

PHYSICAL METALLURGY

UNIT – I: CRYSTAL STRUCTURES

Review of atomic bonds-crystal systems and Bravais lattices, principal metallic crystal systems- BCC, FCC, HCP, atom positions and directions in cubic unit cells, miller indices for crystallographic planes in cubic unit cells, crystallographic planes and directions in hexagonal unit cells, volume, planar and linear atomic density calculations, allotropy, single crystal and polycrystalline materials, anisotropy, X-ray diffraction and determination of crystal structures, non-crystalline solids.

UNIT – II: CRYSTALLINE IMPERFECTIONS

Types of point defects, vacancy dependence on temperature, solid solutions, formation of substitutional solid solutions and interstitial solid solutions, line defects-dislocations-edge, screw and mixed dislocations- Burger's vector-slip and twinning. Planar defects-grain boundaries, high angle and small angle grain boundaries, grain size determinations. Volume defects-voids in BCC and FCC unit cells.

UNIT – III: PHASE DIAGRAMS:

Gibb's phase rule, binary isomorphous alloy systems, non-equilibrium cooling, binary eutectic system, eutectoid, peritectic and monotectic reaction, phase diagrams with intermediate phases and compounds, iron-carbon diagram, ternary phase diagrams, development of microstructures.

UNIT – IV: STRENGTHENING MECHANISMS

Grain size strengthening-solid solution strengthening-factors affecting solid solution strengthening. martensitic strengthening, precipitation hardening-conditions for precipitation hardening-aging-formation of precipitates-coarsening of precipitates, mechanism of strengthening. dispersion strengthening-Introduction, factors for effective dispersion hardening-strengthening mechanism-examples for above strengthening mechanisms-worked examples.

UNIT – V: ATOMIC DIFFUSION IN SOLIDS

Diffusion mechanisms, steady state diffusion and non-steady state diffusion, Fick's first law and second law. Inter diffusion-Kirkindal effect. Darken's equation, diffusion calculations, factors that influence diffusion, Industrial applications of diffusion processes.

UNIT – VI: COLD WORKING AND HOT WORKING

Cold working- structure and properties of cold worked metals. recovery, recrystallisation and grain growth. recrystallisation temperature. factors influencing recrystallisation temperature. comparison of cold working and hot working.

REFERENCE BOOKS

1. Donald R Askeland, "The Science and Engineering of Materials", Brooks Cole Engineering Division, Monterey, U.S.2007.
2. William D Callister, "Materials Science and Engineering - An Introduction", John Wiley and Sons, USA, 2007.
3. James F Shackelford, "Introduction to Material Science for Engineers", Macmillan Publisher, New York, 1992.
4. William F Smith, "Foundations of Materials Science and Engineering", McGraw Hill, New York, 2004.
5. Avner S H, "Introduction to Physical Metallurgy", McGraw Hill, New York, 1997.