

Syllabus of the written test for PhD admission (in the Department of Metallurgical and Materials Engineering)

Basic knowledge in Metallurgical and Materials Engineering is expected from the candidate. For the simplicity of candidates, some of the key topics (as part of the syllabus) are given below. However, some of the questions in written test may be from the syllabus of B.Tech./M. Tech. programs of above discipline.

Calcination, roasting, smelting, refining processes. Fe-Fe₃C phase diagrams, Al-Si phase diagram, free energy-temperature diagrams (Ellingham diagrams) for the formation of oxides, sulphides, and chlorides and their applications, pearlitic, bainitic and martensitic transformations. Applications of metals and alloys, ceramics and composites.

Polymers: classification, structure, properties and applications.

Strengthening mechanisms in solids, Engineering stress-strain curve, true stress – strain curve, factors affecting tensile properties, tensile testing machines, Hardness Testing machines, Ductile - brittle transition behaviour and its significance. Fatigue Testing – S-N curves, mechanisms of fatigue in metals, factors affecting fatigue properties. Creep Testing – Typical creep curve, Mechanisms of creep deformation in metals, factors affecting creep behaviour.

Forms of corrosion- Galvanic, Crevice, Pitting, intergranular, stress corrosion cracking, corrosion fatigue, hydrogen embrittlement. Importance, properties and application of organic coatings and metallic coating.

Composite materials: General requirements of composite materials, classification of composites on the basis of matrices, functions of reinforcement and matrices, dispersion strengthened, particle strengthened, fibre-reinforced composites, role of interfaces in composites, toughening mechanisms in composites, applications of composites.

Characterization: Basic principle and applications of X-ray diffraction, scanning electron microscope, transmission electron microscope (TEM), selected area electron diffraction (SAED), Energy dispersive spectroscopy, and dilatometry.

Powder Metallurgy: Mechanical Alloying Process, sintering phenomena and mechanisms involved.

Following are some suggestive books:

1. Materials Science and Engineering: An Introduction - William D. Callister, Jr.
2. Materials Science and Engineering: A First Course - by V. Raghavan
3. Physical Metallurgy: Principles and Practices - by V. Raghavan
4. Testing of Metallic Materials by A.V.K. Suryanarayana

Model questions;

1. Which one of the following signals from a specimen is used in a scanning electron microscope to get quantitative elemental analysis?
 - (a) Secondary electrons
 - (b) Backscattered electrons
 - (c) X-rays
 - (d) Transmitted electrons

2. In one FCC unit cell, there are
 - (a) 4 tetrahedral and 8 octahedral sites
 - (b) 8 tetrahedral and 4 octahedral sites
 - (c) 12 tetrahedral and 4 octahedral sites
 - (d) 4 tetrahedral and 4 octahedral sites

3. Zone refining is usually done for
 - (a) Ge
 - (b) Ni
 - (c) Zr
 - (d) Cu

4. The preferred alloying element for low temperature of steel is
 - (a) Ni
 - (b) Mo
 - (c) Cr
 - (d) C

5. Which class of composite is generally the most expensive class?
 - (a) Polymer matrix composite
 - (b) Ceramic matrix composite
 - (c) Metal matrix composite
 - (d) Carbon-carbon composite