BITS Pilani, Dubai Campus
Dubai International Academic City, Dubai, UAE.

II Year, FIRST SEMESTER:2013 – 2014

COMPREHENSIVE EXAMINATION

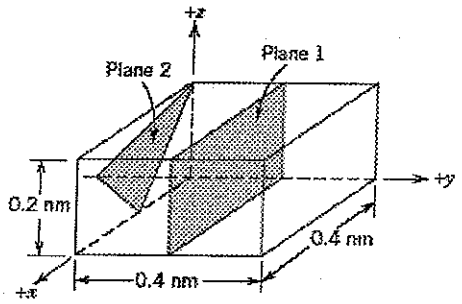
Course Code:	**ME F213**	Date:	**08.01.2014**
Course Title:	**Materials Science & Engg.**	Maximum Marks:	**80**
Duration:	**2½ Hours**	Weightage:	**40%**

Notes:
- Answer all the questions in Part A and Part B in separate answer books.
- Assume $N_A = 6.023 \times 10^{23}$, $k = 8.62 \times 10^{-5}$ eV/atom-K, R = 8.31 J/mol- K.

PART A

1. Compute the percents ionic character of the interatomic bonds for the following compounds: TiO_2, ZnTe. Given electronegativities of $X_{Ti} = 1.5$, $X_O = 3.5$, $X_{Zn} = 1.6$ and $X_{Te} = 2.1$ **[8M]**

2. What are the indices for the two planes drawn in the sketch below? **[8M]**



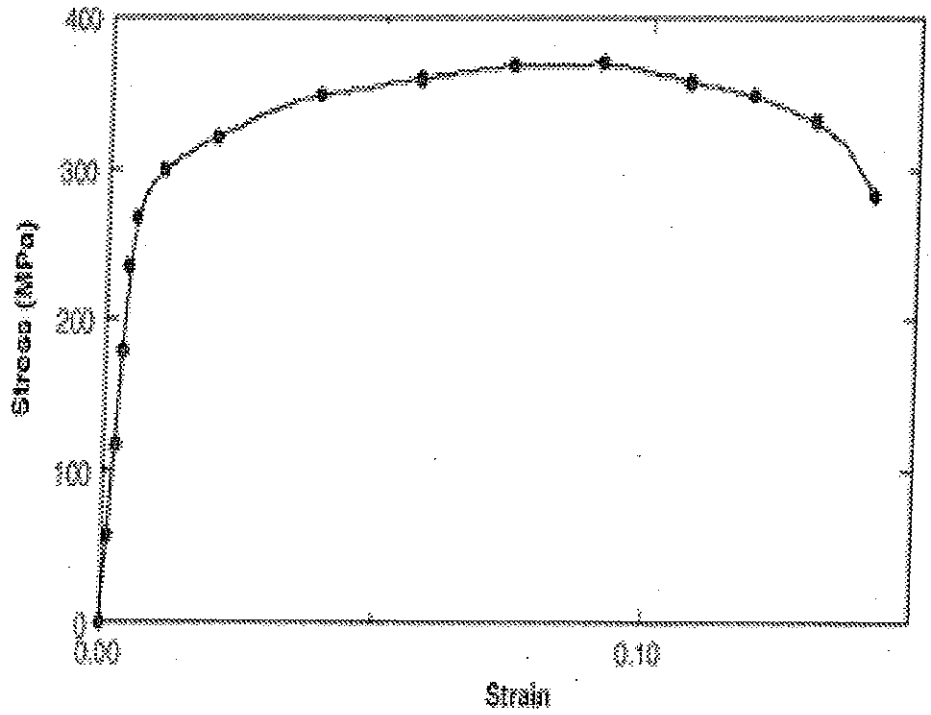
3. Calculate the theoretical density of NiO, given that it has the rock salt crystal structure. The atomic weight of Ni and O are 58.69 g/mol and 16 g/mol respectively. The ionic radii of Ni^{2+} and O^{2-} are 0.069 nm and 0.140 nm respectively. **[8M]**

