Government Women Engineering College, Ajmer

Model paper of I Mid Term Assessment Test (Branch: ME) **B.Tech. III Sem.**

Time: 1 hr. **Maximum marks: 12**

Instruction to Candidates: All Questions are compulsory. Schematic diagrams must be shown wherever necessary. Any data you feel missing suitably be assumed and stated clearly. Units of quantities used/ calculated must be stated clearly.

1. In a single component system how many maximum number of phases coexists in equilibrium? **01**

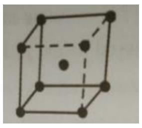
   Sol. – Gibbs phase rule- F=C-P+2

   C=1(single component system) and minimum no. of degree of freedom can be zero

   Therefore, 0 = 1-P+2

   P = 3

2. Draw the Body Centered Unit cell and calculate the no. of particles in it. **01**

   Sol. – 2 

3. Calculate the % of ferrite and cementite in the slow cooling of eutectoid steel. **03**

   Sol. – Applying the lever rule with fulcrum at 0.%C and the lever arm extending upto ferrite i.e. 0.025%C at one end and upto cementite i.e. 6.67% C at the other end.

Ferrite Cementite

0.025%C 0.8%C 6.67%C

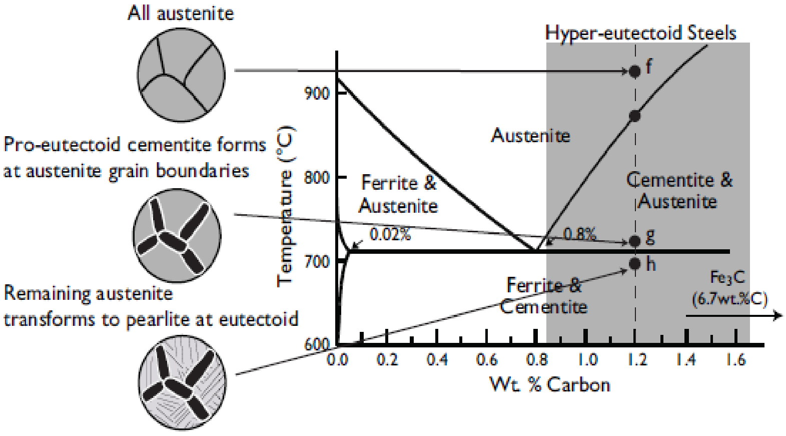
% of Ferrite = c-b/ c-a

= 6.67-0.8 / 6.67-0.025 = 0.88)%

% of cementite = 1- (% of Ferrite) = 0.12 %

4. Explain micro structural changes during slow cooling of hypereutectoid steel, with a suitable diagram.

   Sol. - Hyper-eutectoid Steel contains more than 0.8 wt.% C



The cooling of a hyper-eutectoid steel is depicted in the above figure with a composition of 1.2 wt.% C from the austenite phase field (point f).

- Transformation of the austenite begins when the temperature falls to point g. At this point cementite starts to form.
- As cementite is rich in C the concentration of C in the austenite decreases as the temperature falls, and more cementite is formed.
- By the time the temperature reaches point h (just above the eutectoid temperature), the concentration of carbon in the austenite falls to 0.8% (the eutectoid composition).
- At this point the fraction of cementite is – Fraction of Fe3C = 1.2 − 0.8 /6.7 − 0.8 = 6.7%.
- Below the eutectoid temperature all the remaining austenite transforms to pearlite.
- One of the distinguishing features of hyper-eutectoid steels is the high percentage of pearlite present, in this case ~ 93.3%.

OR

Define Crystal Imperfection. Explain Line defect.

The concept of an ideal crystal is possible when no molecular motion takes place and it is possible at 0K. At elevated temperature due to dislocation of particles from their respective sites crystal imperfection occur.

