MSE 214 (Metals)
Exercise 10 — Properties
10th Dec 2025

Question 1.

Consider an elliptical crack in the center of a body subjected to an applied stress of 170 MPa. What is the maximum stress that exists at the tip of this internal crack if it has a radius of curvature of 2.5×10^{-4} mm and a total crack length of 2.5×10^{-2} mm?

Question 2.

A part made of a steel alloy with a K_{IC} value of 45 $MPa\sqrt{m}$ is exposed to a stress of 1000 MPa. Will this part fail if it has a surface crack 0.75 mm long? Justify your answer. Assume that Y is 1.0.

Question 3.

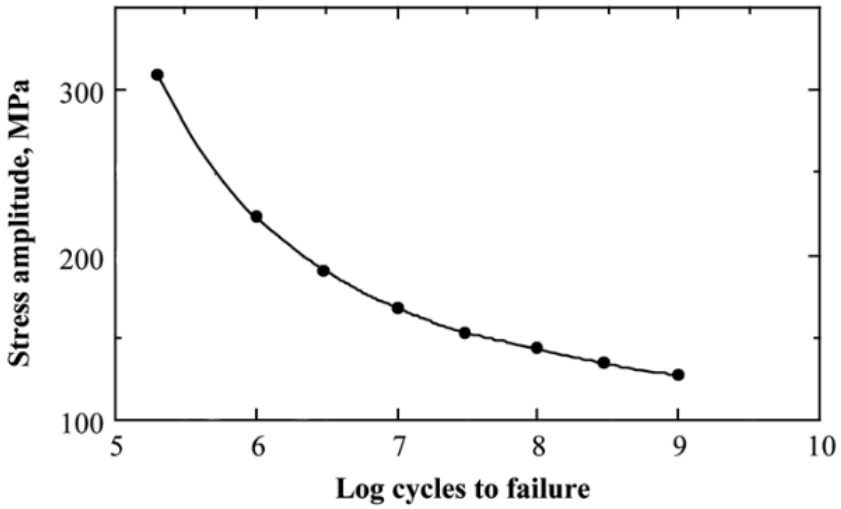
A cylindrical steel bar is subjected to repeated compression-tension stress cycling along its axis. If the load amplitude is 22000 N, determine the minimum bar diameter needed to ensure that fatigue failure does not occur. Assume that the steel has a fatigue limit stress amplitude of 310 MPa.

Question 4.

List three differences between ductile and brittle fracture.

Questions 5.

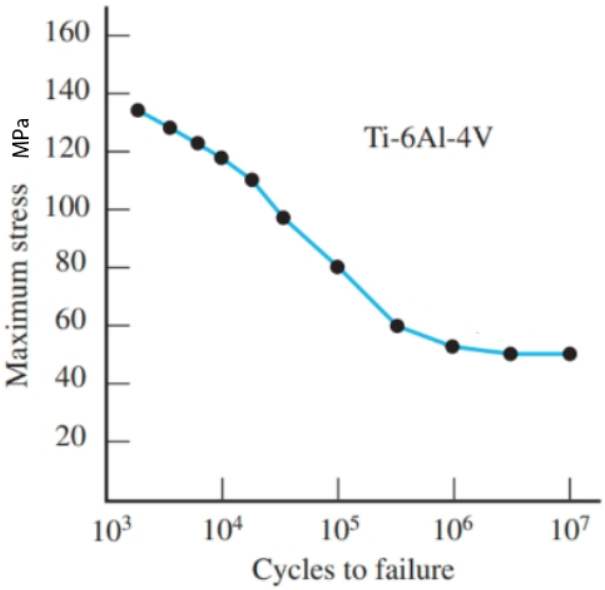
The S-N plot for a brass alloy, as determined from torsional tests, is shown below:



A shaft of this alloy is going to be attached to a motor operating at 1500 rpm. Find the maximum torsional stress amplitude possible if the part has a service lifetime of a) 1 year or b) 1 day.

Question 6.

The S-N plot for a titanium alloy is shown below:



Using the S-N plot, determine if the alloy will fail if it is subjected to the following loading conditions:

250 cycles at 120 MPa
3000 cycles at 100 MPa
15000 cycles at 80 MPa
120000 cycles at 60 MPa
500000 cycles at 40 MPa

You can assume a linear scale between each decade on the x-axis (e.g. The mid-point between 10^4 and 10^5 is 5×10^4.)