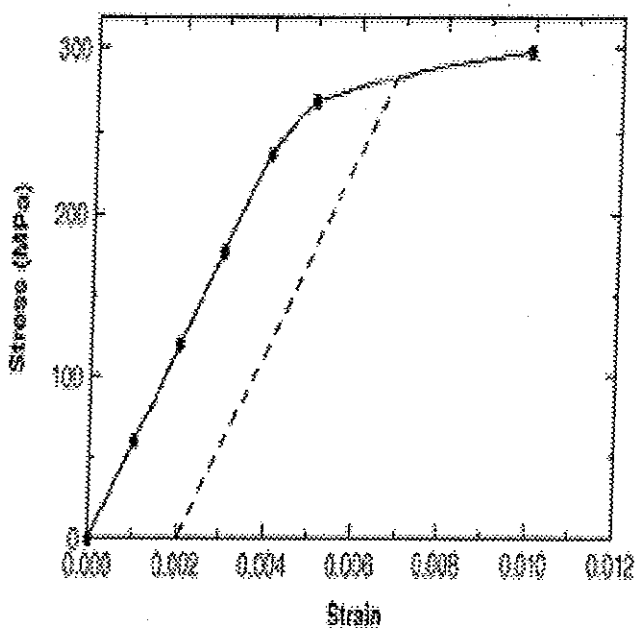
4. Calculate the number of vacancies per cubic meter in iron at 850°C. The energy for vacancy formation is 1.08 eV/atom. Furthermore, the density and atomic weight for Fe are 7.65 g/cm^3 and 55.85 g/mol, respectively. **[10M]**

5. At what temperature will the diffusion coefficient for the diffusion of zinc in copper have a value of 2.6×10^{-16} m^2/s? Given $D_0 = 2.4 \times 10^{-5}$ m^2/s and $Q_d = 189{,}000$ J/mol. **[6M]**

PART B

6. A cylindrical specimen of aluminum having a diameter of 12.8 mm and a gauge length of 50.800 mm is pulled in tension. Use the load–elongation characteristics graph to complete problems a –e.
   (a) Compute the modulus of elasticity.
   (b) Determine the yield strength at a strain offset of 0.002.
   (c) Determine the tensile strength of this alloy.
   (d) What is the approximate ductility, in percent elongation?
   (e) Compute the modulus of resilience. **[10M]**





7. Consider the isothermal transformation diagram for an iron–carbon alloy of eutectoid composition as shown below .Sketch and label on this diagram time– temperature paths to produce the following microstructures in the graph attached and pin it along with your Part B answer book.
   (a) 100% coarse pearlite.
   (b) 100% tempered martensite.
   (c) 50% coarse pearlite, 25% bainite, and 25% martensite. **[10M]**

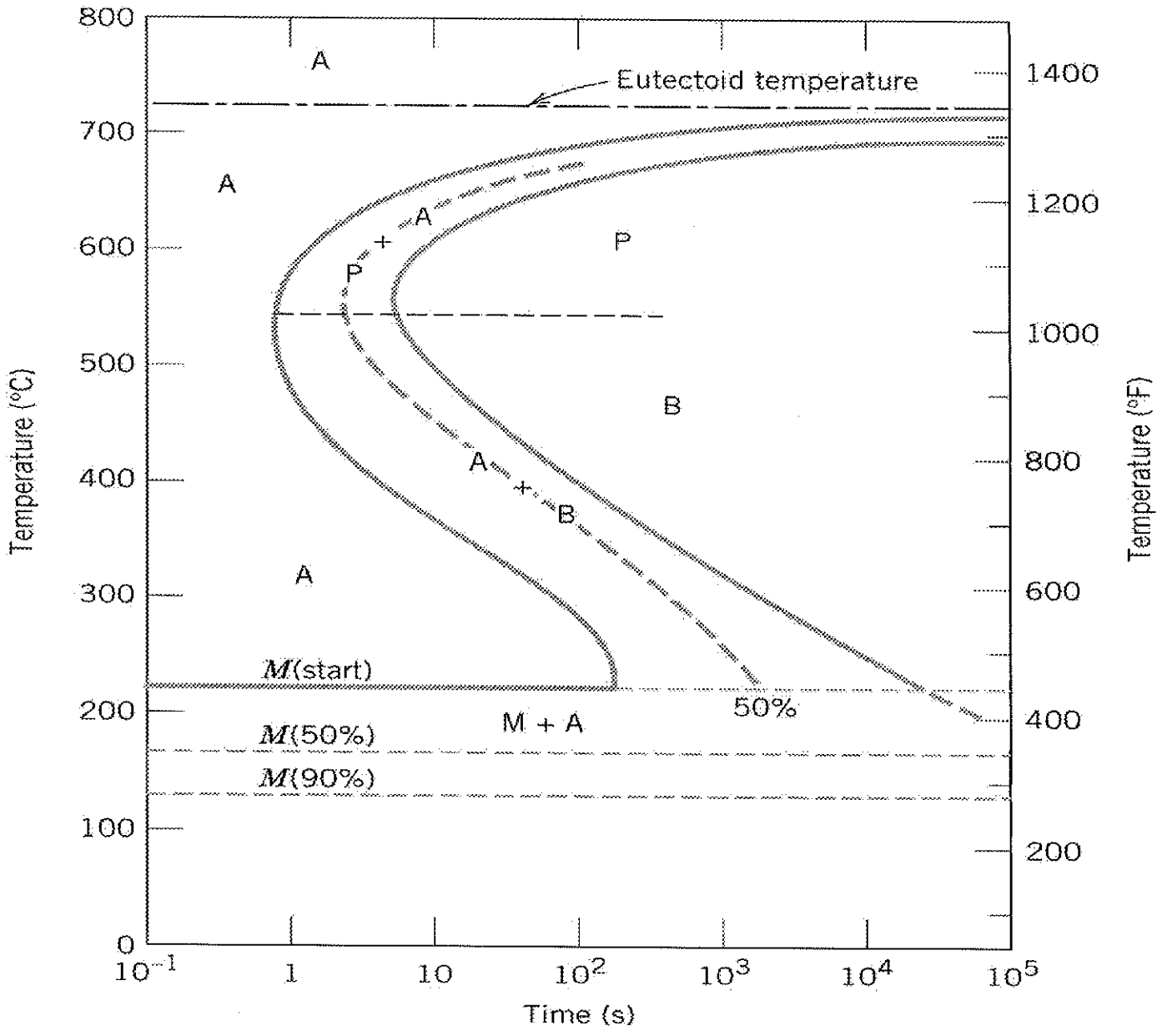
8. Molecular weight data for a polypropelene material are tabulated. Compute
   (a) the number-average molecular weight,
   (b) the weight-average molecular weight. **[10M]**

