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**UNIVERSITY OF SASKATCHEWAN
COLLEGE OF ENGINEERING**

ELECTRICAL ENGINEERING EE271

**Midterm Examination
Part A**

Instructor: K. V. Koughia

November 2, 2005

Time allowed: Part A is nominally 1 hour.

Total time allowed: 2 hours for Parts A and B.

Instructions

Part A: Closed book examination. *Answer any 2 questions from 3 questions.* If you answer more than 2 questions, only the first 2 will be marked. All questions carry equal marks. Marks for part-questions depend on the relative difficulty and are shown in brackets. All answers must be given in conventional units. All sketches must be clearly labeled and self-explanatory. Diagrams that are not properly and clearly labeled and are subject to ambiguity will be heavily penalized. Next to each diagram write short explanations that provide the key concepts and principles on which the diagram is based. Wrong concepts will be heavily penalized. State clearly all assumptions made in your derivations.

Part B: You must hand in Part A before you can start Part B. Allowed for Part B:

- Textbook (third edition)
- Three ring binder
- Calculator

Note: You may spend more or less time on Part A; but the total exam time is 2 hours.

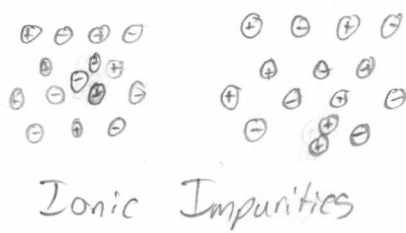
Question	Marks
1	18
2	17
3	
TOTAL	35

18

QUESTION 1

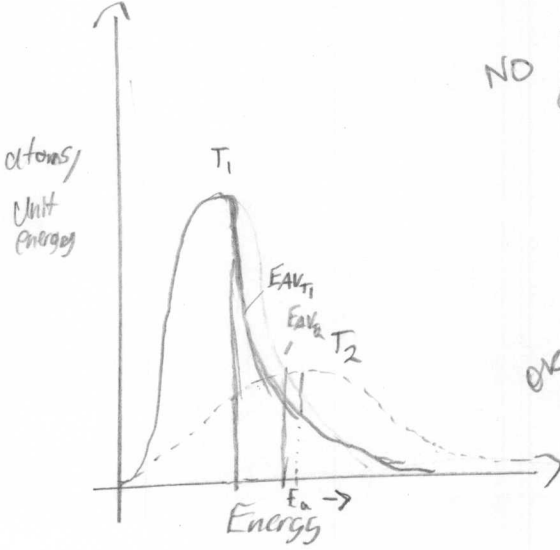
[7] 6	Sketch schematically the following in a crystal 1. A vacancy. 2. A large substitutional impurity and 3. A small substitutional impurity. 4. An interstitial impurity. 5. Edge dislocation in a crystal. 6. Schottky and Frenkel defects in an ionic crystal (e.g. NaCl) 7. Two possible (but distinctly different) ionized substitutional impurity defects in an ionic crystal
[8] 5	The resistivity of copper polycrystalline thin film is known to be substantially larger than the resistivity of monocrystalline copper. Why?
[10] 7	Sketch schematically the number of atoms per unit energy vs. energy for gas molecules in a cylinder at two temperatures T_1 and $T_2 > T_1$. How we can find the average energy and where is it on the graph? Identify how you would find the number of atoms with energies greater than E_A ? (assume E_A is arbitrary energy much larger than average energy)

pictures are extremely confusing too small and not clear



Polycrystalline copper resistivity will be higher than monocrystalline copper because of Matthiessen's rule. As grain boundaries are added, impurities are introduced to the monocrystalline structure to make it polycrystalline the resistivities are added. Resistivity of each grain boundary, resistivity of impurities & any other changes made to the copper will have additive resistivities. + surface

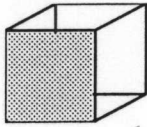
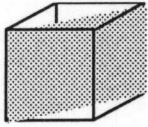
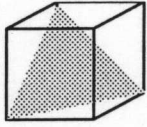
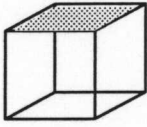
NO To find average energy you would have to take the largest energy & divide by the total area under the curve.

