Dr Vishal

Roll No.:

## Department of Material Science and Engineering National Institute of Technology, Hamirpur

Heat Treatment (MS-221)

End Term Examination (2022-23) B. Tech. (MSE) IV<sup>th</sup> Semester

## Duration: 3 hrs 00 Minute

Note:

- Attempt all questions.
- Draw a well labeled diagram wherever necessary.

## Question 1: Write brief notes on following:

- a. Invariant reactions in Iron-Carbon diagram
- b. Isoforming and Cryoforming
- c. Effect of Cobalt, Silicon and Chromium addition (less than 2 wt.%) on TTT curve of steel.
- d. Hall-petch relation and Zenner Holloman Parameter
- e. Hot Forging and Hot rolling
- f. Austempering and Martempering

Question 2: What is case hardening of steels? How is it different from surface hardening? Discuss the different methods used for case hardening of steels. (6)

**Question 3:** Explain the heat treatment of cast iron. What are the different types of cast iron and how do they differ in their microstructure and properties? (6)

P.T.O.

Max Marks: 50

 $(3 \times 6 = 18)$ 

Question 4: Discuss the effect of heat treatment on mechanical properties, such as strength, toughness, and ductility. (3)

Question 5: What are the various factors that need to be considered while selecting a heat treatment process for a particular material? Explain the importance of process parameters such as heating rate, cooling rate, and soaking time. (6)

Question 6: What are the various heat treatment defects that can occur during the process? Explain their causes and how they can be avoided. (5)

Question 7: Enlist the different Thermo mechanical processes. Also, explain the objective of thermo-mechanical treatment. (3)

Question 8: A researcher has used casting and powder metallurgy route to fabricated gears made of steels. He analyzed the microstructure of steels for both the techniques using linear intercept method. He calculated the average grain size and found 15  $\mu$ m for casting route and 10  $\mu$ m for powder metallurgy route. Suggest the fabricating route in this case to achieve higher yield strength. (Given  $\sigma o = 390$  MPa, Hall petch constant= 0.32 MPa.m<sup>1/2</sup>.) (3)

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