

GUJARAT TECHNOLOGICAL UNIVERSITY

BE-5 SEMESTER – OLD PAPER – S22 TO W24 – QUESTION BANK

Subject Name & Code:

Material Science and Engineering- 3150508

Unit 1: Introduction

Repeated Questions:

1. **Classify engineering materials based on nature and major areas of applications. Cite examples.**
 - **Appeared in:** WIN 23 (Q1b, 04 marks), SUM 22 (Q1b, 04 marks), SUM 23 (Q1b, 04 marks), WIN 24 (Q1a, 03 marks).
 - **Total Marks Weightage:** 15 marks over 4 papers.
2. **Explain the various 'levels of structure' (macro, micro, substructure) in materials.**
 - **Appeared in:** WIN 22 (Q2c, 07 marks), SUM 22 (Q1c, 07 marks), SUM 23 (Q1c, 07 marks), WIN 24 (Q1c, 07 marks), WIN 24 (Q2c, 07 marks).
 - **Total Marks Weightage:** 35 marks over 5 papers.
3. **Discuss the structure-property relationship in engineering materials with suitable examples.**
 - **Appeared in:** WIN 22 (Q4c, 07 marks - OR part), SUM 22 (Q2c, 07 marks - OR part), WIN 23 (Q2c, 07 marks - OR part).
 - **Total Marks Weightage:** 21 marks over 3 papers.

Other Important Questions:

- WIN 22 (Q2c): What do you understand by levels of structure? Explain their types briefly. (07 marks)
- WIN 22 (Q4c - OR): With suitable illustrations, discuss the relationship between the variation in bonding character and properties of materials. (07 marks)
- SUM 23 (Q2c - OR): Discuss the bonding character and properties relationship of materials with suitable examples. (07 marks)

Unit 2: Atomic Structure & Chemical Bonding

Repeated Questions:

1. **Define Ionization Potential and state its importance.**
 - **Appeared in:** WIN 22 (Q2a, 03 marks), SUM 22 (Q1a, 03 marks).
 - **Total Marks Weightage:** 06 marks over 2 papers.
2. **Explain secondary bonding and its types / examples.**
 - **Appeared in:** WIN 22 (Q1a, 03 marks), SUM 23 (Q1a, 03 marks).
 - **Total Marks Weightage:** 06 marks over 2 papers.
3. **How do melting and boiling points of materials vary with bond strength?**
 - **Appeared in:** WIN 23 (Q1a, 03 marks). (*Implied in many bonding questions*).

Other Important Questions:

- WIN 23 (Q2b): Explain liganacy of an ionic solid and various conditions for stable configuration. (04 marks)
- SUM 22 (Q2b): State the properties of ionic solids. (04 marks)
- SUM 23 (Q2b): Explain the differences between ionic and covalent materials. (04 marks)

Unit 3: Structure of Solids

Repeated Questions:

1. **Differentiate between Crystalline and Non-crystalline (Amorphous) states.**
 - **Appeared in:** WIN 22 (Q1b, 04 marks), WIN 24 (Q1b, 04 marks).
 - **Total Marks Weightage:** 08 marks over 2 papers.
2. **Name the constituents and percentage distribution of common alloys (Nichrome, Inconel, Alumel, Chromel, Brass).**
 - **Appeared in:** WIN 23 (Q2a, 03 marks), SUM 22 (Q2a, 03 marks), SUM 23 (Q2a, 03 marks), WIN 24 (Q2a, 03 marks).
 - **Total Marks Weightage:** 12 marks over 4 papers.
3. **Discuss factors promoting non-crystallinity / influencing crystallinity in long chain polymers.**
 - **Appeared in:** WIN 22 (Q3b, 04 marks), SUM 22 (Q4c, part of 07 marks), SUM 23 (Q4c, part of 07 marks).
 - **Total Marks Weightage:** Significant coverage.
4. **Differentiate between Thermoplastic and Thermosetting polymers.**
 - **Appeared in:** WIN 23 (Q4c, 07 marks), SUM 22 (Q4c, 07 marks), SUM 23 (Q4c, 07 marks).
 - **Total Marks Weightage:** 21 marks over 3 papers.
5. **Define Glass Transition Temperature (T_g) and state its significance.**
 - **Appeared in:** WIN 22 (Q5b, 04 marks), WIN 23 (Q4a, 03 marks), WIN 24 (Q4b, 04 marks).
 - **Total Marks Weightage:** 11 marks over 3 papers.
6. **Explain Tacticity and classify polymers based on it.**
 - **Appeared in:** SUM 22 (Q4a, 03 marks), SUM 23 (Q4a, 03 marks).
 - **Total Marks Weightage:** 06 marks over 2 papers.

