UNIVERSITI SAINS MALAYSIA

First Semester Examination
Academic Session 2009/2010

November 2009

EBB 521/3 - Industrial Heat Treatment

Duration : 3 hours

Please ensure that this examination paper contains <u>FIVE</u> printed pages before you begin the examination.

This paper consists of SEVEN questions.

Instruction: Answer **FIVE** questions. If candidate answers more than five questions only the first five questions answered in the answer script would be examined.

The answers to all questions must start on a new page.

All questions must be answered in English.

1. [a]   Outline the principle of normalizing of steel. What are the major effects of normalizing on the mechanical properties and microstructures of steel.

(7 marks)

    [b]   A steel cylinder of diameter 3.8 inches is heated slowly and held at 800^oC for 4 hours. It was found to contain 96% γ and 4% Fe_3C at that temperature. Estimate the carbon content of the steel.

(6 marks)

    [c]   What are the steps to be followed while conducting a spheroidizing heat treatment of steel? Discuss in brief the microstructural changes and the associated mechanical properties thus obtained by this treatment.

(7 marks)

2. [a]   Explain the principle of austempering of steel and cast iron with the help of a hypothetical TTT diagram.

(10 marks)

    [b]   What are the major advantages and applications of austempering?

(10 marks)

3. [a]   How does residual stress affect the properties of a heat treated work piece of steel? How can it be controlled?

(10 marks)

    [b]   Outline the various methods adopted to measure the residual stress in a heat treated work piece.

(10 marks)

4. [a] What are the major reactions involved in a pack carburizing process? Explain the role of energizers in this process.

(10 marks)

[b] How liquid carburizing is superior over pack carburizing? What do understand by case depth?

(10 marks)

5. [a] Discuss the principle of intense quenching of steel. Mention some applications of intense quenched steels.

(8 marks)

[b] What are the major advantages of intense quenching of steel?

(4 marks)

[c]   Calculate the hardenability of 4340 steel containing 0.40%C, 0.80%Mn, 0.20%Si, 1.80%Ni, 0.90%Cr, 0.30%Mo, and an austenitic grain size of ASTM 7 with the help of the following given figures.
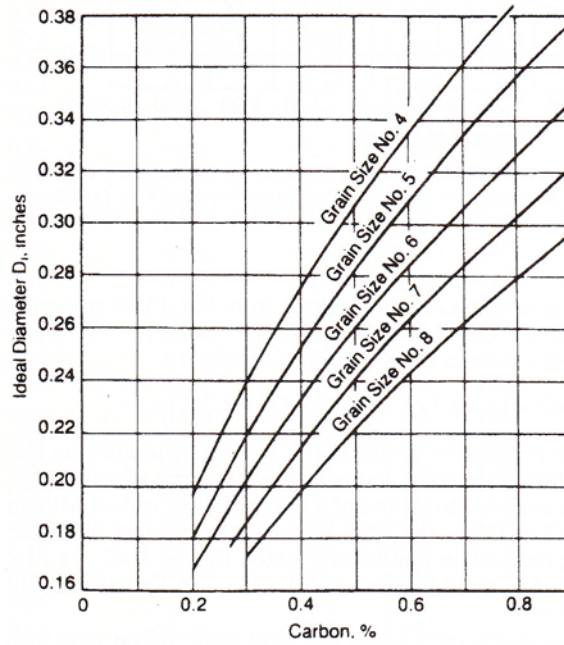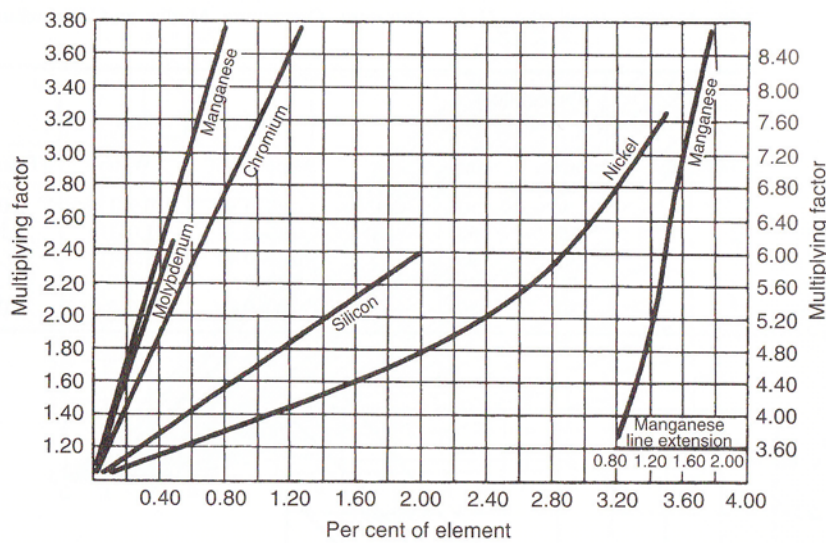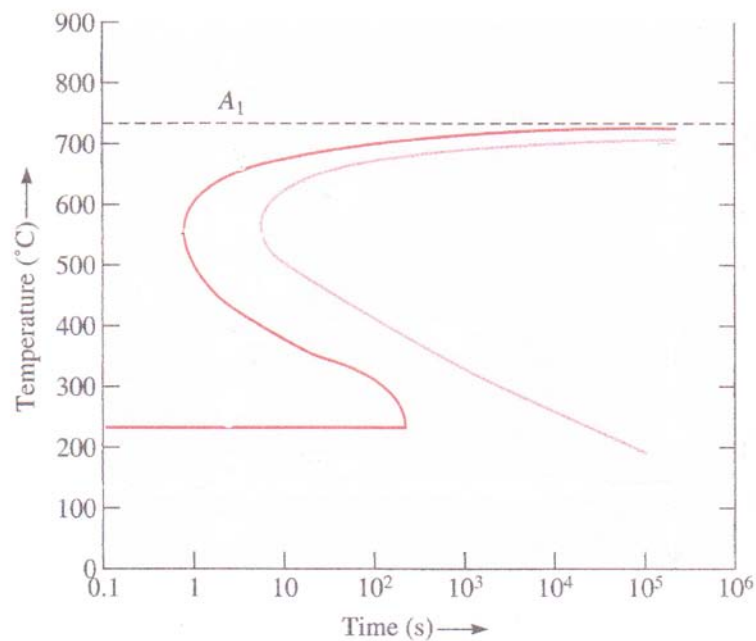
(8 marks)

Figure 1

Figure 2

6. [a] You have to develop the Time Temperature Transformation (TTT) diagram of a steel whose composition is not known to you. Point out the methodology you have to adopt to do that.

(10 marks)

[b] You are provided with the TTT diagram of a steel of eutectoid composition as shown below. How will you design your heat treatment cycle to get (1) fully martensitic and (2) fine pearlitic structures in the heat treated product?

(10 marks)

Figure 3

7. [a] What is the principle of precipitation hardening? How is it used to harden stainless steel?

(10 marks)

[b] What are the major characteristic features of martensitic transformation in steel?

(10 marks)

- oooOooo -