School of Engineering and Applied Science (SEAS), Ahmedabad University

Name: _____ Roll no.: _____

B. Tech. (All Majors)
Course: ENR108 Materials and the Engineering World
End Term Exam (Winter Semester: 2025); Full Marks: 50; Wt.: 30% (Theory) and 20% (Practical)
May 02, 2025, Friday, 02.00 PM – 03.30 PM

Instructions (Read carefully and follow):

1. **The questions are in three parts – Part A, Part B, and Part C (from practical).**
2. **Write answers for Part A in the answer sheets provided to you.**
3. **Write answers for Part B and Part C in the space given in the question paper.**
4. **Submit all the question papers and answer sheets.**
5. **All parts of a question must be answered together.**
6. **The number to the right indicates full marks for the question.**
7. **All acronyms and symbols carry their usual meaning.**
8. **Assume suitable data wherever necessary and specify it clearly in your answers.**
9. **No digital device is allowed except only a non-programmable scientific calculator, if required.**
10. **This is a No Book –No Note Examination.**

PART A

Answer any four questions. Each question is of 5 marks.

Q-1. The unit cell for uranium has orthorhombic symmetry with **a**, **b**, and **c** lattice parameters of 0.286, 0.587, and 0.495 nm, respectively. If its density, atomic weight, and atomic radius are 19.05g/cc, 238.03 g/mol, and 0.1385 nm, respectively, compute the atomic packing factor.

Q-2. Indium has tetragonal unit cell for which the **a** and **c** lattice parameters are 0.459 and 0.495 nm, respectively.

(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; calculate its theoretical density.

Q-3. (a) Derive the planner density expressions for FCC for the given planes (110) and (111) in terms of the atomic radius R.

(b) Calculate planner density values for these two planes for copper. The atomic weight, and atomic radius are 63.54 g/mol, and 1.278 $A°$, respectively.

Q-4. (a) Obtain the miller indices of a plane whose intercepts are a, b/2, and 3c on x, y and z axes respectively, in a simple cubic unit cell. Draw the same plane.

