MANGALORE UNIVERSITY

Department of Materials Science

MSc Materials Science

MSH 453: **ELEMENTS OF MATERIALS SCIENCE – II (**4 Credits)

Objectives: Objective of the course is to study the basics of mechanical properties of materials. The course deals with the crystal imperfections, diffusion in solids, elastic behaviour of materials, plastic deformation and fracture, etc.

Expected course outcomes: At the end of this course, students should be able to classify various types of defects in the materials and their connection with elastic/plastic deformations and various mechanical properties of materials. This would help students in the selection of materials for various applications during their career.

Unit I

Crystal Imperfections: Point imperfections - configurational entropy - Schottky and Frenkel defects - equilibrium concentrations. Line imperfections - edge and screw dislocations - Buerger's vector in cubic crystals. Surface imperfections - grain boundary - tilt and twin boundaries.

Diffusion in solids: Fich's laws of diffusion - solutions to Fich's second law - Gaussian and error function solutions. Determination of diffusion coefficient - diffusion couple. Applications based on second law. Kirkendal effect. Atomic model of diffusion -other diffusion processes - electrical conductivity of ionic crystals.

18 hours

Unit II

Elastic Behaviour of Materials: Atomic model of elastic behaviour - the modules as a parameter in design - rubber like elasticity - Anelastic behaviour - Viscoelastic behaviour.

Elements of Physical Metallurgy: Fracture in metals – Ductile fracture, ductile brittle transition, brittle fracture-Griffith theory. Notch effect, Compressive and tensile strength - size effect, stress intensity factor, toughness measurements. Protection against fracture. Fatigue failure - Characteristic of fatigue failure-statistical nature of fatigue-correlation of fatigue strength and plastic properties. Factors affecting fatigue strength. Tribology: wear of metals–mechanisms, factors influencing wear, wear resistance-protection against wear. Metallurgical microscopes, sample preparation, grain size measurements of typical ferrous and non-ferrous alloys.
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18 hours

Unit III

Plastic Deformation in Crystalline Materials: The tensile stress-strain curve - Plastic deformation by slip - the shear strength of perfect and real crystals - CRSS - the stress to move a dislocation. interactions between dislocations - multiplication of dislocations during deformation – Frank- Reed Source. Work hardening and dynamic recovery. Strengthening against plastic deformation – strain hardening – grain refinement – solid solution – precipitation strengthening. Creep in Crystalline Materials - Mechanism of creep and creep resistant materials. 18 hours

References

1. Elements of Materials science and Engineering – Lawrence H van Vlack (Addision Wesley, 1975)
2. Materials Science and Engineering – V Raghavan (Prentice Hall,1993)
3. Materials Science and Processes – B S Narang (CBS,1983)
4. Introduction to solids – L V Azaroff (McGraw Hill, 1960)
5. Introduction to Solid State Physics – C Kittel (II Ed. Asia publishing House, 1965)
6. The Structure and Properties of Materials-Vol.I-IV – Rose, Shepard and Wulff (Wiley Eastern,1987)
7. Physical Metallurgy – V Raghavan (Printice Hall, 1989)
8. Materials Science and Metallurgy – O P Khanna (Dhanpat Rai & Sons, 1984)
9. Solid State Physics Source Book – Sybil P Parker (McGraw Hill, 1987)
10. Materials Science and Technology – A comprehensive treatment – (ed.) R W Cahn, P Haasen & E J Kramer – Electronic and Magnetic properties of metals and ceramics, Vol – 3A & -3B (VCH, 1992 & 1994)
11. Introduction to properties of Materials – Daniel Rosenthal and Robert M Asimow (Affiliated East-West Press, 1974)
12. Physical Metallurgy Principles – R E Reed Hill (Affiliated East –West Press, 1974)
13. Physical Metallurgy – S H Avner (Tata McGraw-Hill 1997)
14. Mechanical Metallurgy – George R Dieter (McGraw-Hill, 1988)