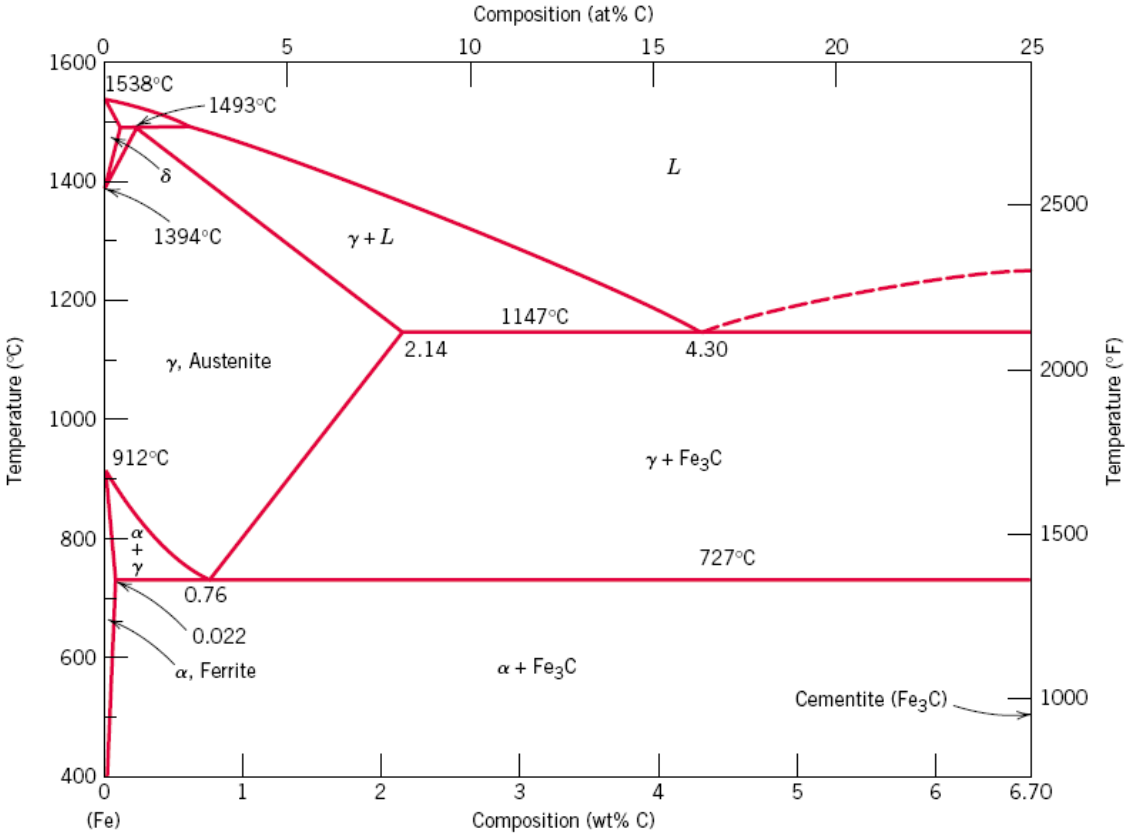
Problem 1. (12%)

The microstructure of an iron–carbon alloy consists of proeutectoid ferrite and pearlite; the mass fractions of these two microconstituents are 0.286 and 0.714, respectively.

(a) Determine the concentration of carbon in this alloy.

(b) Determine the fraction of total ferrite and cementite in the alloy, and

(c) Sketch the microstructure and name all components.



Problem 2. (15%)

Boron coated with SiC (or Borsic) reinforced aluminum containing 40 vol% fibers is an important high-temperature, lightweight composite material. The properties of the fibers and aluminum are as shown in the table below.

a) Estimate the density, modulus of elasticity and tensile strength parallel to the fiber axis.
b) Estimate the modulus of elasticity perpendicular to the fibers.
c) If the material is subjected to a force in the direction of the fibers of 54 kN, what fraction of the applied force is carried by the fibers and what fraction by the matrix?

Material	Density (g/cm^3)	Modulus of Elasticity (GPa)	Tensile Strength (MPa)
Fibers	2.36	385	2800
Aluminum	2.7	70	35

Problem 3. (12%)

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 0.507 V. Calculate the concentration of Pb^{2+} ions if the temperature is 25°C. The standard electrode potential of copper is +0.340 V and of lead is -0.126 V.

Problem 4. (8%)

5.1 Draw an electrochemical cell and name its four components (4)

5.2 The following four techniques are used to combat corrosion (2):

a)_____, b)_____,

c)_____ and d)_____.

5.3 Name four forms of corrosion (2):

a)_____, b)_____,

c)_____ and d)_____.

Question 5. (8%)

1. Name the four elements that are always present in steels: a) _____,

   b) _____, c) _____ and

   d) _____.

2. Name four types of structural steels:
   a. _____
   b. _____
   c. _____ and
   d. _____.
3. Sketch the following steel shapes showing relevant dimensions:

a) Shape W410x60

b) Shape C200x28

c) Shape L125x90x16

d) Shape PL 8x500

4. Name four properties of steel that can be obtain from the tensile test:

a) _____, b) _____,

c) _____ and d) _____.

Question 6. (6 %)

a) On a moisture scale, draw the four moisture conditions of aggregates and identify absorption capacity, effective absorption, and surface moisture.

Question 7. (8)

a) Describe the five CSA types of Portland Cement (5)

Type _____ _____

_____

_____

Type _____ _____

_____

_____

Type _____ _____

_____

_____

Type _____ _____

_____

_____

Type _____ _____

_____

_____

b) Two concrete mixes were tested for their slump. Mix 1 had a slump of 75 mm and Mix 2 a slump of 150 mm. (3)

a) Which mix has a higher water/cement ratio? _____

b) Which mix is easy to place and work with? _____

c) Which mix is expected to be stronger? _____

Question 8. (11%)

(a) Fill in the blanks: (5)

1. Name the three types of bitumen a) _____
   b) _____and c) _____.
2. A cutback asphalt is obtained from _____
3. What is the difference between the ingredients of a rapid curing and slow curing cutback asphalt? _____.
4. What is the effect of oxidation on asphalt? _____

5. Name the three types of asphalt grading systems. a) _____
   b) _____and c) _____.
6. What are emulsified asphalts? _____.

Question 9. (8 %)

1. Wood obtained from conifers is called _____.
2. Name three hardwoods a) _____
   b) _____and c) _____.
3. Name three softwoods a) _____ b)
   _____ and c)_____.
4. Moisture content in wood is the ratio of _____
   _____
5. The critical moisture content below which wood would shrink is called
   _____
   _____.
6. Name three wood defects a)
   _____ b)
   _____ and c) _____.
7. Controlled removal of moisture from wood is called _____.
8. Wood is composed of a) _____
   b) _____and c) _____.

$$E_{cl} = E_m V_m + E_f V_f$$

$$\frac{1}{E_{ct}} = \frac{V_m}{E_m} + \frac{V_f}{E_f}$$

$$\frac{F_f}{F_m} = \frac{V_f E_f}{V_m E_m}$$

$$\Delta V = (V_2^0 - V_1^0) - \frac{0.0592}{n} \log \frac{[M_1^{n+}]}{[M_2^{n+}]}$$