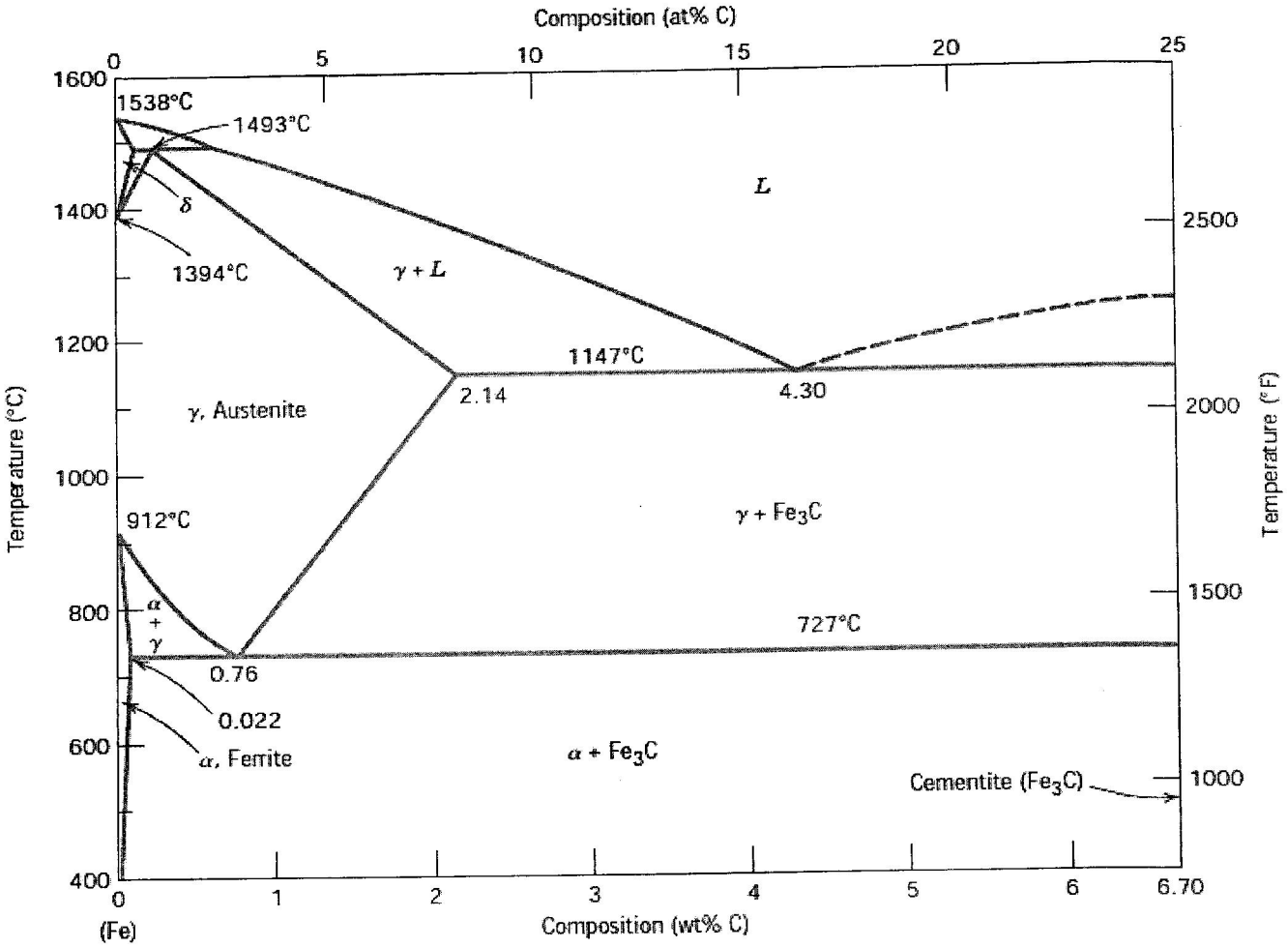
(b) Draw an orthorhombic unit cell and within that cell a [2 -1 1] and (0 2 1)

Q-5. Draw the following Crystal directions and planes in a cubical crystal system:

a) [-3 2 -1] b) [1 0 -2] c) [1 0 -2] d) (2 -1 0) e) (-2 -1 -2) f) (2 0 -4)

PART B

Q-1. Use the given iron-iron carbide phase diagram to answer the following questions.



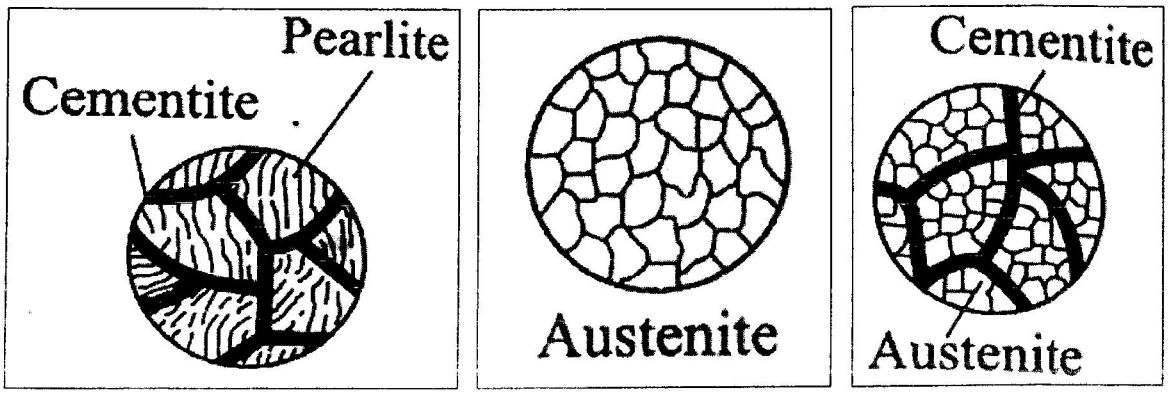
(a) For a 99.6 wt.% Fe – 0.40 wt.% C at a temperature just below the eutectoid, determine the composition of cementite and ferrite phases in the system. [2]

Ans.

