MSE160 – Molecules and Materials
Problem Set #9 - Due February 26th, 2020

1. Summarize the processes of recovery, recrystallization, and grain growth. Make specific mention of how the ductility, yield strength, and grain sizes are changing during each process.

2. You are asked to select a material which must subject a tensile load of 500kN. The cross-sectional areas of these plates can be assumed to be $5cm^2$. Based on the resolution limit of flaw detection of the manufacturer, the flaw size must be smaller than 700 μm. Assume a Y value of 1. Make this justification based on the numbers provided below

Material	**Yield Strength (MPa)**	**K_{IC} (MPa $\sqrt{m}$)**
Aluminum	345	45
Titanium	910	55
Steel	1640	50

3. Two previously undeformed specimen of the same metal are plastically deformed by reducing their cross-sectional area. One of these cross sections is a circle, which the other is a rectangle. It can be assumed that after the deformation process, the cross sections should maintain their cross-sectional shape (the circular section must remain circular). Given the following dimensions, which material will be harder after deformation?

	Circular (diameter, mm)	**Rectangular (mm)**
Original Dimension	15.2	125 x 175
Deformed dimension	11.4	75 x 250

4. A component in the form of a wide plate is to be fabricated from a steel alloy that has a plane strain fracture toughness of 77.0 $MPa*m^{1/2}$ and a yield strength of 1400MPa. The flaw size resolution limit of the equipment used to detect flaws in this component is 4.0mm. If the design stress is half of the yield strength and the value of Y is 1.0 determine whether a critical flaw would be detected.

a. How could flaws have been introduced to this plate? If the flaw in this problem is below the critical flaw detection limit, is this product safe for use? What factors would influence your decision