11. Chemistry in Engineering and Technology (Vol 1&2) – J C Kuriacose and J Rajaram (McGraw Hill, 1988)
12. Materials Science and Engineering – V Raghavan (Printice Hall, 1995)
13. An Introduction to Metallurgy – A H Cottrell (Edward Arnold, 1971)
14. Materials Science and Processes – B S Narang (CBS, 1983)
15. Advanced Physical Chemistry – Gurdeep Raj (Goel, 1992)
16. Inorganic Chemistry – Mallik, Tuli and Madan (S Chand & Co, 1990)
17. Chemistry of Transition Elements – Atkin & Holiday (Oxford, 1985)
18. Text book of Materials Science and Metallurgy – O P Khanna (Dhanpat Rai & Sons, 1984)
19. Physical Metallurgy Principles – R E Reed Hill (Affiliated East –West Press, 1974)
20. Physical Metallurgy – S H Avner (Tata McGraw-Hill, 1997)
21. Mechanical Metallurgy – George R Dieter (McGraw-Hill, 1988)
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23. Engineering Chemistry – Jain & Jain (Dhanpat Rai & Sons, 1993)
24. Elements of Materials Science – L H van Vlack (Addison-Wesley, 1989)
25. An Introduction to Ancient Indian Metallurgy – K T M Hegde (GSI, 1991)
26. Physical Metallurgy – Haasen Peter (Cambridge CUP, 1996)
27. Physical Metallurgy and Advanced Materials – Smallman R E (Oxford Butterworth, 2010)
28. Introduction to Physical Metallurgy – Sidney H Avner (McGraw Hill Ed., 2016)
29. Inorganic Chemistry: Principles of Structure and Reactivity- Huheey James E (Hharper and Row, 1978)

II SEMESTER

MSH 451 MECHANICAL BEHAVIOUR OF MATERIALS (4 Credits)

Objectives: The objectives of this course are to, (i) discuss the mechanical properties of metals, ceramics, and polymers, (ii) explain different types of crystal imperfections and their importance, (iii) describe the elastic and plastic deformations in various materials, (iv) explain fracture in materials including ductile and brittle fracture, and the tribology of materials.

Expected course outcomes: At the end of this course, students will be able to (i) classify various types of defects in materials and their connection with elastic and plastic deformations, (ii) students will correlate the mechanical properties with the nature of bonding in materials. (iii) students will be able to identify the conditions under which materials fail (iv) students will be able to apply knowledge to select appropriate materials for various applications in industries and research.

Unit I

Crystal Imperfections: Introduction to defects- 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. Problems and related experiments.

Deformation of a material: Types of deformation, temporary deformations, permanent deformation. Elastic behaviour of materials: atomic model of elastic behaviour - modulus as a parameter in design - rubber-like elasticity - anelastic behaviour -

viscoelastic behaviour- Maxwell element, Voigt-Kelvin model, and related experiments. 18 hours

Unit II

Plastic Deformation in Crystalline Materials: The tensile stress-strain curve – different types of plastic deformation, slip and twinning - 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. Effect of temperature on plastic deformation. Strengthening against plastic deformation – strain hardening – grain refinement – solid solution – precipitation strengthening. Creep in crystalline materials - mechanism of creep and creep resistant materials. Problems and related experiments.

Fracture in metals and ceramics –introduction, 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. problems and related experiments. 18 hours

Unit III

Tribology: Introduction, wear of metals–mechanisms, factors influencing wear, wear resistance-protection against wear. ASTM number and their significance. Metallurgical microscopes, sample preparation, grain size measurements of typical ferrous and non-ferrous alloys.

Mechanical properties- static and dynamic tensile, flexural, compressive, abrasion, endurance, tear, resilience, impact, toughness.

Heat deflection temperature- Vicat softening temperature, brittleness temperature, glass transition temperature. Thermal expansion, shrinkage, flammability.

Polymer rheology, measurement of rheological parameters by capillary rotating, parallel plate cone plate rheometer. Control of rheological characteristics. 18 hours

References

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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, 1991 & 1993)