



Course Title: Metallurgy
Course Code: MPD1104
Year: 1st Year Mechanical Engineer

Final Exam

Date: 21-3- 2021.
Allowed time: 3 hrs.
No. of pages: 2

Q1. State which of the following statements is true and which is false: (14 marks)

- a. Polymorphism is the same compound occurring in more than one crystal structure ()
- b. The general definition of a phase is "homogeneous aggregation of matter". ()
- c. Ferrite and austenite are solid solution where carbon atoms dissolve interstitially. ()
- a. Alloys in the type two phase diagram contain two different solid phases ()
- b. The planer density on the (100) plane and on (110) plane of a FCC is the same ()
- c. Nucleation starts just under the solidus line of a phase diagram ()
- d. Vacancy is formed due to a missing atom. ()

Q2. Put a line under the correct answer: (10 marks)

- a. A phase has the following characteristics: (the same structure or atomic arrangement throughout - roughly the same composition and properties throughout - All of the previous - None of the previous).
- b. Which of the following materials may form crystalline solids?
(Polymers – Metals – Ceramics - All of the previous - None of the previous)
- c. Single phase alloys classified into two Types (Solid solution alloys - Intermetallic compound alloys- All of the previous - None of the previous).
- d. The line in the phase diagram that gives the solubility of one element in the other solid element is: (solidus - liquidus - eutectic - solvus).
- e. Aging treatment is the best way to increase the strength of the components under (high -normal - any) service temperature.

Q3. (16 marks)

1. For FCC unit cell if we can put one atom of the same diameter of atoms in FCC in the position ($\frac{1}{2}$, $\frac{1}{2}$, $\frac{1}{2}$), If not. What the distance by which will the face center atoms to be moved.
2. Calculate the linear density (atoms/m) of atoms in the [100], and [111] directions in BCC iron [$a = 2.86 \text{ \AA}$].
3. Determine the Miller indices of the cubic crystal plane which intersects the following position coordinates: (1,0,0); ($\frac{1}{2}$,0, $\frac{1}{2}$); (0, $\frac{1}{4}$, $\frac{1}{2}$).

Q4.

(20 marks)

1. For two metals "A" & "B" the eutectic point is (72; 780). Four points were detected in the phase diagram as follows:

Point	Note
(5; 1080)	a nuclei of a solid solution had been detected
(5; 950)	a nuclei of liquid still remains in the alloy
(100; 1000)	start of solidification
(95; 600)	lies on a solvus line

Knowing that at room temperature the two metals are pure and all the given compositions are percentage of metal "B" determine the following:

- a- The melting points of the two metals
 - b- The maximum solubility of each metal in the other
2. Use a neat sketch to identify each of the four cast iron types by the microscopic examination?

Q5.

(15 marks)

1. Explain the aim and technique of annealing heat treatment of steel? What are some of its purposes?
2. Consider 2.5 Kg of a 99.5% wt Fe - 0.3% wt C alloy that is cooled to a temperature just below the eutectoid.
 - a. How many kilograms of proeutectoid ferrite form?
 - b. How many kilograms of eutectoid ferrite form?
 - c. How many kilograms of cementite form?
 - d. Sketch the microstructure of this alloy above and below the eutectoid temperature.
 - e. What will be the structure of this alloy if it is rapidly quenched? And what will be the effect on the mechanical properties?

With my best wishes

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