

## **Materials Science II exam – questions topics**

1. Deformation and fracture (mechanisms, characteristics, types, description)
2. Draw isomorphous phase diagram (e.g. Cu-Ni). Describe solidification and development of structure. Apply the lever rule.
3. Draw the binary eutectic phase diagram and explain development of structure during cooling.
4. Three phase reactions in phase diagrams-define eutectic, peritectic, eutectoid reactions.
5. Draw schematically equilibrium diagram having intermediate phases.
6. Demonstrate allotropy of pure iron during heating from room temperature to melting.
7. Iron - carbon system-define ferrite,austenite,cementite,graphite.
8. Draw and explain iron-iron carbide phase diagram. Apply Gibbs phase rule and lever rule.
9. Classify the iron -carbon alloys by phase diagram (iron, steel, cast iron).
10. Phase transformation in metals-classification, mechanism, kinetics (Avrami equation).
11. Describe pearlite reaction in steel.
12. Give main characteristics of martensite transformation.
13. Bainite transformation in steel- mechanism, structure of lower and upper bainite.
14. Draw T-T-T diagram for eutectoid (hypereutectoid, hypoeutectoid)iron carbon steel. Superimpose a critical cooling rate for martensite.
15. Draw C-C-T diagram for 0.3 %C (0.8 %, 1 %) steel. Superimpose critical cooling curve for quenching.
16. Describe four stages of tempering of martensite.
17. Explain purpose annealing in steels-stress relief, recrystallisation, diffusion annealing, normalising, spheroiding.
18. Hardening of steels-hardening temperature, hardening capacity.
19. Hardenability-Jominy test, hardening curve.
20. Hardening methods- demonstrate in T-T-T and C-C-T diagrams.
21. Briefly explain formation of quench cracks during quenching.
22. Surface hardening of steels -purpose, main methods.
23. Surface treatment- cite treatments in which a hard structure is produced at the surface and briefly clarify principle.
24. Thermomechanical treatment of steels-two basic methods, demonstrate in C-C-T diagram.
25. Chemical heat treatment of steels - principal purpose, conditions of carburising and nitriding.
26. Precipitation hardening -give conditions that must be satisfied for age-hardening response during heat treatment.

27. Draw hypotetical phase diagram for precipitation hardenable alloy. Briefly explain three steps in the age-hardening treatment.
28. Basic classification of ferrous alloys (steel, cast iron).
29. Depict schematically microstructure of plain carbon steel with 0.4%C in normalising state.
30. What is the function of alloys-elements in tool steel. Give the typical composition and typical heat treatment of high-speed steels.
31. Draw the iron - chromium phase diagram and classify stainless steels according to this diagram.
32. Explain main differences between white and gray cast iron.
33. Tensile test - types of diagrams, main characteristics, symbols, relationships
34. Transition temperature and methods of their determination
35. Mechanical properties and testing methods.
36. Fatigue, creep, wear – definition, typical curves
37. Structure and properties of metals, plastic and ceramics
38. Non ferrous metals and alloys – taxonomy
39. Alloys of Al, Cu Ni and Ti – main characteristics, groups, typical alloys representing of each group.
40. Plastics – structure, groups, properties
41. Application of main groups of plastics
42. Advanced ceramics – characteristics, groups, properties and application
43. Composite materials – description of main phases (role, classification, ...)
44. Advantages, disadvantages and application of composites
45. Powder metallurgy – main characteristics and applications