RANGE	x_i	w_i
80,000 - 16,000	0.5	0.02
16,000 - 24,000	0.16	0.1
24,000 - 32,000	0.24	0.2
32,000 - 40,000	0.28	0.3
40,000 - 48,000	0.2	0.27
48,000 - 56,000	0.07	0.11

9. An electrochemical cell is composed of pure copper and pure lead electrodes immersed in solutions of their respective divalent ions. For a 0.6 M concentration of Cu^{2+}, the lead electrode is oxidized, yielding a cell potential of 0.508 V. Calculate the concentration of Pb^{2+} ions if the temperature is 25°C. Given V^{O}_{CU} = +0.340 V and V^{0}_{Pb} = -0.126 V. Faraday constant, F = 96,500 C/mol. **[10M]**

7. Use the graph below for question 7

FIGURE 10.13 The complete isothermal transformation diagram for an iron–carbon alloy of eutectoid composition: A, austenite; B, bainite; M, martensite; P, pearlite.



BITS Pilani, Dubai Campus

II Year I Semester 2013-2014

Test No.2 (Open Book)

Course No. ME F213 **Course Title:** Materials Science and Engg.

Date: 31-10-2013 **Max.Marks:** 40

Weightage: 20% **Duration:** 50 min

Notes:

- Answer all the questions.
- Draw neat sketches wherever necessary.
- Make suitable assumptions if required and clearly state them

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1. Determine the carburizing time necessary to achieve a carbon concentration of 0.45 wt% at a position 2 mm into an iron–carbon alloy that initially contains 0.20 wt% C. The surface concentration is to be maintained at 1.30 wt% C, and the treatment is to be conducted at 1000°C. Use the diffusion data for γ-Fe in Table 6.2. Given R=8.31 J/mol-K **[10 M]**

2. The activation energy for the diffusion of carbon in chromium is 111,000 J/mol. Calculate the diffusion coefficient at 1100 K (827°C), given that D at 1400 K (1127°C) is 6.25×10^{-11} m^2/s. Given R=8.31 J/mol-K **[4 M]**

3. Cite the phases that are present and the phase compositions for 4.5 mol Sn and 0.45 mol Pb at 200°C (390°F). Identify the point as H. Given A_{Sn} = 118.71 g/mol and A_{Pb} = 207.2 g/mol. **[10 M]**

