MET-1300: ENGINEERING MATERIALS AND METALLURGY

Cuyahoga Community College

Viewing: MET-1300 : Engineering Materials and Metallurgy

Board of Trustees:
June 2023

Academic Term:
Fall 2023

Subject Code
MET - Mech Eng/Manuf Ind Eng Tech

Course Number:
1300

Title:
Engineering Materials and Metallurgy

Catalog Description:
Analysis of the behavior and characteristics of metals and other materials used in manufacturing including polymers, ceramics, and composites: their structure, physical and mechanical properties. Examining and interpreting phase diagrams and crystallized microstructures of metals and alloys; heat treatment of ferrous and nonferrous metals; hardness, tensile, and charpy impact tests.

Credit Hour(s):
3

Lecture Hour(s):
2

Lab Hour(s):
3

Requisites

Prerequisite and Corequisite
MATH-0955 Beginning Algebra or qualified Math Placement to enroll in MATH-0965 Intermediate Algebra.

Outcomes

Course Outcome(s):
Analyze the behavior and characteristics of metals and other materials used in manufacturing including polymers, ceramics, and composites: their structure, physical and mechanical properties.

Objective(s):
1. Describe the extraction of metals from ores.
2. Correctly define and describe the mechanical properties of metals.
3. Describe the various mechanical testing machines and their uses.
4. Calculate stress, elastic limit, yield point, ultimate tensile strength, percentage elongation, percentage reduction in area of test specimen using the formulae provided.
5. Explain how steel products are manufactured.
6. Describe how steel is formed into various shapes and products.
7. List the advantages of some processes over others for a given product.
8. Describe the methods used to manufacture P/M parts and some of their characteristics.
9. Describe the characteristics of metal matrix composite.
10. Explain the manufacture an application of plastics and composites.
11. Explain the chemical structures of several plastic materials and the reason for their particular behavioral characteristics.
12. List the various steps, basic materials, and principles involved in iron making.
13. Describe the processes by which a sticky substance such as latex can be made elastic and resilient.
14. Identify kings of plastics and rubbers and some of their uses.
15. Identify various steelmaking processes.
16. Explain several processes used in producing metals.
17. Explain the methods of casting of metals.
18. Identify and list the various types of casting processes.

19. Describe each casting process.
20. Select the appropriate casting processes for various manufactured products.
21. Describe the physical and mechanical properties of metals.

Course Outcome(s):

Examine and interpret phase diagrams microstructures of metals and alloys; heat treatment of ferrous and non-ferrous metals; harness, tensile, and Charpy Impact Tests.

Objective(s):

1. Describe the crystalline structure of metals, basic phase diagrams and the metallographic sample preparation laboratory.
2. Describe the various phases of crystalline structures of metal.
3. Describe the various aspect of solid solutions.
4. Demonstrate an understanding of phase diagrams by recognizing their parts.
5. Explain the methods of classifying, identifying, and selecting iron alloys on the shop floor.
6. Identify different types of ferrous metals by various means of shop testing.
7. Select several commercial methods of determining AISA numbers.
8. Identify and select heat-treating equipment.
9. Describe the head treatment equipment for through hardening.
10. Reorganize the physical differences between furnaces and their use.
11. Read the iron-carbon phase diagram.
12. Describe allotropic forms of iron, along with the crystalline structures formed when slowly heating and cooling various iron-carbon alloys.
13. Identify areas in the iron carbon diagram where phase changes occur.
14. Identify temperature ranges for the various heat treatments associated with iron-carbon alloys.
15. Recognize and describe the various iron-carbon compound formations and microstructures at room and elevated temperatures.
16. Read the hardenability of steels, I-T/T-T-T diagrams and cooling curves.
17. Explain the methods of determining and evaluating the depth of hardening of various steels.
18. Demonstrate and measure the hardenability of shallow-hardening steel.
19. Demonstrate the use of mechanical properties chart for predicting the hardness and strength of a hardened and tempered specimen.
20. Determine the hardenability of steels and their quenching rates by using information gained form I-T diagrams.
21. Recognize certain microstructures of transformation products produced at various temperatures.
22. Describe the process of annealing, stress relieving, normalizing, hardening and tempering of steels.
23. Explain the principles of and differences among the various kind of annealing processes.
24. Explain the relationship between tempering temperature and hardness change.
25. Explain how steels and alloys are hardened.
26. Explain the tempering of steel and its purpose.
27. Select and describe welding processes for iron and iron alloys.
28. Describe the effect of welding on the microstructures and properties of several steel alloys
29. Describe the changes in welds and heat affected zones because of heat of welding and the effects of these changes upon welded structure.
30. Describe the effects of slag and fluxes in welding.
31. Explain the methods of identification and heat treatment of nonferrous metals.
32. Classify some non-ferrous metals by numerical system and identify others by testing methods.
33. Explain the processes of solution heat treatment and precipitation hardening in which hardening takes place.
34. List the use of various nonferrous metals.
35. Describe how oxygen in water affects the rate of corrosion of iron.
36. Explain techniques of non-destructive Testing.
37. Name several non-destructive testing methods and explain the specific uses and operation of each.
38. Explain which testing methods are best suited for nonferrous materials.
39. Explain what defects that can be discovered by X-rays.
40. Explain the differences between fluorescent penetrant and dye penetrant inspection.
41. Describe the techniques of hardness testing.
42. Explain the operation of common industrial hardness testers.
43. Differentiate between load and indenters.
44. Carryout hardness testing using Brinell and Rockwell testers.

