MANGALORE UNIVERSITY

Department of Materials Science

MSc Materials Science

MSH 502: **SOLID STATE ENGINEERING MATERIALS – I** (4 Credits)

Objectives: The objective of the course is to teach fundamentals of the electronic structures of different types of electronic materials especially metals and semiconductors along with details about the alloys and nuclear materials. The band structures of the materials are important to understand the optical and electrical properties. With the help of theory of semiconductors, fabrication of the devices is also discussed.

Expected course outcomes: Student should understand the concepts of band structures of materials, and be able to interpret the optical and electrical data. They should be in a position to understand various aspects of alloys and familiar with the fundamentals of nuclear reactors and materials used in them.

Unit I

Metals: Band structure - Brillouin zones- Wigner Seitz approximation. 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 – Boltzman transport equation. Electrical conductivity, thermal conductivity, Galvanomagnetic effects, thermionic and field emission in metals. 18 hours

Unit II

Semiconductors: 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 (brief description). 18 hours

Unit III

Alloys: Long range order theory-Super lattices and transitions. Diffusion in alloys - Darken's equations, determination of diffusion coefficient. Some special alloys - ferrous and non-ferrous. Super alloys.

Nuclear materials: General aspects of reactor design. Fissile materials used in different types of reactors- Moderator and coolant and cladding materials. Radiation effects in materials - Swelling, He-embrittlement, induced radioactivity. Erosion and fretting corrosion-stress corrosion cracking, H_2-embrittlement. 18 hours

References

1. Solid State Physics – A J Dekker (McMillan, 1985)
2. Solid State Physics – C Kittel (Wiley Eastern, 1993)

Solid State Physics –N W Ashcroft and N D Mermin (W B saunders, Ithaca, 1976)
3. Electronic Materials and devices – D. K. Ferry (Academic Press, New York, 2001)
4. Semiconductor Physics – P S Kireev (MIR Publishers, 1978)
5. Physics of Semiconductors Devices – S M Sze (Wiley Eastern, 1991)
6. Solid State Devices – Ben G Streetman (Prentice-Hall, 1995)
7. Solid State and Semiconductor Physics – John Mckelvey (John Wiley, 1976)
8. Introduction to properties of Materials – Daniel Rosenthal and Robert M Asimow (Affiliated East-West Press, 1974)
9. Physical Metallurgy Principles – R E Reed Hill (Affiliated East –West Press, 1974)
10. Physical Metallurgy – S H Avner (Tata McGraw-Hill 1997)
11. Mechanical Metallurgy – George R Dieter (McGraw-Hill, 1988)
12. Nuclear Reactor Engineering – S Glasstone and Alexander Sesonske (CBS Pub., 1986)