THESE PROBLEMS/QUESTIONS HAVE BEEN DEVELOPED TO MEET THE NEEDS OF SPECIFIC STUDENTS ASKING FOR HELP TO PREPARE FOR THE FINAL EXAMINATION.

THESE PROBLEMS/QUESTIONS ARE RELEVANT TO THE SUBJECT MATTER FOR TEST 3.

THIS SET OF PROBLEMS/QUESTIONS IS IN NO WAY REPRESENTATIVE OF ALL POSSIBLE PROBLEMS/QUESTIONS FOR TEST 3. IT IS BEING MADE AVAILABLE IN RESPONSE TO SUGGESTIONS FROM STUDENTS IN PRIOR TERMS.

STUDENTS CHOOSING TO USE THIS RESOURCE TO PREPARE FOR TEST 3 ARE STRONGLY URGED TO USE THE OTHER TEST PREPARATION RESOURCES. UNDER NO CIRCUMSTANCES IS IT RECOMMENDED THAT THIS BE THE SOLE RESOURCE STUDENTS USE TO STUDY FOR TEST 3.

Nucleation and Growth Problems

1) A single phase alloy is solidified from the melt. Identify the order in which the following processes occur (recognizing that some might not occur at all).

___ Coarsening
___ Grain Growth
___ Growth
___ Nucleation

2) A eutectic alloy is solidified from the melt. Identify the order in which the following processes occur (recognizing that some might not occur at all).

___ Coarsening
___ Grain Growth
___ Growth
___ Nucleation

3) Eutectoid steel is austenitized and then slowly cooled to room temperature. Identify the order in which the following processes occur (recognizing that some might not occur at all).

___ Coarsening
___ Grain Growth
___ Growth
___ Nucleation

Structure Formation

1) In order to form a coarse grained structure which of the following is required
- ☐ Large critical radius
- ☐ Small critical radius
- ☐ Fast growth rate
- ☐ Slow growth rate
- ☐ Fast nucleation rate
- ☐ Slow nucleation rate

2) In order to form a fine grained structure which of the following is required
- ☐ Large critical radius
- ☐ Small critical radius
- ☐ Fast growth rate
- ☐ Slow growth rate
- ☐ Fast nucleation rate
- ☐ Slow nucleation rate

3) Which of the following matches make sense
- ☐ Large critical radius, Fast growth rate, Fast nucleation rate
- ☐ Large critical radius, Fast growth rate, Slow nucleation rate
- ☐ Small critical radius, Fast growth rate, Fast nucleation rate
- ☐ Small critical radius, Fast growth rate, Slow nucleation rate
- ☐ Large critical radius, Slow growth rate, Fast nucleation rate
- ☐ Large critical radius, Slow growth rate, Slow nucleation rate
- ☐ Small critical radius, Slow growth rate, Fast nucleation rate
- ☐ Small critical radius, Slow growth rate, Slow nucleation rate

$\frac{T}{T_M}$	The homologous temperature (fraction of melting point) is considered
75-100%	high
50-75%	intermediate
<50%	low

$\frac{T}{T_M}$	The solidification temperature is considered
90-100%	high
75-90%	intermediate
<75%	low

Consider a single phase alloy with a melting temperature of 2000C

T (C)	Grain Growth Should Occur	A Coarse Structure Should form From the Melt	A Fine Structure Should form From the Melt
1800			
1600			
1500			
1400			
1200			
1100			
1000			
800			
600			

What is fracture toughness?

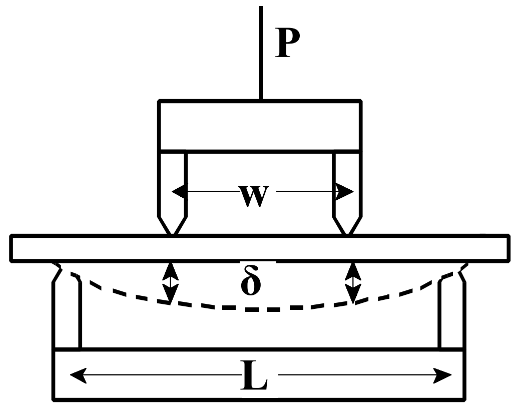
A material has a fracture toughness of $2.8 MPa\sqrt{m}$. Assume the sample will be loaded in pure tension.

- What is the maximum surface crack length if the applied stress is to be 200MPa? How will increasing the applied stress to 250MPa effect this?
- If the sample has a crack length of 3 microns; what is the maximum applied stress? How will reducing the surface crack length to 0.5 microns effect this?

You are given the data from a 4 point bend test on a cylindrical specimen (δ,l,P,r,w) and asked to determine the maximum load (F) that a fiber with a cross-sectional area (A) and a surface crack length (a) can support in pure tension without breaking or exceeding a certain strain (ε).

- Identify and justify the problem solving steps
- Show the algebra

Problem 1) A cylindrical beam with diameter (d) and a surface crack length (a) is subjected to a 4 pt bend test. Identify (and justify) the relevant variables needed to determine:



Breaking Strength

Elastic Modulus

Fracture Toughness

Problem 2) You need to determine the length under load for a given material and are given the dimensions (cross-sectional area and length). You have the following results from a previous experiment.

- The dimensions (cross-sectional area and length)
- The force required for a certain elongation.

Explain how you are going to solve this problem. What are you going to do? In what order? Why?

Problem 3) Through a previous experiment you have determined the fracture toughness K_{IC} of a material. How are the following related?

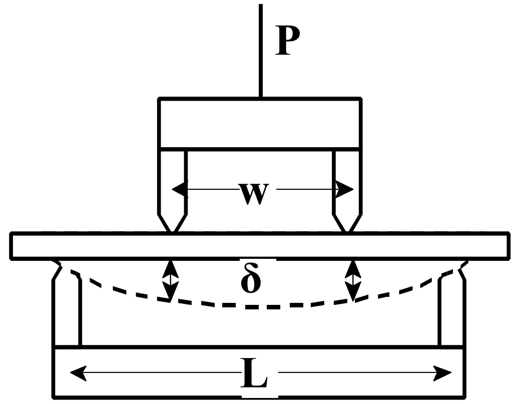
- Breaking Load
- Cross-Sectional Area
- Surface Crack Length.

Problem 4) You have determined that the Fracture Toughness K_{IC} of a material is $8.5MPa\sqrt{m}$. A bar of this material needs to support a 140kN load in pure tension.

If the crack length is 5 microns what is the cross-sectional area required to support the required load? (ans. 1.1 sqcm) [Note max stress = 1260MPa]

If the cross-sectional area is 2.7 sqcm what is the maximum surface crack length? (ans. 30 microns) [Note max stress = 515MPa]

Problem 5) A cylindrical rod is subjected to a 4 pt bend test. The pertinent information is below.



r	1.5	cm
a	30	microns
l	60	cm
w	25	cm
P	12.5	kN
delta	3	mm

Determine the following material properties:

The Elastic Modulus (ans. 284GPa)
The Fracture Toughness (ans. $4.0 MPa\sqrt{m}$)