4. Gold forms a substitutional solid solution with silver. Compute the wt % of gold that must be added to silver to yield an alloy that contains $5.5x10^{21}$ Au atoms per cubic cm.The densities of pure Au and Ag are 19.32 and 10.39 g/cm^3, respectively and A_{Au} = 196.97 g/mol and A_{Ag} = 107.87 g/mol. $N_A = 6.023X10^{23}$ atoms/mol **[8 M]**

5. Molydenum forms a substitutional solid solution with tungsten. Compute the number of molybdenum atoms per cubic cm for a molybdenum – tungsten alloy that contains 16.4wt% Mo and 83.6 wt% W. The densities of pure molybdenum and tungsten are 10.22 and 19.3 g/cm^3, respectively. Atomic weight of Mo is 95.94g/mol. $N_A = 6.023X10^{23}$ atoms/mol. **[8 M]**

3. Use the following diagram for answering question 3. Mark the phase composition and point H in the diagram and return it with the answer sheet.

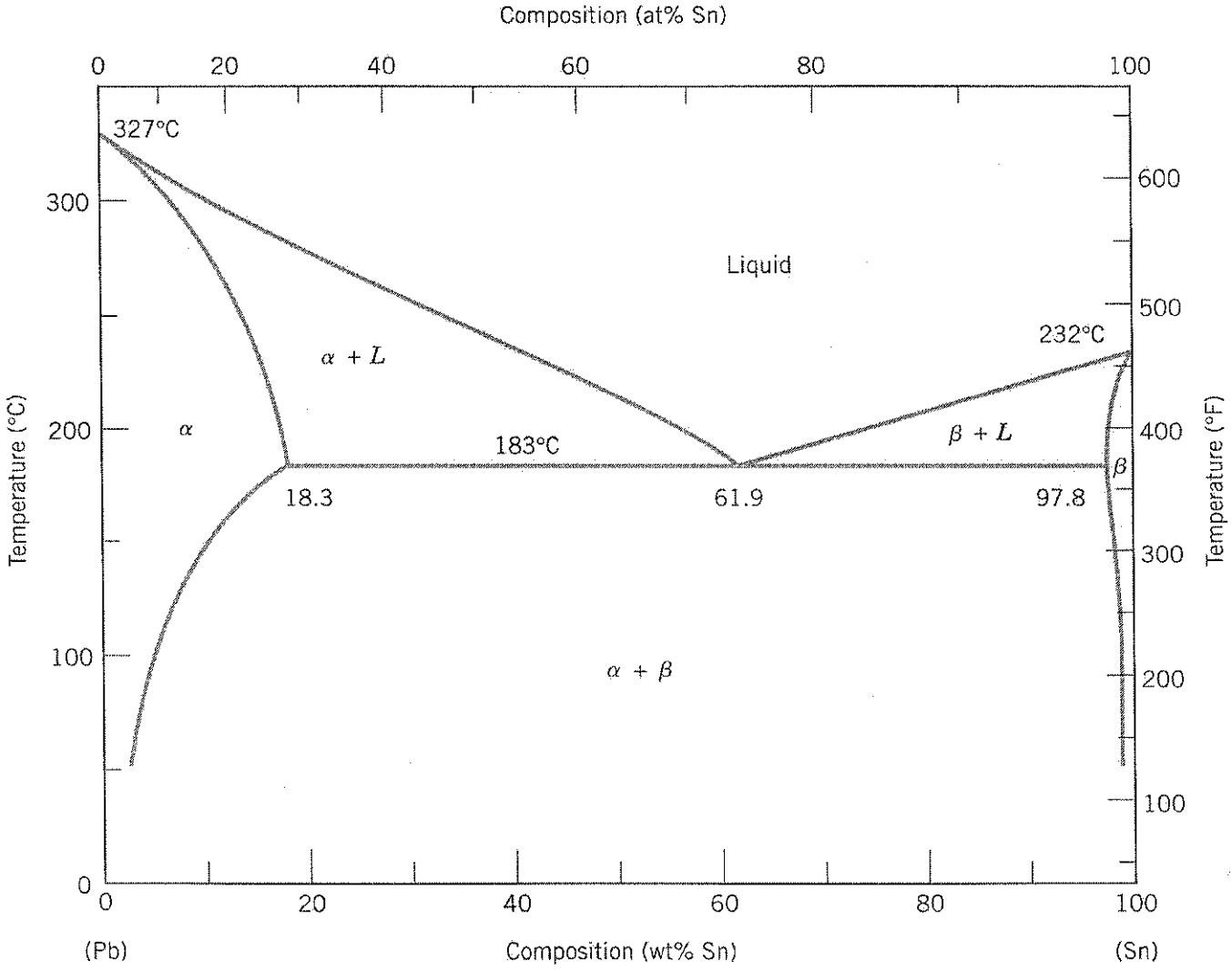

FIGURE 9.7 The lead–tin phase diagram. [Adapted from *Binary Alloy Phase Diagrams*, 2nd edition, Vol. 3, T. B. Massalski (Editor-in-Chief), 1990. Reprinted by permission of ASM International, Materials Park, OH.]