Line Defect: Line defect are geometric imperfections of two dimensional nature. These defects are due to dislocation of atoms along a line and also when a central portion 22of a crystal lattice slips without affecting the outer portion. Linear crystal defects are:

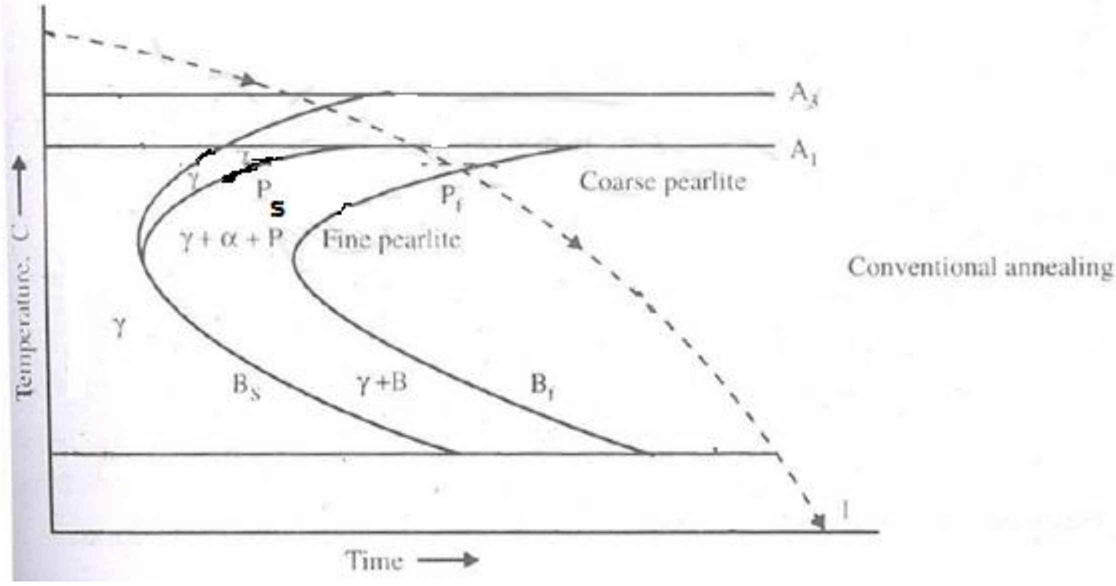
(a) Edge Dislocation (b) Surface Dislocation

5. Explain the process of full annealing in terms of heat treatment of steel. 04

Sol. - Full annealing process consists of three steps.

1. First step is heating the steel component to above A3 (upper critical temperature for ferrite) temperature for hypoeutectoid steels and above A1 (lower critical temperature) temperature for hypereutectoid steels by 30-50^{0}C

2. The second step is holding the steel component at this temperature for a definite holding (soaking) period of at least 20 minutes per cm of the thick section to assure equalization of temperature throughout the cross-section of the component and complete austenization.
3. Final step is to cool the hot steel component to room temperature slowly in the furnace, which is also called as *furnace cooling*. The *full annealing* is used to relieve the internal stresses induced due to cold working, welding, etc, to reduce hardness and increase ductility, to refine the grain structure, to make the material homogenous in respect of chemical composition, to increase uniformity of phase distribution, and to increase machinability.



Or

Explain process of conventional hardening with suitable diagram. **04**

Sol. - Conventional hardening process consists of four steps. The *first step* involves heating the steel to above A3 temperature for hypoeutectoid steels and above A1 temperature for hypereutectoid steels by 50^0C. The *second step* involves holding the steel components for sufficient socking time for homogeneous austenization. The *third step* involves cooling of hot steel components at a rate just exceeding the critical cooling rate of the steel to room temperature or below room temperature. The *final step* involves the tempering of the martensite to achieve the desired hardness. Detailed explanation about tempering is given in the subsequent sections. In this conventional hardening process, the austenite transforms to martensite. This martensite structure improves the hardness. Following are a few salient features in conventional hardening of steel.

1. Proper quenching medium should be used such that the component gets cooled at a rate just exceeding the critical cooling rate of that steel.
2. Alloy steels have less critical cooling rate and hence some of the alloy steels can be hardened by simple air cooling.
3. High carbon steels have slightly more critical cooling rate and has to be hardened by oil quenching.
4. Medium carbon steels have still higher critical cooling rates and hence water or brine quenching is necessary.

Following figure depicts the conventional hardening process which involves quenching and tempering. During quenching outer surface is cooled quicker than the center. Thinner parts are cooled faster than the parts with greater cross-sectional areas. In other words the transformation of the austenite is proceeding at different rates. Hence there is a limit to the overall size of the part in this hardening process.