

**31N1002/31N1104**  
**B. Tech. III - Sem. (Main) Exam., May – 2023**  
**Mechanical Engineering**  
**3ME4-02 Materials Engineering and Technology**  
**Common to ME, MX**

Time: 3 Hours

Maximum Marks: 70

**Instructions to Candidates:**

**Part – A:** Short answer questions (up to 25 words)  $10 \times 2$  marks = 20 marks.  
All **ten** questions are compulsory.

**Part – B:** Analytical/Problem solving questions  $5 \times 4$  marks = 20 marks.  
Candidates have to answer **five** questions out of seven.

**Part – C:** Descriptive/Analytical/Problem Solving questions  $3 \times 10$  marks = 30 marks. Candidates have to answer **three** questions out of five.

*Schematic diagrams must be shown wherever necessary. Any data you feel missing may suitably be assumed and stated clearly. Units of quantities used/calculated must be stated clearly.*

*Use of following supporting material is permitted during examination.  
(Mentioned in form No. 205)*

1. NIL2. NIL**PART – A**

- ~~Q1~~ Draw a [110] direction within a cubic unit cell. [2]
- ~~Q2~~ Differentiate between anisotropy and isotropy of a single crystal. [2]
- ~~Q3~~ Define the hot working. [2]
- ~~Q4~~ What is the Gibbs phase rule? [2]
- ~~Q5~~ What is the industrial importance of flame hardening? [2]

- Q.6 What is the endurance limit? What is the role of endurance limit in material design? [2]
- Q.7 What is Twinning? [2]
- Q.8 What is an interstitial solid solution? [2]
- Q.9 What are the differences between a composite and an alloy? [2]
- Q.10 Discuss the S – N curve for ferrous and non – ferrous materials. [2]

### PART – B

- Q.1 Show that the atomic packing factor for the FCC crystal structure is 0.74. [4]
- Q.2 Estimate the minimum cation – to – anion radius ratio for the coordination number 3. [4]
- Q.3 Discuss the TTT curve for eutectoid steel. [4]
- Q.4 Differentiate between linear and planar densities. [4]
- Q.5 Discuss the favorable conditions for heterogeneous and homogeneous nucleation. [4]
- Q.6 Distinguish between the hardness and hardenability of a steel, outlining the factors that influence each of these. [4]
- Q.7 Discuss the effect of alloying additions – Mn, Si, Cr and Ti on the properties of steel. [4]

### PART – C

- Q.1 What is a crystal lattice? How is it different from Bravais lattice? Indium has a tetragonal unit cell for which the a and c lattice parameters are 0.459 and 0.495 nm, respectively. Estimate – (a) If the atomic packing factor and atomic radius are 0.693 and 0.1625 nm, respectively, determine the number of atoms in each unit cell. (b) The atomic weight of indium is 114.82 g/mol; compute its theoretical density. [2+2+3+3=10]

- Q.2 Figure 1 shows the first five peaks of the x-ray diffraction pattern for Tungsten (W), which has a BCC crystal structure; monochromatic x-radiation having a wavelength of 0.1542 nm was used. Discuss the following – (a) Index (i.e., give h, k and l indices) for each of these peaks. (b) Determine the interplanar spacing for each of the peaks. (c) For each peak, determine the atomic radius for W.

[3+3+4=10]

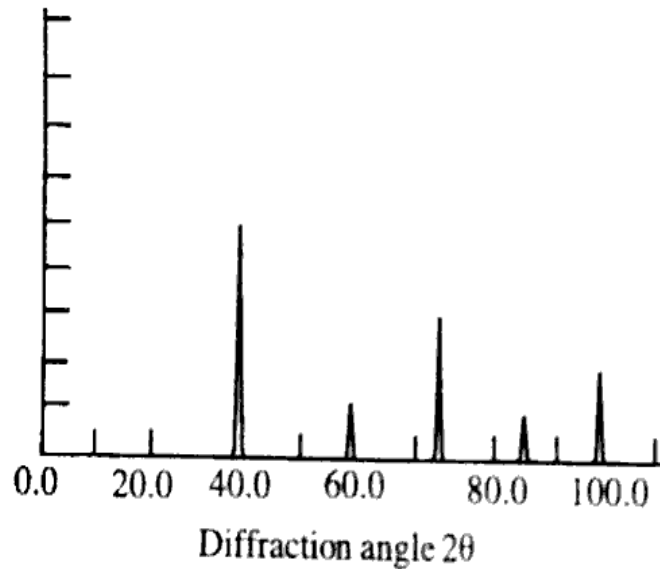


Figure - 1

- Q.3 Why is the strengthening of a solid solution required? Discuss different methods/techniques which are used in industries for strengthening different materials. <https://www.btubikaner.com>

[2+8=10]

- Q.4 What is nucleation? Explain different types of nucleation. Derive the expression for critical free energy for nucleation to take place in terms of equilibrium melting point, enthalpy change per unit volume of the product, degree of super cooling, surface energy per unit area of the interface separating the parent and product phase.

[2+8=10]