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NATIONAL INSTITUTE OF TECHNOLOGY, HAMIRPUR, H.P. Department of Material Science and Engineering End Term Examination (2022-23) Materials Science & Engineering (MS-101)

Duration: 3 hrs (180 min)

Attempt all questions. Draw a well labeled diagram wherever necessary.

Q.1) Use the diagram and match the following correctly:



Cooling Rate	Heat Treatment Process	Microstructure
1.	(a) Tempering	(p) Coarse Pearlite
2. •	(b) Normalizing	(q) Fine Pearlite
3.	(c) Annealing	(r) Bainite
4.	(d) Austempering	(s) Martensite
5.	(e) Quenching	(t) Tempered Martensite
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Max Marks: 50

(5)

- Q.2) Determine the planar density and packing fraction for FCC Nickel (lattice constant 'a'=3.1567 Å) in (100) and (111) planes. Which, if any, of these planes is/are close packed? (4+1)
- Q.3) How are phase diagrams constructed? Why is condensed Gibb's phase rule generally studied for material systems? (1+2)

Q.4) What are surface defects in crystalline solids? Explain the various types of surface defects? (1+2)

- Q.5) For a 99.65 wt% Fe-0.35 wt% C alloy at a temperature just below eutectoid, determine the following: -
 - (a) The fraction of total ferrite and cementite phases
 - (b) The fraction of the proeutectoid ferrite and pearlite
 - (c) The fraction of eutectoid ferrite
- Q.6) Why carbon dissolves more in Austenite rather than in ferrite? Neatly sketch the Iron-Iron Carbide phase diagram and explain the various invariant reactions and phases that are present in it? (1+3+1+1)
- Q.7) Draw Stress-strain curve for Metal, Ceramic and polymer materials. Mark the different regions and describe the various properties that can be derived from this curve in the case of metal. (3+2)
- Q.8) Explain the following:
 - a) Piezoelectric and Ferroelectric (*with examples*)
 - b) Hume-Rothery rules

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- c) Metallic and covalent bonds in solid materials (*with examples*)
- d) Homogenous nucleation and Avrami Equation (*with formulae*)

- e) Flame hardening and Precipitation Hardening
- f) Ferromagnetism and Paramagnetism (*with examples*)
- g) Strength and Hardness
- h) Resilience and Toughness
- i) Austempering and Martempering

(2+2+1)