LEARNING OBJECTIVES

CHAPTER 6 - MECHANICAL PROPERTIES OF METALS

1. List three factors that should be considered in designing laboratory tests to assess the mechanical characteristics of materials for service use.
2. Given the tensile load on a specimen and its original and instantaneous cross-sectional dimensions, be able to compute the engineering stress and the true stress.
3. Given the original and instantaneous lengths of a specimen which is being loaded in tension, be able to compute the engineering strain and the true strain.
4. Given the magnitude of a tensile stress that is applied parallel to the specimen axis, compute the magnitudes of normal and shear stresses on a plane that is oriented at some specified angle relative to the specimen end-face.
5. Distinguish between elastic and plastic deformations, both by definition, and in terms of behavior on a stress-strain plot.
6. Compute the elastic modulus from a stress-strain diagram.
7. Given the elastic modulus and either elastic engineering stress or strain, be able to compute the other (strain or stress).
8. For a material that exhibits nonlinear elastic behavior, be able to compute tangent and secant moduli from its stress-strain diagram.
9. State what is occurring on an atomic level as a material is elastically deformed.
10. Briefly explain how the shape of a material's force versus interatomic separation curve influences its modulus of elasticity.
11. Given the cross-sectional area of a specimen over which a shear forced of specified magnitude acts, and, in addition, the resulting shear strain, be able to compute the shear modulus.
12. Define *anelasticity*.
13. Given Poisson's ratio and the elastic strain in the direction of the applied load (i.e., axial strain), be able to compute the elastic strain in the lateral (or perpendicular) direction.
14. Cite typical value ranges of modulus of elasticity and Poisson's ratio for metallic materials.
15. Given values of modulus of elasticity and Poisson's ratio for an isotropic material, estimate the value of its shear modulus.

16. Given an engineering stress-strain diagram estimate the proportional limit, and then determine the yield strength (0.002 strain offset) and the tensile strength.
17. Schematically sketch the stress-strain behavior for a material that displays distinct upper and lower yield points, and then explain how the yield strength is determined.
18. Given the stress-strain behavior for two metals, be able to distinguish which is stronger.
19. For a cylindrical specimen of a ductile material that is deformed in tension, describe how the specimen's profile changes in moving through elastic and plastic regimes of the stress-strain curve, to the point of fracture.
20. Explain why engineering stress decreases with increasing engineering strain past the tensile strength point.
21. Cite typical yield and tensile strength ranges for metal alloys.
22. Give a brief definition of ductility, and schematically sketch the engineering stress-strain behaviors for both ductile and brittle materials.
23. Given the original and fracture dimensions of a specimen deformed in tension, be able to determine its ductility in terms of both percent elongation and percent reduction of area.
24. Cite which tensile parameters are sensitive (and also which are insensitive) to any prior deformation, the presence of impurities, and/or any heat treatment.
25. For metallic materials cite how elastic modulus, tensile and yield strengths, and ductility change with increasing temperature.
26. Give brief definitions of and the units for modulus of resilience and toughness (static).
27. Given yield strength and modulus of elasticity values for some material, compute its modulus of resilience.
28. Given the stress-strain behavior for two metals, determine which is the most resilient and which is the toughest.
29. Given values of the constants K and n in the equation relating plastic true stress and true strain, be able to compute the true stress necessary to produce some specified true strain.
30. Schematically plot both the tensile engineering stress-strain and true stress-strain behaviors for the same material and then explain the difference between the two curves.
31. Describe the phenomenon of elastic recovery using a stress-strain plot.

32. Determine the elastic strain recovered for some material, given its stress-strain plot and the total strain to which a specimen has been subjected.
33. Define *hardness* in a one- or two-sentence statement.
34. Cite three reasons why hardness tests are performed more frequently than any other mechanical test on metals.
35. Name the two most common hardness-testing techniques that are used in the U.S., and give two differences between them.
36. Name and briefly describe the two different microhardness testing techniques. Now cite situations for which these techniques are generally used.
37. Cite three precautions that should be taken when performing hardness tests in order to insure accurate readings.
38. Schematically diagram tensile strength versus hardness for a typical metal.
39. Cite five factors that can lead to scatter in measured data.
40. Given a series of data values that have been collected, be able to compute both the average and the standard deviation.
41. Given the yield strength of a ductile material, be able to compute the working stress.
42. Briefly describe how the strength performance index for a solid cylindrical shaft is determined.
43. Explain the manner in which materials selection charts are employed in the materials selection process.