National Examination, December 2003

98-Met-B6, Physical Metallurgy of Iron ands 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 with a clear statement of any assumptions made.

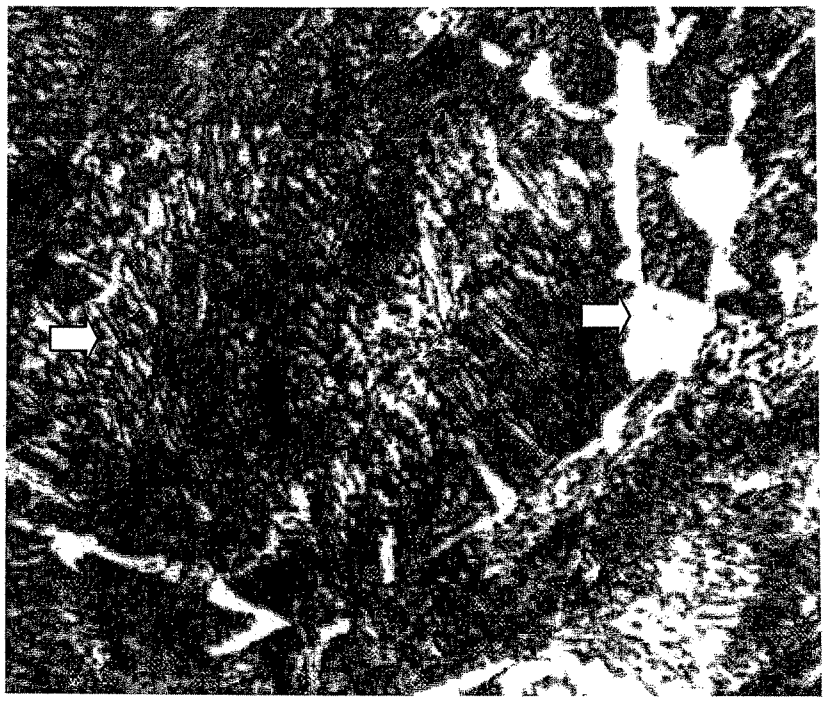
2. Candidates may use one of two calculators, the Casio or Sharpe approved models. This is a *Closed Book* exam.

3. There are totally 6 questions. You must answer all of them.

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

(i) Verify/indicate the phase and/or the structure as pointed by the arrows in the following micrograph, which was taken from a steel sample with C content less than the eutectoid composition.

(ii) Describing the process through which the microstructure in the micrograph could be obtained.



II. (i) 10 marks. (ii) 15 marks.

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

(ii) Explain the reason(s) qualitatively behind the "C" shape of a typical TTT curve, i.e. explain why a typical TTT curve has a "C" shape.

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

(i) Define "Hardenability".

(ii) When the C content in steel increases, so does the hardenability of the steel. Why?

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

IV. 15 marks

Describe the microstructural changes upon temperature increase during tempering in a mid-carbon steel, say SAE1045. Assume that the steel was fully austenitized, at 860°C and quickly cold-water-quenched.
(Hint: there are 3 stages.)

V. (i) 8 marks, (ii) 5 marks, (iii) 7 marks.

(i) A block of SAE 1090 steel is heated to and then held for a long time at a temperature just above the eutectoid temperature. Calculate the weight fraction of cementite in the steel at this temperature.

(ii) Assuming that the sample is then very slowly cooled down to and held at a temperature just below the eutectoid temperature, calculate the weight fraction of the cementite in the steel at this temperature.

(iii) If now that the sample is held at the temperature indicated in Question (ii) for a very lengthy period of time, what would be the most likely microstructure in the steel? (Draw a schematic micrograph to show your consideration.)

VI. (i) 7 marks, (ii) 8 marks.

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

(ii) Provide a practical method and explain the mechanism(s) of your method for producing ductile cast irons so that the ductility of cast irons could be considerably improved.