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

conditions for equilibrium, thermodynamic potential functions-Maxwell relations. Applications: TdS equations, energy and heat capacity equations. Problems.

Phase transitions: Condition for equilibrium between phases, first, second, and higher order phase changes with specific examples interpretations- lambda transition, Clapeyron and Clausius-Clapeyron equation. Specific heat and latent heat anomalies. Problems. 18 hours

Unit II

Phase rule- Introduction- phase, component, degrees of freedom, crystalline and amorphous solids, cooling curves. Phase diagrams of binary alloy systems- Mixtures, solid solution, compound, eutectic, peritectic, and eutectoid reactions. Microstructural changes during cooling- pearlite, austenite, ferrite, bainite phases. Lever rule. Typical systems-Ag-Pb, Cu-Ni, Pb-Sn, Iron-Carbon, TTT and CCT diagrams, Martensitic transformation. Free energy-composition diagrams, Ternary alloy systems.

Phase transformation- Free energy changes, Nucleation and grain growth, kinetics. Application - transformation in steel-annealing, normalizing, austempering, quenching, tempering, precipitation process, solidification and crystallization. Glass transition. Problems and related experiments. 18 hours

Unit III

Diffusion in solids: Fick's laws of diffusion - solutions to Fich's second law - Gaussian and error function solutions. Determination of diffusion coefficient - diffusion couple. Applications based on the second law. Kirkendall effect, atomic model of diffusion -other diffusion processes. Alloys: Long-range order theory-Super lattices and transitions. Diffusion in alloys - Darken's equations, determination of diffusion coefficient.

Theoretical principles of extraction of Metals – Ellingham diagram. Extraction of Iron and copper, preparation of steel, effect of alloying elements, and heat treatment on property improvement. Cold working of steel. Some special alloys - ferrous and non-ferrous. Examples and areas of applications. 18 hours

References

1. Heat and Thermodynamics – Mark W Zemansky, (McGraw-Hill, 1968)
2. Thermodynamics of Solids – Richard A Swalin, (John Wiley & Sons 1972)
3. Equilibrium Thermodynamics – C J Adkins (Cambridge University press, 1983)
4. Solid State Phase Transformation – V Raghavan (Prentice Hall, 1992)
5. Principles of Materials Science and Engineering – William F Smith (McGraw Hill, 1988)
6. Phase Rule – Gurdeep Raj (Goel pub., 1991)
7. Phase Rule and its Applications – Findlay Alexander (Dover, 1951)
8. Understanding Phase Diagrams – John V B (Macmillan, 1974)
9. Phase Diagrams: Understanding the basics- Flake C Campbell (ASM International, 2012)
10. Physical Metallurgy, Principles and Practice – V Raghavan (PHI Learning Pvt. Ltd. 2015)