Other Important Questions:

- WIN 23 (Q1b): Categorize engineering materials... (Similar to Unit 1, but focuses on classification).
- WIN 23 (Q4b), SUM 22 (Q4b), SUM 23 (Q4b): Give four examples of ethylene-based long chain polymers and state one industrial application for each. (04 marks)
- WIN 24 (Q2b): Briefly discuss the classification of polymers. (04 marks)
- WIN 24 (Q4a - OR): Cite examples of some allotropes of carbon other than graphite and diamond. State their important structural characteristics. (03 marks)

Unit 4: Crystal Defects

Repeated Questions:

1. **Differentiate between Frenkel and Schottky defects.**
 - **Appeared in:** WIN 22 (Q3a, 03 marks), SUM 22 (Q3b, part of 04 marks), WIN 24 (Q3a, 03 marks).
 - **Total Marks Weightage:** 10+ marks over 3 papers.
2. **Differentiate between Edge and Screw dislocations. What is a grain boundary?**
 - **Appeared in:** WIN 22 (Q3a - OR, 03 marks + Q3c, 07 marks), WIN 23 (Q3b, part of 04 marks + Q3c, 07 marks), SUM 22 (Q3c, 07 marks), SUM 23 (Q3c, 07 marks), WIN 24 (Q3c - OR, 07 marks).
 - **Total Marks Weightage:** Extremely High (over 30 marks).
3. **Identify three types of crystal defects (point, linear, planar) and their effects on properties.**
 - **Appeared in:** WIN 23 (Q3c, 04 marks), SUM 23 (Q3b, 04 marks).
 - **Total Marks Weightage:** 08 marks over 2 papers.

Other Important Questions:

- WIN 22 (Q3b): Briefly explain the slip mode of plastic deformation in crystalline materials. (04 marks)
- WIN 24 (Q3b - OR): Discuss various types of stoichiometric defects with neat sketches. (04 marks)

Unit 5: Phase Rule and Phase Diagrams

Repeated Questions:

1. **State and explain Gibbs Phase Rule. Apply it to find degrees of freedom.**
 - **Appeared in:** WIN 22 (Q4b, 04 marks), WIN 23 (Q3b, part of 04 marks + Q3c, 07 marks), SUM 22 (Q3c, 07 marks), SUM 23 (Q3c, 07 marks), WIN 24 (Q4c, 07 marks).
 - **Total Marks Weightage:** Very High (over 25 marks).
2. **State important applications of Phase Diagrams.**
 - **Appeared in:** WIN 22 (Q4a - OR, 03 marks), SUM 22 (Q3a - OR, 03 marks), SUM 23 (Q3a, 03 marks).
 - **Total Marks Weightage:** 09 marks over 3 papers.
3. **Explain the Lever Rule and Tie Line.**
 - **Appeared in:** WIN 22 (Q4b, 04 marks), WIN 23 (Q3b, part of 04 marks), SUM 22 (Q3b, part of 04 marks), SUM 23 (Q3b, part of 04 marks).
 - **Total Marks Weightage:** 16 marks over 4 papers.
4. **Explain the mechanism of nucleation during crystal growth.**
 - **Appeared in:** WIN 23 (Q3a, 03 marks), SUM 22 (Q3a, 03 marks), SUM 23 (Q3a, 03 marks).
 - **Total Marks Weightage:** 09 marks over 3 papers.
5. **Draw the Iron-Iron Carbide (Fe-Fe₃C) phase diagram and explain phase transformations in steel.**
 - **Appeared in:** WIN 22 (Q4c, 07 marks), WIN 23 (Q3c, 07 marks), SUM 22 (Q3c, 07 marks), SUM 23 (Q3c, 07 marks), WIN 24 (Q4c, 07 marks).
 - **Total Marks Weightage:** 35 marks over 5 papers. **(VERY HIGH PRIORITY)**

Other Important Questions:

- WIN 22 (Q4a): Mention the conditions for unlimited solid solubility for an alloy system. (03 marks)
- WIN 23 (Q3a - OR): What are the degrees of freedom of a system of two components when the number of phases is one, two, three...? (03 marks)
- WIN 24 (Q4a): Same as above. (03 marks)
- WIN 24 (Q3a - OR): Explain triple point with a diagram. (03 marks)
- WIN 24 (Q4c - OR): Discuss the progressive transformation of a liquid to solid crystals by nucleation and growth. (07 marks)

Unit 6: Plastic Deformation and Creep

Repeated Questions:

1. **Differentiate between Plastic Deformation and Creep.**
 - **Appeared in:** WIN 22 (Q5a, 03 marks), WIN 23 (Q4a - OR, 03 marks).
 - **Total Marks Weightage:** 06 marks over 2 papers.
2. **Define Creep and explain its mechanism. Draw the ideal creep curve and its stages.**
 - **Appeared in:** WIN 22 (Q3c - OR, 07 marks + Q5c, 07 marks), WIN 23 (Q2c - OR, 07 marks), SUM 22 (Q5c, 07 marks).
 - **Total Marks Weightage:** 28 marks over 3 papers.
3. **State the important applications of Creep-resistant materials.**
 - **Appeared in:** WIN 22 (Q3c - OR, part of 07 marks), WIN 23 (Q4b - OR, 04 marks), SUM 22 (Q4b - OR, 04 marks).
 - **Total Marks Weightage:** 15+ marks over 3 papers.
4. **Draw and explain the Tensile Load-Elongation curve and the True Stress-True Strain curve for a ductile material.**
 - **Appeared in:** WIN 23 (Q4c - OR, 07 marks), SUM 22 (Q4c - OR, 07 marks), WIN 24 (Q5c, 07 marks).
 - **Total Marks Weightage:** 21 marks over 3 papers.
5. **Explain the general methods of strengthening of engineering materials.**
 - **Appeared in:** SUM 22 (Q4a - OR, 03 marks), SUM 23 (Q4a - OR, 03 marks).
 - **Total Marks Weightage:** 06 marks over 2 papers.

Other Important Questions:

(This unit is well-covered by the repeated questions above).

Unit 7: Oxidation and Corrosion

Repeated Questions:

1. **Define Pilling-Bedworth Ratio (PBR) and state its importance in evaluating oxidation propensity.**
 - **Appeared in:** WIN 23 (Q2c, 07 marks), SUM 22 (Q2c, 07 marks), SUM 23 (Q2c, 07 marks), WIN 24 (Q5c, 07 marks).
 - **Total Marks Weightage:** 28 marks over 4 papers.
2. **Discuss various types of corrosion and their preventive measures.**
 - **Appeared in:** WIN 22 (Q1c, 07 marks), WIN 23 (Q5c, 07 marks), WIN 24 (Q3c, 07 marks), SUM 22 (Q5c - OR, 07 marks).
 - **Total Marks Weightage:** 28 marks over 4 papers.
3. **Why is stainless steel non-corrosive? Name important types of stainless steel.**
 - **Appeared in:** SUM 22 (Q5a - OR, 03 marks), WIN 23 (Q5a, 03 marks), WIN 24 (Q3b, 04 marks).
 - **Total Marks Weightage:** 10 marks over 3 papers.

Other Important Questions:

- WIN 22 (Q5c - OR): Explain the mechanism of oxidation briefly. Also discuss oxidation-resistant materials. (07 marks)

Unit 8: Electrical and Magnetic Properties

Repeated Questions:

1. **Explain the Superconducting phenomenon and its potential applications.**
 - **Appeared in:** WIN 23 (Q5a, 03 marks + Q5c, 07 marks), SUM 22 (Q5a, 03 marks + Q5b, 04 marks), SUM 23 (Q5a, 03 marks + Q5b, 04 marks).
 - **Total Marks Weightage:** 24 marks over 3 papers.
2. **Define Fermi Energy Level and explain how electron distribution changes at 0K and above 0K.**
 - **Appeared in:** WIN 23 (Q5b, 04 marks), SUM 22 (Q5b, 04 marks), WIN 24 (Q5b, 04 marks).
 - **Total Marks Weightage:** 12 marks over 3 papers.
3. **In terms of electron energy band structure, discuss the difference in electrical conductivity of metals, semiconductors, and insulators.**
 - **Appeared in:** WIN 22 (Q5b, 04 marks). (*A fundamental concept that underpins many questions*).
4. **Differentiate between n-type and p-type extrinsic semiconductors.**
 - **Appeared in:** WIN 22 (Q5a - OR, 03 marks).

Other Important Questions:

- WIN 23 (Q5b): Write a note on Ferromagnetism phenomena. (04 marks)
- WIN 24 (Q5a - OR): Briefly discuss about soft and hard magnetic materials. (03 marks)
- WIN 24 (Q5b - OR): Write a note on Ferromagnetism phenomena. (04 marks)
- WIN 24 (Q5a): How is semiconductor grade silicon synthesized? Write reaction. (03 marks) (*Note: This is a specific, applied question*).