Methods of Evaluation:

a. Quizzes and tests
b. Lab experiments and reports

c. Foundry and welding projects
d. Final examination

Course Content Outline:

a. Concepts
   i. Extracting metals from ores
   ii. The casting of metals
   iii. The physical and mechanical properties of metals
   iv. The crystal structure of metals, basic phase diagrams and the metallographic sample preparation laboratory
   v. Classification, identification and selection of iron alloys
   vi. The manufacturing of steel products
   vii. Heat treating equipment
   viii. The iron-carbon phase diagram
   ix. The hardenability of steels, I-T/T-T-T diagrams and cooling curves
   x. Annealing, stress relieving, normalizing, hardening and tempering of steels
   xi. Welding processes for iron and iron alloys
   xii. Identification and heat treatment of nonferrous metals
   xiii. Powder metallurgy
   xiv. Corrosion of metals
   xv. Composite materials
   xvi. Nondestructive testing
   xvii. Plastics and elastomers
   xviii. Ceramic materials
   xix. Hardness testing
b. Skills
   i. Select the appropriate casting processes for various manufactured products.
   ii. Calculate stress, elastic limit, yield point, ultimate tensile strength, percentage elongation, percentage reduction in area of test specimen using the formulae provided.
   iii. Identify different types of ferrous metals by various means of shop testing.
   iv. Select several commercial methods of determining AISA numbers.
   v. Reorganize the physical differences between furnaces and their use.
   vi. Identify areas in the iron carbon diagram where phase changes occur.
   vii. Identify temperature ranges for the various heat treatments associated with iron-carbon alloys.
   viii. Recognize and describe the various iron-carbon compound formations and microstructures at room and elevated temperatures.
   ix. Recognize certain microstructures of transformation products produced at various temperatures .
   x. Classify some non-ferrous metals by numerical system and identify others by testing methods.
   xi. Identify various nonferrous metals.
   xii. Identify kings of plastics and rubbers and some of their uses.
   xiii. Perform hardness testing using Brinell and Rockwell testers.
c. Issues
   i. Equipment unavailability and failure
   ii. Safe use of testing equipment
   iii. Theory to practice transition
   iv. Equipment updates

Resources

Kalpakjian, Serope and Steven Schmid. *Manufacturing Engineering and Technology*. 8th Ed. Upper Saddle River, NJ., 2020.

Groovr, Mikell. *Fundamentals of Modern Manufacturing: Materials, Processes, and Systems*. 7th ed. Quad Graphics, 2020.

Callister, William D. Jr. and David G. Rethwisch. *Materials Science and Engineering: An Introduction*. 10th ed. Wiley, 2020.

Smith, William and Javad Hashemi. *Foundations of Materials Science and Engineering*. 6th ed. McGraw-Hill, 2018.

Resources Other

a. Algor - FEA Software Package.
b. Metallographic Equipment

Instructional Services

OAN Number:
Transfer Assurance Guide OET013

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