MANGALORE UNIVERSITY

Department of Materials Science

MSc Materials Science

MSH 552: **SOLID STATE ENGINEERING MATERIALS – II** (4 Credits)

Objectives: Objective of this course is to provide a detailed basic knowledge about technologically important materials such as superconducting materials, liquid crystalline materials, ceramics, etc. the studies of semiconductor devices such as Lasers and solar cells are included to provide essential knowledge on the modern optoelectronic devices.

Expected course outcomes: This course provides good basic knowledge to the students about the superconductivity, liquid crystals, lasers, solar cells and ceramic materials. This would help them to perform research work in these areas and it is also useful in continuing their career in many industries.

Unit I

Superconductivity: Nature and properties of superconducting materials - Type I and II superconductors - Phenomenological theories - BCS theory – concept of energy gap. Superconducting tunneling phenomena: metal-insulator-superconductor (MIS) and superconductor-insulator-superconductors (SIS). AC and DC Josephson effect. Applications - superconducting magnets, super density switches, SQUID and magnetic levitation. superconducting composites. Nb_3Sn/Cu. High temperature (High T_c) superconductors: material preparation - ceramic and thin film technique, structure.

Liquid Crystalline Materials: Introduction - classification of thermotropic liquid crystals. Elementary ideas on material. Properties of liquid crystals - birefringence, dielectric anisotropy, viscosity, conductivity anisotropy and elasticity of liquid crystals, electro-optic, thermo-optic effects and LCD devices and applications.

18 hours

Unit II

Lasers and applications: Spontaneous emission - stimulated transitions and rate equation balance, amplifications in a medium, population inversion methods, oscillation threshold, optical resonator theory. Gas lasers - applications.

Solid state lasers: Semiconductor lasers – absorption-direct and indirect band gaps, material requirement, conditions for laser oscillations, homojunction and heterojunction lasers - applications.

Photovoltaic and solar cells: material requirement, efficiency, efficiency limits, spectral response, types of solar cells-conventional tandem-junction solar cells, heterojunction solar cells, thin film solar cells, amorphous silicon solar cells. 18 hours

Unit III

Ceramics: Ceramics and their structure- silicate structure - polymorphism and allotrophy: Processing - Recrystallization and grain growth, sintering, hot pressing, fire shrinkage. Basic refractory materials.

Glasses: Preparation and structure - Types of glasses -borate glasses, silicate glasses, oxide glasses, metallic and semiconducting glasses. Properties of glasses – electrical, optical, thermal, mechanical properties, Applications - photo sensitive, photochromic glasses, optical fiber- principle of fiber communication.
Optical properties: Luminescence: Frank Condon principle, excitation process - thermoluminescence and electroluminescence. Luminescent materials and industrial applications. 18 hours

References

1. Introduction to superconductivity – A C Rose-Innes and E H Rhoderick (Pergamon Press, 1978)
2. Superconductivity and Superconducting Materials – A V Narlikar and S N Ekbote (South Asian Pub., 1983)
3. Physics of high T_c superconductors – J C Phillips (Academic Press, 1989)
4. Liquid Crystals – S Chandrasekhar (Cambridge University Press, 1977)
5. The Physics of Liquid Crystals – P G de Gennes (Oxford, 1975)
6. Electronic Materials and devices – D K Ferry (Academic Press, New York, 2001)
7. Semiconductor Physics – P S Kireev (MIR Publishers, 1978)
8. Physics of Semiconductors Devices – S M Sze (Wiley Eastern, 1991)
9. Solid State Devices – Ben G Streetman (Prentice-Hall, 1995)
10. High efficiency silicon Solar Cells – M A Green (Tran. tech., 1987)
11. Solid State and Semiconductor Physics – John Mckelvey (John Wiley, 1976)
12. Introduction to Ceramics – W D Kingery, H K Bower and U R Uhlman (John Wiley, 1960)
13. Glasses and vitreous state – J Zarzycki (Cambridge University Press, 1982)
14. Materials Science and Technology Vol. 9: Glasses and amorphous materials, (Ed.) R W Cahn, P Haasen, E J Kramer, (VCH Weinheim, 1991)
15. Optical fiber communications – G Keiser (McGraw-Hill, 2000)