | 3hours | U24OE320PH |
| CIE | Assignments (02) | | Quizzes (02) | Internal Exams(01) | | Total CIE Marks |
| Ave. Marks | 5 | | 5 | 30 | | 40 |

**UNIT I: Basics of Quantum Mechanics (8 Hrs)**
Existence of matter waves, Wave function and its significance, Schrodinger time dependent and independent wave equations, Wave equation of a free particle, Origin of band gap, Energy bands in solids, Postulates of quantum mechanics, Quantum mechanical operators and expectation values, Potential well , Quantum tunnelling.

**UNIT II: Semiconductors: Energy Band and Charge Carriers (6 Hrs)**
Types of semiconductors (doping, bandgap, composition), Fermi-Dirac statistics- Density of states of semiconductor, Fermi level in semiconductors, Law of mass action, Charge compensation and charge neutrality, Hall probes and its applications.

**UNIT-III:Growth of Semiconductors (6 Hrs)**
Introduction, Bulk crystal growth, Epitaxial crystal growth, Evaporation and sputtering, defects in crystal, Band gap engineering, GaAs crystal growth.

**UNIT IV: Carrier Transport in Semiconductors (6 Hrs)**
Carrier generation, Carrier life time, Carrier scattering and mobility, Low-field and high-field transport, introduction to diffusion, Drift-diffusion current and total current density, Einstein relation , Direct and indirect recombination and trapping, Current continuity equation, Carrier injection, ambipolar transport, Diffusion length.

**References:**
1.P. Bhattacharya, Semiconductor Optoelectronic Devices, Prentice Hall of India (1997).
2. Donald Neamen, Semiconductors Physics and Devices, Tata Mc Graw Hill, 2003
3. Tyagi, Introduction to Semiconductor Materials and Devices, Wiley Publications, 2002.
4. Semiconductor Devices, Basic Principles Jasprit Singh, Wiley Publications, 2001
5. Electronic Devices and Circuits- Millman and Halkias-Tata Mc Graw Hill, 1983.
6. Solid State Electronic Devices - Ben G Streetman-Prentice Hall, New Delhi, 1995.

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# VASAVI COLLEGE OF ENGINEERING (AUTONOMOUS)
## DEPARTMENT OF PHYSICS
## PHYSICS OE TRACKS (B.E-IV Sem)
## Semiconductor Physics and Device Applications
## Basic Semiconductor Devices

| L : T : P | Credits | CIE | | SEE | | Course Code |
|---|---|---|---|---|---|---|
| | | Marks | Exam Duration | Marks | Exam Duration | |
| 03 :0 :0 | 3 | 30 | 90 min | 60 | 3hours | U24OE410PH |
| CIE | Assignments (03) | | Quizzes (03) | Internal Exams(01) | | Total CIE Marks |
| Ave. Marks | 5 | | 5 | 30 | | 40 |

**UNIT I: Junction Diode (8 hours)**

Basic structure of PN junction, Band bending, Zero bias condition, Expression for built in potential, Electric field and space charge width, Abrupt and Graded junctions, Diode equation, Effect of temperature on PN junction diode, Capacitive effects in PN junction, Diode –applications.

**UNIT II: Metal-Semiconductor Junction(10 hours)**

Schottky and Ohmic contacts, Schottky barrier diode, Current voltage relationship, comparison of Schottky barrier diode and pn junction diode, Static Barrier Characteristics, Dynamic Characteristics, Ohmic Contact, Metal Oxide Semiconductor Capacitor-Capacitance-Voltage, Ideal MOS system-Threshold voltage.

**UNIT III: Special Semiconductor Devices (8 hours)**

Small signal equivalent circuits of PN-diode, Short and Long diode, Breakdown mechanisms in Zener diode, Varactor diode, Tunnel diode, Gunn diode, Shockley diode, IMPATT diode.

**UNIT IV: BJT and Thyristor (8 hours)**

BJT's – Construction and characteristics, Thyristor – Construction, working and characteristics, comparison of BJT and Thyristor, Heterojunction Bipolar junction transistor, Basics of gate turn-off thyristor (GTO), SiC based Bipolar devices-Applications, Building a GaN Transistor-GaN Transistor Electrical Characteristics.

**UNIT V: Fabrication Techniques(6 hours)**

BJT fabrication: Diffused, point contact, fused or alloy and rate grown techniques, molecular beam epitaxy (MBE), epitaxial vapour phase, Liquid phase growth.

**References:**

1.P. Bhattacharya, Semiconductor Optoelectronic Devices, Prentice Hall of India (1997).
2. Donald Neamen, Semiconductors Physics and Devices, Tata Mc Graw Hill, 2003
3. Tyagi, Introduction to Semiconductor Materials and Devices, Wiley Publications, 2002.
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