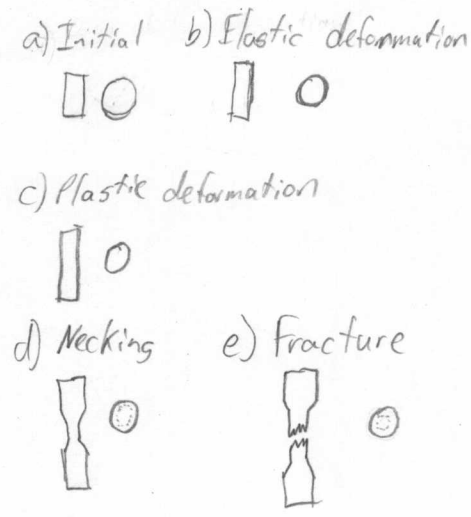
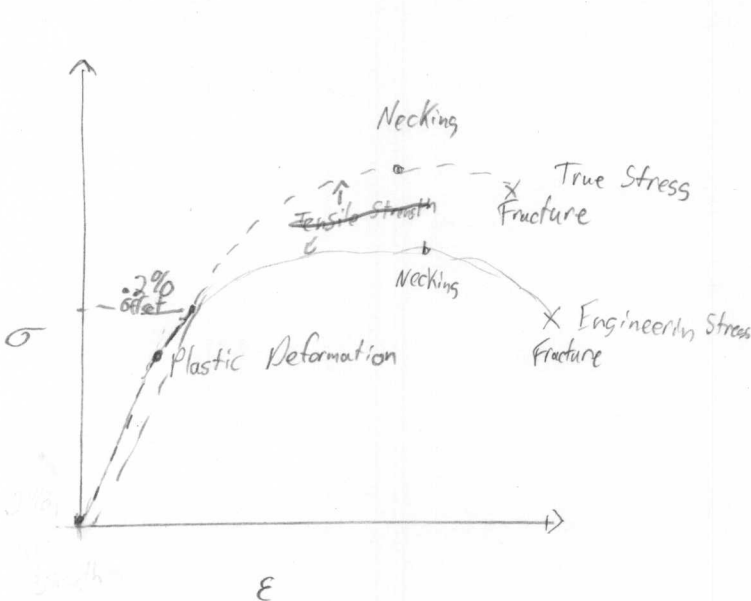


OK You would find the number of atoms with energy E_a by taking the area under the curve to the right of the E_a point on the energy axis.

17

QUESTION 2

<p>[10] 8</p>	<p>Sketch schematically the engineering stress vs. engineering strain, and true stress vs. true strain behavior of an aluminum alloy specimen under a tension test (use the same σ-ϵ axes for both). Assume the specimen is eventually fractured. Identify on your sketches:</p> <ol style="list-style-type: none"> 1. 0.2% offset yield strength, 2. plastic deformation region, 3. tensile strength, 4. the onset of necking, 5. fracture. <p>Show schematically the evolution of sample cross-section.</p>
<p>[6] 4</p>	<p>Figures below show atomic planes in a cubic crystal. For each of the planes find the corresponding Miller indices.</p> <div style="display: flex; justify-content: space-around; align-items: flex-end;"> <div style="text-align: center;">  <p>(a) (100) (010)</p> </div> <div style="text-align: center;">  <p>(b) (110)</p> </div> <div style="text-align: center;">  <p>(c) (111)</p> </div> <div style="text-align: center;">  <p>(d) (001)</p> </div> </div>
<p>[9] 5</p>	<p>In modern microelectronics the interconnects are mostly done using copper rather than aluminum. Give at least two reasons for this choice.</p>



~~Copper is used because it is mechanically harder than aluminum so it resist corrosion & stress better.~~
Copper is also more conductive than Aluminum giving a greater flow of electrons.

QUESTION 3

[9]	Consider a metal rod subjected to a tensile stress. Plot the shear stress experienced by a plane inside the rod as a function of the angle between the plane and the tensile load.
[9]	Sketch schematically in two-dimensions the structure of (i) Crystalline Si (ii) a-Si (iii) a-Si:H Sketch schematically the installation for a-Si:H deposition. What are the applications of this material?
[7]	Plot the cooling curve (temperature vs. time) from above the melting temperature to room temperature for (i) pure Cu, (ii) 80%Cu-20%Ni. What is the difference?