National Examination, 2013

10-Met-B6, Physical Metallurgy of Iron and Steel

3-Hour Duration

NOTES:

1. If doubt exists as to the interpretation of any question, the candidate is urged to submit with the answer paper a clear statement of any assumptions made.

2. Candidates may use one of two calculators, the Casio or Sharp approved models. This is a *Closed Book* exam.

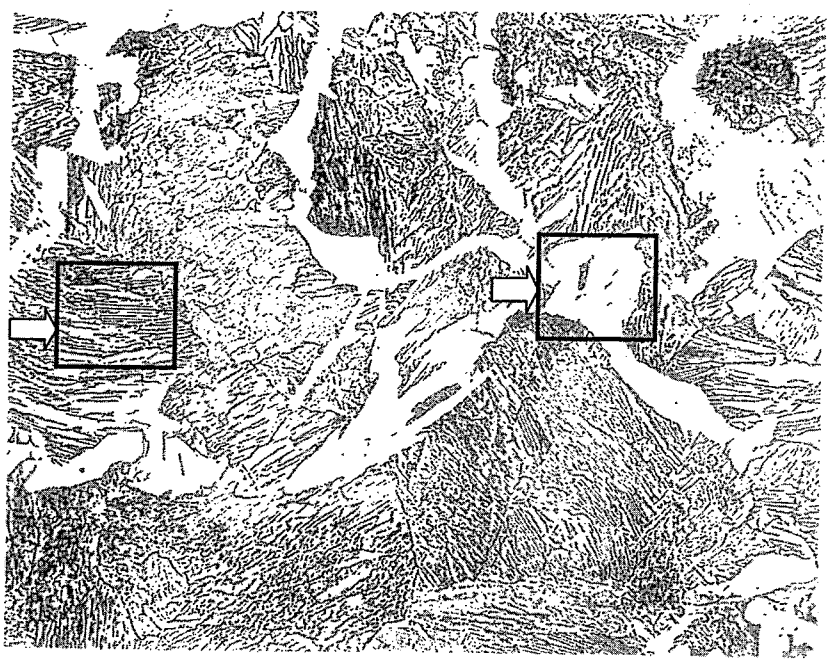
3. There are 7 questions in total. You must answer all of them.

I. (i) 4 marks, (ii) 4 marks, (iii) 4 marks

(i) Verify/indicate the phase and/or the structure in the two boxes as pointed by the two arrows in the following micrograph, which was taken from a proeutectoid steel.

(ii) Describe the process by which the microstructure in the micrograph formed.

(iii) Through a quantitative metallography study, it is found that the estimated weight percentage of white region in the micrograph is 40%. Estimate the C concentration in the steel?



II. (i) 5 marks, (ii) 5 marks, (iii) 5 marks

Using schematic (micrograph) figures show the preferred nucleation sites for austenite formation during the heating process for autenitization for the following three conditions:

(i) Starting with a ferrite structure in an annealed low-C steel,

(ii) Starting with a spheroidized structure in a mid-C steel, and

(iii)Starting with a pearlite structure in slowly cooled eutectoid steel.

III. (i) 10 marks. (ii) 10 marks.

(i) Describe step by step how you would experimentally construct a CCT curve for a given steel.

(ii) Explain the reason(s) qualitatively why, unlike the TTT curves, the lower part of the CCT curves are usually 'disappeared', i.e. why the shape of CCT curves usually is incomplete missing the lower portion of the "C" shape?

IV. (i) 4 marks, (ii) 4 marks, (iii) 4 marks.

(i) Define "Hardenability".

(ii) What is the phenomenon of Temper Embrittlement (TE)? What is the most commonly accepted mechanism for TE?

(iii) Why does the hardness of martensite increases with increasing C content for most structural steels?

VI. (i) 4 marks, (ii) 4 marks, (iii) 4 marks, (iv) 4 marks.

In modern manufacturing, especially the auto-manufacturing industry, the following newly developed steels are being used more and more frequently for their respective special properties.

Please provide the full names for these steels, and briefly explain the significance of these names, respectively.

a. TRIP steels,
b. DP steels,
c. IF steels,
d. HSLA steels.

V. (i) 5 marks, (ii) 5 marks, (iii) 5 marks.

(i) What is the driving force for an austenite to martensite transformation in steel? What is the driving force for an austenite to pearlite transformation? What is the difference between the two, if any?

(ii) What is the phase-transformation micro-mechanism of martensite formation in steel?

(iii) Why does the hardness of martensite increase with increasing C content for most structural steels?

VII. (i) 5 marks, (ii) 5 marks.

(i) Conventional gray cast irons are generally considered to be brittle materials as they have very limited potential for plastic deformation. Why?

(ii) Provide a practical method for increasing the ductility of cast irons and explain the metallurgical mechanism(s) behind it.