

Topics for Comprehensive Exam for PhD Students in the Materials Engineering Programme

1. Structure of materials
 - a. Atomic structure and interatomic bonding
 - b. Structure of crystalline solids
 - c. Imperfections in solids
 - d. Electron theory and band structure
 - e. Glasses/amorphous
 - f. Molecular structures
2. Thermodynamics
 - a. Thermodynamic laws, functions and relations
 - b. Electrochemical thermodynamics
 - c. Solution thermodynamics & Phase diagrams
3. Kinetics/Transport
 - a. Heat flow
 - b. Mass flow (liquid/gas)
 - c. Diffusion (solid state)
 - d. Fluid flow
4. Mechanical Properties
 - a. Elasticity
 - b. Plasticity (Crystalline/ Non-crystalline)
 - c. Viscoelasticity
 - d. Fracture
5. Metals
 - a. Phase transformations in metals
 - b. Thermal processing of metals
 - c. Solidification
 - d. Alloys
6. Ceramics
 - a. Structure and properties of ceramics
 - b. Processing of ceramics and glasses
7. Polymers
 - a. Polymer structures
 - b. Polymer processing
 - c. Properties of polymers
8. Composites
 - a. Matrices and reinforcing
 - b. Composite processing
 - c. Mechanical properties of composites
9. Semiconductors
 - a. Semiconductor materials
 - b. Processing of semiconductors
 - c. Semiconductor devices
10. Biomaterials
 - a. Structure of biomaterials
 - b. Processing of biomaterials
11. Functional Properties
 - a. Electrical properties
 - b. Thermal properties
 - c. Magnetic properties
 - d. Optical properties
 - e. Biocompatibility
12. Electrochemistry

- a. Corrosion and degradation of materials
 - b. Behaviour of solutions
 - c. Electrochemical kinetics
 - d. Leaching kinetics
13. Extractive Metallurgy
- a. Hydrometallurgy
 - b. Pyrometallurgy
 - c. Slag chemistry
 - d. Aqueous precipitation
 - e. Solvent extraction and ion exchange

Textbooks:

W.D. Callister, Jr.: Materials science and engineering

D.R. Gaskell: Introduction to the thermodynamics of materials

D.A. Porter, K.E. Easterling, M.Y. Sherif: Phase transformation in metals and alloys

S.M. Sze: Semiconductor devices

J.D. Plummer, M. Deal, P.D. Griffin, Silicon VLSI Technology: Fundamentals, Practice, and Modeling

C. Kittel: Introduction to solid state physics

K.J. Vetter: Electrochemical kinetics

D.A. Jones: Principles and prevention of corrosion

O. Levenspiel: Chemical reaction engineering

Meyers: Mechanical properties of materials

B. D. Ratner et al., Biomaterials Science, Elsevier

Supervisors select 6-8 topics from above list (at least 2 topics from themes 1-3 and at least 2 from themes 4-11) and advise candidate about specific chapters in the above textbooks and additional reading materials as required.