16. Structure and Properties of Engineering Materials – V S R Murthy (Tata McGraw Hill, 2003).
17. Inorganic Chemistry – Mallik, Tuli and Madan (S Chand & Co., 1990)
18. Chemistry of Transition Elements – Adkin & Holiday (Oxford Uni. Press, 1985)
19. Inorganic Chemistry: Principles of structure and reactivity – Huheey James E (Harper and Row, 1983) Principles of Materials Science and Engineering – William F Smith (McGraw Hill, 1996)
20. Chemistry in Engineering and Technology (Vol 1&2) – J C Kuriacose and J Rajaram (McGraw Hill, 1988)

MSH 403: FUNDAMENTALS OF ELECTRONIC MATERIALS AND DEVICES (4 Credits)

Objectives:

The course aims to (i) outline the fundamentals of the electronic structures of different types of electronic materials, especially metals and semiconductors. (ii) correlate the band structures of the materials with optical and electrical properties. (iii) extend the theory of semiconductors to the fabrication of the devices and basic circuit designs.

Expected course outcomes: At the end of the course, (i) students will be able to define the concepts of band structure of materials, and interpret the optical and electrical data. (ii) students will be able to execute the IC fabrication techniques in semiconductor industries (iii) students will experiment with basic electronic circuits in the laboratory and be familiar with the electronics part, which will help them troubleshoot any possible minor faults in electronic equipment. (iv) students get the basic training required for placements in semiconductor industries.

Unit I

Metals: Band structure - Brillouin zones- Wigner Seitz approximation-construction of Brillouin zones. Energy wave vector curves. Brillouin zones relation with Bragg planes. Density of states. Fermi surface - F.C.C & B.C.C- De Haas van Alphen effect. Electronic properties of metals- Boltzmann transport equation. Electrical conductivity, thermal conductivity, galvanomagnetic effects, thermionic and field emission in metals. Problems and related experiments. 18 hours

Unit II

Conductors, Resistors and Semiconductors – Types of metals - The resistivity range - Quantum free electron theory of metals. Semiconductors: Energy bands-formation of energy bands, effective mass. Direct and indirect band gaps. Determination of band gaps. Donors and acceptors, carrier concentrations at thermal equilibrium. Calculation of Fermi level. Degenerate and non-degenerate semiconductors. Semiconductor Crystal growth – Introduction, methods - Bridgman, Czochralski, zone melting/refining techniques. Contact phenomenon- semiconductor-semiconductor, metal-semiconductor contacts. Schottky and Ohmic contacts. Preparation of semiconductor devices - Fabrication of junctions- wafer preparation, IC technology: monolithic IC- masking and etching - elements of lithography. Recent developments. Problems and Areas of applications. 18 hours

Unit III

p-n junctions under equilibrium and under bias, generation- recombination currents Transistors-amplifiers: Types of transistor amplifiers - small signal amplifiers-design calculation, power amplifiers. Oscillators: Feedback concepts - negative and positive.

Oscillators-phase shift oscillators, crystal oscillators, LC oscillators - Hartly and Colpitt's oscillators. FET, MOSFET, MESFET.

Operational amplifiers: Introduction - characteristics. Applications - inverting, non-inverting, difference, and summing amplifier. Differentiation and integration circuits using opamp. Related experiments. 18 hours

References

1. Semiconductor Devices – J Brophy (George Allen, 1964)
2. Solid State Electronic Devices – Ben G Streetman (Prentice-Hall, 1995)
3. Electronic Devices and Circuits – A Mottershead (Prentice-Hall, 1991)
4. Integrated Electronics – Millman and Halkias (McGraw Hill, 1995)
5. Digital Principles and Applications – A P Malvino and Lach (McGraw-Hill, 1986)
6. Microprocessors: Principles and applications – C M Gilmore (McGraw-Hill, 1995)
7. Introduction to Microprocessors – A P Mathur (Tata McGraw-Hill, 1995)
8. Solid State Physics – A J Dekker (McMillan, 2000)
9. Introduction to Solid State Physics – C Kittel (Wiley India Publications, 2018)
10. Solid State Physics –N W Ashcroft and N D Mermin (W B Saunders, 1976)
11. Electronic Materials and Devices – D K Ferry (Academic Press, 2001)
12. Semiconductor Physics – P S Kireev (MIR Publishers, 1978)
13. Physics of Semiconductors Devices – S M Sze (Wiley Eastern, 2006)
14. Solid State and Semiconductor Physics – John Mckelvey (John Wiley, 1976)
15. Introduction to Properties of Materials – Daniel Rosenthal and Robert M Asimow (AffiliatedEast –West Press, 1974)
16. Solid State Physics – Giuseppe Grosso, Giuseppe Pastori Parravicini (Academic Press, 2014)

MSH 404: THERMODYNAMICS AND PHYSICAL METALLURGY (4 Credits)

Objectives: This course aims to (i) record the basic concepts of heat and dynamics in a system under various thermodynamic conditions. (ii) apply the concepts of thermodynamics in phase equilibrium, phase diagrams and phase transformations to understand industrially important alloys and polymer blends. (iii) formulate targeted physical properties by using the principles of physical metallurgy, and processing of metals and alloys.

Expected course outcomes: By the end of this course, students will be able to(i) apply the laws of thermodynamics to various processes. (ii) analyze the numerical problems on heat and dynamics. (iii) sketch free energy curves for different compositions of alloy systems in industries. (iv) apply the principles of metal extraction, purification and alloying technology in industries.

Unit 1

Thermodynamics- energy conversion, heat flow, zeroth law, thermodynamic equilibrium and reversibility. Laws of thermodynamics - First law - Internal energy, work in various systems, heat capacity, enthalpy, flow processes, Second law - Carnot theorem, Clausius inequality. Combined law of thermodynamics- entropy calculations for various processes, T-S diagram. Advanced engineering applications. Thermodynamic properties of pure substances in solid, liquid, and vapour phases, P-V-T behaviour of simple compressible substances- ideal and real gases, equation of state, compressibility factor. Free energy functions and thermodynamic potentials - Helmholtz and Gibbs free energy functions, Gibbs-Helmholtz equations. General