



## Term Evaluation (Odd) Semester Examination September 2025

Roll no.....

Name of the Course: **B.Tech., Mechanical Engineering**

Semester: **III**

Name of the Paper: **Material Science**

Paper Code: **TME 302**

Time: **1.5 hour**

Maximum Marks: **50**

Note:

- (i) Answer all the questions by choosing any one of the sub-questions
- (ii) Each question carries 10 marks.

**Q1. (10 Marks)**

- a. Calculate the equilibrium number of vacancies per cubic meter for copper at 1000 °C. The energy for vacancy formation is 0.9 eV/atom; the atomic weight and density (at 1000 °C) for copper are 63.5 g/mol and 8.4 g/cm<sup>3</sup>, respectively. **(CO1 & CO5)**

OR

- b. Differentiate between solid solutions, intermediate phases, and intermetallic compounds. Give two examples of each and describe their significance in engineering applications. **(CO1 & CO5)**

**Q2. (10 Marks)**

- a. Sketch a unit cell for the simple cubic (SC), body centered cubic (BCC), face centered cubic (FCC), tetragonal, and orthorhombic crystal structure. **(CO1 & CO5)**

OR

- b. Compute the atomic packing fraction (APF) for the BCC and FCC crystal structure. **(CO1 & CO5)**

**Q3. (10 Marks)**

- a. Within a cubic unit cell, sketch the following directions:

[101] [211] [301] [111] and [012]. **(CO1 & CO5)**

OR

- b. Determine the unit cell volume of the FCC crystal structure with neat and clean diagram. **(CO1 & CO5)**

**Q4. (10 Marks)**

- a. Calculate the theoretical density of the copper where copper has an atomic radius of 0.128 nm, an FCC crystal structure, and an atomic weight of 63.5 g/mol. **(CO1 & CO5)**

OR

- b. Discuss Hume-Rothery rules for the formation of substitutional solid solutions. Illustrate with examples how atomic size, electronegativity, valency, and crystal structure affect solubility. **(CO2 & CO5)**

**Q5. (10 Marks)**

- a. Answer the followings:

(i) Write Fick's first and second laws in equation form, and define all parameters.

(ii) Differentiate the elastic deformation and plastic deformation in detail. **(CO1, CO2 & CO5)**

OR

- b. Compare diffusion mechanisms: vacancy diffusion and interstitial diffusion, with suitable examples. Explain the working principle of X-Ray Diffraction (XRD) in determining crystal structures. **(CO2 & CO5)**