

**IV B.Tech. II Semester Regular Examinations, April/May -2006****SUPER ALLOYS****(Metallurgy & Material Technology)****Time: 3 hours****Max Marks: 80**

**Answer any FIVE Questions**  
**All Questions carry equal marks**

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1. (a) What are super alloys? Explain the important properties and applications of super alloys. [8]  
(b) Explain the functions of different alloy additions made in super alloys. [8]
2. (a) Describe the microstructure of wrought heat resisting alloys. [6]  
(b) Compare Ni-base super alloys with cobalt base super alloys with respect to composition, microstructure, properties and applications. [10]
3. (a) What are stainless steels? Can these steels be claimed as Iron-base super alloys? Explain with necessary reasons. [4]  
(b) Give typical composition, microstructures properties and applications of any two types of super alloys. [8]  
(c) What is a gas turbine? Discuss the material requirements of gas turbines. [4]
4. (a) What is physical metallurgy? [2]  
(b) What are the important high temperature materials. Give their composition. [4]  
(c) Explain the effect of various metallurgical factors that could significantly influence the microstructure of cast and wrought super alloys. [10]
5. (a) Discuss in detail the melting and refining process of super alloys using vacuum induction melting process. [8]  
(b) Explain the precautions that are to be taken to avoid contamination of the alloys by the harmful trace elements like Pb, Sn, Sb etc. [4]  
(c) List some of the chemical reactions that occur during the melting process. [4]
6. (a) Discuss in detail the technological considerations during the forging of super alloy rotor parts. [6]  
(b) What is hot isostatic processing? What are the advantages and limitations of the above process. [5]  
(c) Discuss the hot isostatic pressing process for the fabrication of super alloys components with suitable examples. [5]
7. (a) Discuss briefly the basic steps involved in the investment casting process for the manufacture of near net shape super alloy cast parts. [9]  
(b) Explain the advantages and limitations of cast super alloy parts. [7]

8. Write short notes on the following:

[4×4=16]

- (a) Joining techniques for super alloys
- (b) Super plastic forming of super alloys
- (c) High temperature corrosion
- (d) Heat treatment of heat resisting alloys.

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1. Give the classification of heat resistant materials.
  - (a) What are the general types of Iron base casting alloys used for resistance purpose and explain them. [7]
  - (b) Discuss the microstructure of wrought heat resisting alloys [4]
  - (c) Compare the microstructure of Ni-base with cobalt base heat resisting casting alloys. [5]
2.
  - (a) Discuss the metallurgy of Nickel-base super alloys. [8]
  - (b) Cobalt based super alloys are extensively used in easily air craft gas turbine engines. Justify the statement with proper reasons. [8]
3.
  - (a) Discuss the microstructural degradation of super alloys in normal operation above 700°C. [7]
  - (b) Discuss the metallurgy of Iron-base super alloys. [9]
4.
  - (a) Discuss the effect of grain size and grain boundaries on the strength of super alloys [2]
  - (b) Explain the precipitation hardening mechanism in some of the super alloys. [6]
  - (c) Discuss the behavior of super alloys in thermal fatigue. [4]
5.
  - (a) Schematically illustrate the principle features of
    - i. VAR and
    - ii. ESR furnaces for melting of super alloys. [10]
  - (b) Discuss the advantages and limitations of the above processes. [6]
6.
  - (a) Explain the important technological factors that are considered in the forging of super alloy rotor parts. [8]
  - (b) Explain why a single crystal turbine blade is preferred over a poly crystalline turbine blade. [4]
  - (c) Write a short note on hot isostatic pressing. [4]
7.
  - (a) Discuss briefly the procedure of joining super alloy parts by welding. Explain the various associated problems during the joining process.
  - (b) Explain how is the performance of turbine blades improved by controlling solidification process. [7]

8. Write short notes on the following:

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|----------------------------------------------|-----|
| (a) Quality control of super alloy castings  | [5] |
| (b) Heat treatment of heat resisting alloys  | [6] |
| (c) Stress rupture behavior of super alloys. | [5] |

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1. (a) What is a super alloy? Explain the important properties of super alloys. [7]  
(b) Explain the basis for the selection of super alloys. [5]  
(c) Explain the applications of super alloys. [4]
2. (a) Compare microstructures of Ni-base with cobalt base heat resisting casting alloys. [6]  
(b) Discuss the heat treatment process as applied to various cobalt based heat resistant alloys. Give the microstructures before and after heat treatment and explain. Discuss the properties and applications of heat treated cobalt base super alloys. [10]
3. (a) Discuss the different forms of high temperature corrosion in various types of super alloys. [8]  
(b) Discuss the effect of various metallurgical variables on creep crack growth rate in some super alloys. [8]
4. (a) Explain the precipitation hardening of nickel base alloys. Discuss the models proposed for the precipitation hardening process. [9]  
(b) Explain the important metallurgical factors that affect some of the important high temperature materials. [7]
5. (a) Describe the various techniques available for melting of different types of super alloys. [10]  
(b) Schematically illustrate what do you mean by electron beam cold hearth refining as applied to super alloys. [6]
6. (a) What is powder metallurgy? What are the main advantages and limitation of powder metallurgy? [6]  
(b) Write a detailed essay on the recent developments in powder metallurgy of certain super alloys? [10]
7. (a) Explain the factors that influence the microporosity formation in nickel based super alloys. [8]  
(b) Discuss the solidification and structure control of super alloys. [8]
8. Write short notes on the following: [4×4=16]

- (a) High temperature coatings
- (b) Quality control of super alloy castings
- (c) Super plastic forming of super alloys
- (d) Phase stability nickel base super alloys versus temperature.

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1. (a) Name any two important wrought super alloys. Give their composition, microstructure, properties and applications. [10]  
(b) Distinguish fully between wrought super alloys and cast super alloys. [6]
2. (a) List five most important and widely used nickel base super alloys. Discuss briefly the role of various alloying elements such as Cr, Mn, Ti and Al on these alloys. [11]  
(b) Explain the microstructure of cobalt base heat resisting casting alloys. [5]
3. Discuss the explain the following in detail: [2×8=16]  
(a) Fracture properties of super alloys  
(b) High temperature corrosion of super alloys.
4. (a) What is sigma phase? State and explain its effects on properties of stainless steels. [8]  
(b) Discuss the solid solution strengthening mechanism in super alloys. [8]
5. (a) Explain the various techniques available for melting and refining of super alloys. [10]  
(b) Bring out the advantages and limitation of the above process. [6]
6. (a) Write a brief essay on the recent developments in the powder metallurgy of super alloys. [8]  
(b) What is hot working? Describe the hot working characteristics of super alloys. Explain the important precautions to be considered during the hot working of super alloys. [8]
7. (a) Write a detailed account, how to improve turbine blade performance by solidification control. [8]  
(b) Discuss the various metallurgical factors that influence the joining of super alloys. [8]
8. Write short notes on the following:  
(a) Casting of aero gas turbine components [5]  
(b) Quality control of super alloy castings [6]  
(c) Relationship of microstructure to properties of super alloys. [5]

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