NATIONAL INSTITUTE OF TECHNOLOGY, HAMIRPUR, H.P.

Department of Materials Science and Engineering

End-Term Examinations

Materials Science and Engineering (MS-101)

Duration: 3 hrs (180 min)

Maximum Marks: 50

Attempt all the questions. Useful data is given at the end of the question paper. (Total Pages =2)

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<u>SECTION I</u>

- 1. Briefly define the following terms/concepts with suitable examples wherever required:
 - a) Surface and Volume Defects
 - b) Creep and Fatigue
 - c) Hume-Rothery Rules
 - d) Martensite and Tempered martensite
 - e) Miller indices for cubic crystal systems
 - f) Interstitial and Substitutional solid solutions
 - g) Continuous Cooling Transformation (CCT) curves
 - h) Lever Rule
 - i) Hall Effect
 - *j*) Dielectric Materials with example

Define 'Heat treatment' of materials. Enlist various heat treatment procedures in brief with their importance. (1+3=4)

- 3. State the difference between 'Ductile' and 'Brittle' materials. With a schematic, explain the various points observed in the stress-strain diagram of a ductile material being tested under the tensile loading. (1+3=4)
- Draw a neat sketch of Fe-Fe₃C phase diagram. Briefly explain various phases, invariant reactions, micro-constituents, and phase transformations associated with it. (5)
- 5. State the key differences between the homogeneous and heterogeneous nucleation. Derive the relations for the critical radius and the activation energy for the formation of a stable nucleus for homogeneous nucleation. (2+4=6)
- 6. Explain 'surface hardening' procedure with its significance. Mention any two methods generally used for the surface hardening. (1+2=3)
- 7. Calculate the density of NaCl from a knowledge of its crystal structure, (Given: The ionic radius of Na⁺ = 0.102 nm and that of Cl⁻ = 0.181 nm. The atomic mass of Na = 22.99 g/ mol. and that of Cl = 35.45 g/mol.)
 (3)

(2*10=20)

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SECTION II

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(1*5=5)

1. Match the invariant reactions in Column I with the names in Column II (L is liquid phase, and olid phases). All reactions proceed to the right on cooling.

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(a) P-5, Q-1, R-4, S-3 (b) P-5, Q-3, R-4, S-2 (c) P-5, Q-1, R-2, S-4 (d) P-2, Q-1, R-4, S-5

2. Match the heat treatment process of steels given in Group 1 with the microstructural feature given in Group 2:

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3. Which one of the following statements is true for an intrinsic semiconductor?

- a) Electrical conductivity increases with increasing temperature and pressure
- b) Electrical conductivity increases with increasing temperature and decreasing pressure
- c) Electrical conductivity increases with decreasing temperature and increasing pressure
- d) Electrical conductivity increases with decreasing temperature and pressure
- 4. Which one of the following is the correct decreasing sequence of quenching power for quenchants used in heat treatment of steels?
 - a) Oil> Water> Brine> Air
 - b) Brine> Oil> Water> Air
 - c) Brine> Water> Oil> Air
 - d) Water> Brine> Oil> Air

5. Match the elements in Column I with their electronic behavior given in Column II

Column I

- (P) Copper (Q) Iron (R) Mercury (S) Silicon
 - - (a) P-1, Q-2, R-3, S-4 (c) P-4, Q-1, R-2, S-3

1. Ferromagnetic 2. Superconducting 3. Semiconducting

Column II

4. Diamagnetic.

(b)	P-3, Q-4, R-1, S-2
(d)	P-4, Q-3, R-1, S-2