(b) For a 99.6 wt.% Fe – 0.40 wt.% C at a temperature just below the eutectoid, determine the amount of carbide (cementite) in grams that forms per 100 g of steel. [2]

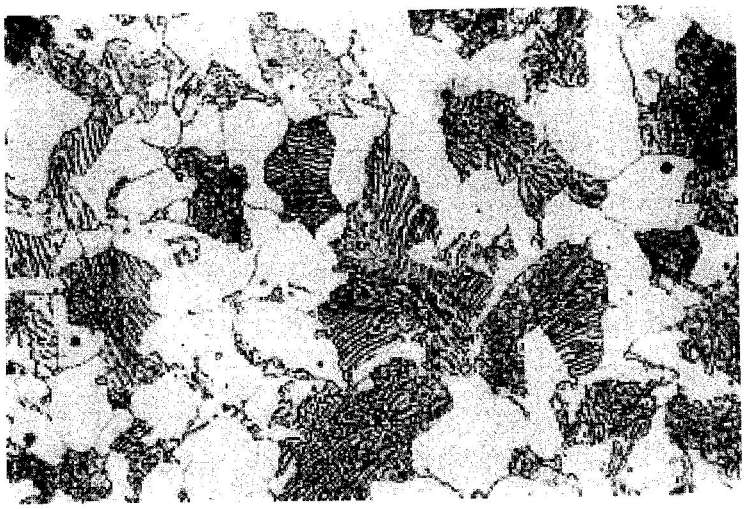
Ans.

(c) The following schematic of microstructures (fixed composition) are observed at different temperatures in carbon steel. Mark the correct phase field points in the phase diagram. Use the phase diagram given in the question to mark these microstructure points. Write A, B, and C on the phase diagram to mark these microstructure points. [3]



A. B. C.

Q-2. In the following microstructure of medium carbon steel, identify and mark pearlite, ferrite, and the grain boundary in the microstructure. Also, define them. [3]



Ans.

PART C

Q-1. Two FDM 3D printed polymer samples with exactly same dimensions and same material were tensile tested. The maximum load observed during the tests was 800 N and 1100 N. Name one 3D printing parameter that could bring this difference with a proper reason. [2]

Ans.

Q-2. What is gauge length, and why is it used in a tensile test sample? [2]

Ans.

Q-3. It was observed that cutting the mild steel rod using the chop saw machine became difficult after the rod was deformed (bent). Which property changed and how? [2]

Ans.

Q-4. Arrange the following steps of metallography in correct order of occurrence – *Microscopy, Mounting, Cross-section cutting, Polishing, Grinding,* and *Etching.* [2]

Ans.

Q-5. Using the UV-visible absorbance spectra of Methyl Orange (or any other compund that you used), explain how to calculate the optical band gap of the compound. Include the type of plot used and the method of extrapolation. [2]

Ans.

Q-6. You were provided with metal oxides like Zinc Oxide (or any other compound) to analyze their transmittance behaviour using UV-vis spectroscopy. Describe how transmittance data can be used to study the optical properties of these oxides, and discuss any trends observed across different oxides. [2]

Ans.

Q-7. Which characterization technique is used to determine the purity and crystallinity of Silicon nanomaterial synthesized via magnesiothermic reduction? What are the expected by- products to be present in the after heat treated product? [4]

Ans.

Q-8. Why is corn starch added in varying ratios to the hydrogel formulation? What role does gelatin play in the synthesis of the hydrogel? [4]

Ans.

***** All the best *****