BITS Pilani, Dubai Campus

II Year I Semester 2013-2014

Test No.1 (Closed Book)

Course No. ME F213 **Course Title:** Materials Science and Engineering

Date: 6-10-2013 **Max.Marks:** 50

Weightage: 25% **Duration:** 50 min

Notes:

- Answer all the questions.
- Draw neat sketches wherever necessary.
- Make suitable assumptions if required and clearly state them

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1. i) On a set of cubic unit cells, draw the directions, with appropriate markings on all the axes a) [$2\,\bar{1}\,2$], b) [$1\,\bar{1}\,0$], c) [$4\,\bar{1}\,\bar{2}$]
   ii) On a set of cubic unit cells, draw the planes, with appropriate markings on all the axes a) ($2\,\bar{1}\,0$), b) ($\bar{2}\;\bar{1}\,\bar{2}$), c) ($2\,0\,\bar{4}$) **[6 M]**

2. Lithium (Li) is a primitive cell. Calculate the density of atoms along [011] and (011) in lithium (Li). The value of the lattice constant in Li is 3.51 Å. Express your answer in units of atoms /Å. **[9 M]**

3. Urbium (Ub) is an upscale element found in large cities. Its unit cell is cubic. Using the values of its molar volume and lattice constant, determine the crystal structure of Ub. DATA: molar volume, V_{mol} = 9.41 cm^3/mol lattice constant, a = 3.15 Å = 3.15 x10^{-8} cm. **[10 M]**

4. Derive $C_1' = \dfrac{C_1 A_2}{C_1 A_2 + C_2 A_1} \text{ x } 100$ **[10 M]**

5. Calculate the energy for the vacancy formation in silver, given that the equilibrium number of vacancies at 800° C (1073K) is 3.6x $10^{23} m^{-3}$. The atomic weight and density for silver are, respectively, 107.9g/mol and 9.5 g/cm^3. **[5 M]**

6. Calculate the composition, in atom percent of an alloy that contains 33 g of Cu and 47 g of Zinc. Then convert the atom percent composition to weight percent. Given A_{Cu} = 63.55amu and A_{Zn} = 65.39 amu. **[10 M]**

A

BITS PILANI, DUBAI CAMPUS

2nd Year, FIRST SEMESTER 2013 – 2014

QUIZ - 1

Course code: **ME F213** Date: **24.9.13**
Course Title: **Materials Science and Engineering** Maximum Marks :**16**
Duration: **20 minutes** Weightage: **8%**

Name _____

ID No: _____ **Section** _____

Answer ALL questions

1. Instantaneous dipole – induced dipole forces are also known as

   _____ [1M]

2. Positive ions are formed when _____

   and are called _____ [1M]

3. The force of attraction between a Ca^{2+} and an O^{2-} , the centers of which are separated by a distance of 1.25nm._____ (ε_o = 8.85x 10^{-12} F/m and e^- 1.6x10^{-19} C) [2 M]

4. Compute the percentage ionic bond for GaP where X_{Ga} = 1.6 and X_P = 2.1 [2 M]

5. Repeatable entity of a crystal structure is known as_____ [1M]

6. If 'a' stands for the edge length of the cubic systems: simple cubic and body centered cubic, then the ratio of the radii of the spheres in these systems will be respectively: [3 M]

7. Percentage of free space in a body centered cubic unit cell is _____ [1 M]

8. Atomic packing factor is [1M]

   (a) Distance between two adjacent atoms

   (b) Projected area fraction of atoms on a plane

   (c) Volume fraction of atoms in cell

   (d) None of the above

9. A metal crystallizes with a face-centered cubic lattice. The edge of the unit cell is 408 pm. The diameter of the metal atom is [2 M]

10. Draw the graph showing the dependence of repulsive, attractive and net potential energies on interatomic separation for two isolated atoms. [2 M]