TMT 4185 Materialteknologi – Øving 4

6.5

An aluminum bar 125 mm long and having a square cross section 16.5 mm on an edge is pulled in tension with a load of 66,700 N, and experiences an elongation of 0.43 mm. Assuming that the deformation is entirely elastic, calculate the modulus of elasticity of the aluminum.

6.6

Consider a cylindrical nickel wire 2.0 mm in diameter and 3E+4 mm long. Calculate its elongation when a load of 300 N is applied. Assume that the de-formation is totally elastic.

6.8

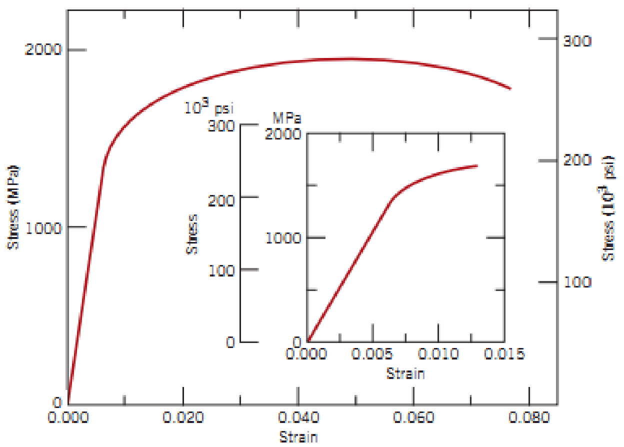
A cylindrical rod of steel (E = 207 GPa) having a yield strength of 310 MPa is to be subjected to a load of 11,100 N. If the length of the rod is 500 mm, what must be the diameter to allow an elongation of 0.38 mm?

6.24

Figure 6.21 shows the tensile engineering stress–strain behavior for a steel alloy.

(a) What is the modulus of elasticity?
(b) What is the proportional limit?
(c) What is the yield strength at a strain off-set of 0.002?
(d) What is the tensile strength?

Figure 6.21 Tensile stress–strain behavior for an alloy steel.



6.25

A cylindrical specimen of a brass alloy having a length of 100 mm must elongate only 5 mm when a tensile load of 100,000 N is applied. Under these circumstances what must be the radius of the specimen? Consider this brass alloy to have the stress–strain behavior shown in Figure 6.12.

6.29

A specimen of magnesium having a rectangular cross section of dimensions 3.2 mm x 19.1 mm is deformed in tension. Using the load-elongation data tabulated as follows, complete parts (a) through (f).

Load		*Length*	
lb_f	*N*	*in.*	*mm*
0	0	2.500	63.50
310	1380	2.501	63.53
625	2780	2.502	63.56
1265	5630	2.505	63.62
1670	7430	2.508	63.70
1830	8140	2.510	63.75
2220	9870	2.525	64.14
2890	12,850	2.575	65.41
3170	14,100	2.625	66.68
3225	14,340	2.675	67.95
3110	13,830	2.725	69.22
2810	12,500	2.775	70.49
	Fracture		

(a) Plot the data as engineering stress versus engineering strain.
(b) Compute the modulus of elasticity.
(c) Determine the yield strength at a strain offset of 0.002.
(d) Determine the tensile strength of this alloy.
(e) Compute the modulus of resilience.
(f) What is the ductility, in percent elongation?

6.41

Find the toughness (or energy to cause fracture) for a metal that experiences both elastic and plastic deformation. Assume Equation 6.5 for elastic deformation, that the modulus of elasticity is 103 GPa, and that elastic deformation terminates at a strain of 0.007. For plastic deformation, assume that the relationship between stress and strain is described by Equation 6.19, in which the values for K and n are 1520 MPa and 0.15, respectively. Furthermore, plastic deformation occurs between strain values of 0.007 and 0.60, at which point fracture occurs.

6.44

A cylindrical specimen of a brass alloy 10.0 mm in diameter and 120.0 mm long is pulled in tension with a force of 11,750 N; the force is subsequently released.

(a) Compute the final length of the specimen at this time. The tensile stress–strain behavior for this alloy is shown in Figure 6.12.
(b) Compute the final specimen length when the load is increased to 23,500 N and then released.

7.1

To provide some perspective on the dimensions of atomic defects, consider a metal specimen that has a dislocation density of 10^5 mm^{-2}. Suppose that all the dislocations in 1000 mm^3 were somehow removed and linked end to end. How far (in miles) would this chain extend?

Now suppose that the density is increased to 10^9 mm^{-2} by cold working. What would be the chain length of dislocations in 1000 mm^3 of material?

7.5

(a) Define a slip system.

(b) Do all metals have the same slip system?
Why or why not?

7.7

One slip system for the BCC crystal structure is {110}<111>. In a manner similar to Figure 7.6b, sketch a {110}-type plane for the BCC structure, representing atom positions with circles. Now, using arrows, indicate two different <111> slip directions within this plane.

7.11 (Assume slip for (111) plane, in <011>-direction)
Sometimes cos φ cos λ in Equation 7.2 is termed the Schmid factor. Determine the magnitude of the Schmid factor for an FCC single crystal oriented with its [120] direction parallel to the loading axis.

7.12

Consider a metal single crystal oriented such that the normal to the slip plane and the slip direction are at angles of 60° and 35°, respectively, with the tensile axis. If the critical resolved shear stress is 6.2 MPa, will an applied stress of 12 MPa cause the single crystal to yield? If not, what stress will be necessary?

7.15

A single crystal of a metal that has the FCC crystal structure is oriented such that a tensile stress is applied parallel to the [100] direction. If the critical resolved shear stress for this material is 0.5 MPa, calculate the magnitude(s) of applied stress(es) necessary to cause slip to occur on the (111) plane in each of the [1 -1 0], [1 0 -1], and [0 -1 1] directions.