Materials

Semester 4 (January)

UMT 202 Structure of Materials (2:1)
(Core for Materials majors and minors)

Elements of bonding, structures of simple metallic, ionic and covalent solids; Coordination polyhedra, projections of structures, stacking; Lattices, symmetry operations, stereographic projection; Structure and thermodynamics of point defects and solid solutions, non-stoichiometry, ordered structures; Dislocations and slip, twinning and interfaces.

N. Ravishankar, S. Karthikeyan

A. Kelly and G.W.Groves: Crystallography & Crystal Defects, Addison Wesley
C.S.Barrett and T.B.Massalski, Structure of Metals, Pergamon
A.R. West,: Introduction to solid state chemistry, John Wiley

UMT 203 Materials Thermodynamics (3:0)
(Core for Materials majors + Soft core for Materials minors)

First Law, Enthalpy, Thermochemistry; Second Law, Entropy, Statistical Interpretation; Helmholtz and Gibbs Free Energies, Chemical Potential; Solution Thermodynamics; Conditions for Equilibrium, Phase Rule, Phase Diagrams; Chemical Reactions and Equilibria; Surfaces and Interfaces.

T.A. Abinandanan

R.T. DeHoff: Thermodynamics in Materials Science, Taylor & Francis (2006)
D.R. Gaskell: Introduction to the Thermodynamics of Materials (4th Ed), Taylor & Francis (2003).

UMT 204 Electronic Properties of Materials (3:0)
(Core for Materials majors + Soft core for Materials minors)

Brief review of the fundamentals of quantum mechanics, statistical mechanics, electrostatics and electrodynamics. Energy bands in crystals, density of states, Electric conduction in metals and alloys, Thermoelectric phenomenon and applications, Semiconductors and devices, Electrical properties of polymers, ceramics, dielectric and amorphous materials, classical and quantum mechanical description of optical properties, Lasers, LEDs, photonics,Magnetic phenomenon and applications, Thermal properties of materials.

R. Ranjan

C. Kittel: Introduction to Solid State Physics, McGraw-Hill.

L. Solymar and D. Walsh, Lectures on Electrical Properties of Materials
M. Ali Omar: Elementary Solid State Physics
R.E. Hummel: Electronic Properties of Materials

Semester 5 (August)

UMT 301 Materials Kinetics (3:0)
(Core for Materials majors + Soft core for Materials minors)

Point defects, Fick's laws of diffusion, concept of jump frequency, activation energy, Kirkendall effect, solidification, nucleation, constitutional supercooling, sintering, interfaces, grain growth, solid state transformations, JMA theory, GP zone, Spinodal decomposition, ordering and martensitic transformations, effect of stress and electric current.

A. Paul

R.E. Reed-Hill and R. Abbaschian, Physical Metallurgy Principles, Cengage (2009)
D.A. Porter and K. E. Easterling, Phase Transformations in Metals and Alloys, Taylor and Francis (2009)

UMT 302 Introduction to Materials Processing (2:1)
(Core for Materials majors + Soft core for Materials minors)

Metals: Principles of extraction of metals, hydrometallurgy, electrometallurgy, pyrometallurgy. Solidification Processing. Ceramics: Synthesis of ceramic powders, consolidation, sintering. Polymer synthesis. Growth and processing of thin films.

S. Subramanian, P.C. Ramamurthy, S. Bose

C.B. Alcock: Principles of pyrometallurgy, Academic Press, London (1976)
S. Venkatachalam: Hydrometallurgy, Narosa, New Delhi (1998).
W.D. Kingery, H.K. Bowen, D.R. Uhlmann, Introduction to Ceramics, Wiley (1976)
D. Braun, H. Cherdron, M. Rehahn, H. Ritter and B. Voit, Polymer Synthesis: Theory and Practice: Fundamentals, Methods, Experiments , Springer (2010)

UMT 303 Mechanical Behaviour of Materials (3:0)
(Core for Materials majors + Soft core for Materials minors)

Introduction to basic concepts of Stress and Strain; Engineering stress-strain response vs. True stress-strain response, Elastic and viscoelastic behavior, dislocations, plastic flow in single crystals, strengthening mechanisms, composites, noncrystalline materials, fracture and toughening mechanisms of ceramics and polymers, creep and fatigue, environmental effects

B. Basu

T.H. Courtney, Mechanical Behavior of Materials, 2nd edition, Tata McGraw Hill (2001).

UMT 306 Mechanical Processing Lab (0:1)
(Core for Materials majors)

Solidification, Mechanical working of materials: Rolling, Extrusion; Powder processing: Sintering; Materials Joining: Welding, Soldering.

G.S. Avadhani, S.V. Kailas, S. Suwas

Semester 6 (January)

UMT 304 Microstructures in Materials (3:0)
(Elective)

Structure and properties of grain boundaries, interface boundaries, and surfaces; Solidification microstructures; Phase transformations: precipitation, eutectoid, martensitic transformations; Sintering.

T.A. Abinandanan

D.A. Porter and K. E. Easterling, Phase Transformations in Metals and Alloys, Taylor and Francis (2009)
J.W. Martin, R.D. Doherty and B. Cantor, Stability of Microstructures in Metallic Systems, Cambridge University Press (1997)

UMT 305 Mechanical Properties Lab (0:1)
(Core for Materials majors)

Tensile and compression testing. Hardness tests. Fatigue. Impact testing. Creep, Dynamic properties of materials.

P. Kumar, R. Ravi, S. Suwas

Electives

An indicative list of graduate-level elective courses is given below; specific recommendations will be made at the beginning of each semester:

For the third year:

Fundamentals of Biomaterials and Living Matter (Bio-Engineering)
Introduction to Biomechanics of Solids (Bio-Engineering)
Corrosion Technology (MT)

Polymer Science and Engineering-I (MT)
Topics in Basic and Applied Electrochemistry (IPC)
Phase Transformations (MT)
Interfacial Phenomena in Materials Processing (MT)
Fracture (MT)
Solidification Processing (MT)
Defects and Materials Properties (MRC)
Functional Materials Lab (MRC)
Introduction to Biomaterials (MRC)
Thin Films, Nanomaterials and Devices: Science and Engineering (MRC)

For the fourth year:
Semiconductor Devices and Integrated Circuit Technology (CeNSE)
Crystal Growth and Thin Films (CeNSE)
Elements of Solid and Fluid Mechanics (CPDM)
Design and Selection of Materials (MT)
Defects in Materials (MT)
Modeling and Simulations in Materials Engineering (MT)
Science of Materials Processing (MT)
Introduction to Biomaterials Science and Engineering (MT)
Electron Microscopy (MRC)
Computational Modeling of Materials (MRC)
Nanostructured Materials (MRC)