Chalmers *Kursnr.: MMK072*
Material och tillverkningsteknik

Exam in Material och tillverkningsteknik, August 19th, 2008

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The answers will be posted on Wednesday, August 20th 2008.
The results of the exam will be available via studieportalen (3 weeks after the exam).
Checking (*granskning*) of the corrected exams: Friday, September 5th, between 12:30 and 13:15h at the department (next to studiehallen; opposite side of cafeteria).

Questions:

First, please read all questions! Don't write long answers but always motivate them.
Please, give back all the pages, even this front page!

1. Atomic structure and interatomic bonding	4 P
2. Phase diagrams	6 P
3. Mechanical properties	4 P
4. Electrical properties	3 P
5. Plastic behaviour	7 P
6. Unconv. machining methods: Abrasive waterjet machining	3 P
7. Metal Cutting –turning	4 P
8. Metal cutting- theory	4 P
9. The viscoelastic properties of polymeric materials	5 P
10. Glas transition and melting point of polymers	5 P
11. Plastics materials	5 P
Σ :	**50 P**

Ranking :
3 ≥ 40 % (20 P)
4 ≥ 60 % (30 P)
5 ≥ 75 % (37,5 P)

Notice: During the exam a **type-approved calculator** (*typgodkänd räknare är tillåten*) and an English-Swedish dictionary (or the wordlist) is allowed. The periodic system and 4 pages with formulas are included in the exam handout **- nothing else is needed!**

Göteborg, August 11th, 2008

Good luck !! **Uta & other teachers**

1. Atomic structure and interatomic bonding (4 P)

a) Give the electron configurations for the following ions: P^{5+}, P^{3-}, Ni^{2+}, and Cu^{1+}.(1 P)

b) Potassium iodide (KI) exhibits predominantly ionic bonding.

(i) Describe ionic bonding! (1 P)
(ii)The ions have electron structures that are similar to which two inert gases? (0.5 P)

c) What type of bonding would be expected for the following materials:

(i) solid xenon (ii) calcium fluoride (CaF2)
(iii) bronze (iv) cadmium telluride (CdTe)
(v) rubber and (vi) tungsten? (1.5 P)

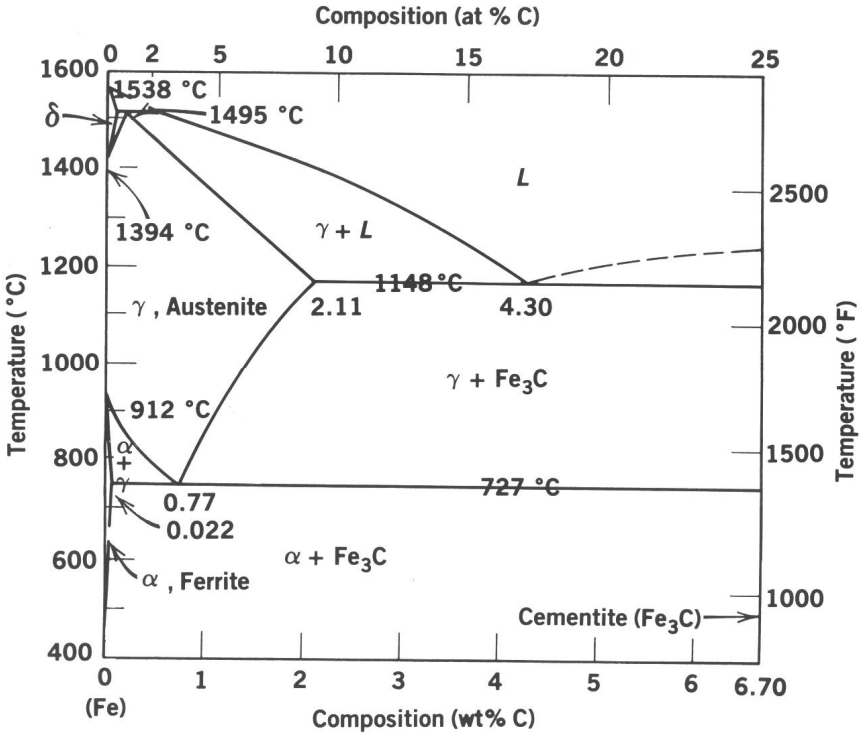
2. Phase diagrams (6 P)

a) Make a sketch of a eutectic phase diagram and explain the microstructural changes at the various (most important) compositions! (2 P)

b) For a Fe – 3 wt% C alloy at a temperature around the eutectoid temperature determine

(i) the fractions of total ferrite and cementite phase. (1 P)
and their composition (1 P)
(ii) the fraction of pro-eutectoid cementite. (1 P)

c) Sketch the microstructures of Fe – 3 wt% C at 1000°C. (1 P)



3. Mechanical properties (4 P)

a) When doing a tensile test, elastic deformation and plastic deformation occurs. Explain with respect to the atomic structure what is happening in the different regimes. (1 P)

b) What is a slip system? Describe briefly! (1 P)

c) The brittle-ductile transition temperature is important to know with respect to application. How can it be determined? What does it mean when a material behaves brittle/ductile? (2 P)

4. Electrical properties (3 P)

a) Make a sketch of the electron energy band structure of metal and a semiconductor. (1 P)

b) The figures below illustrate the variation of electrical conductivity with temperature of different metals (left hand side) and of silicon (right hand side). Explain the differences for the two types of materials. (2 P)

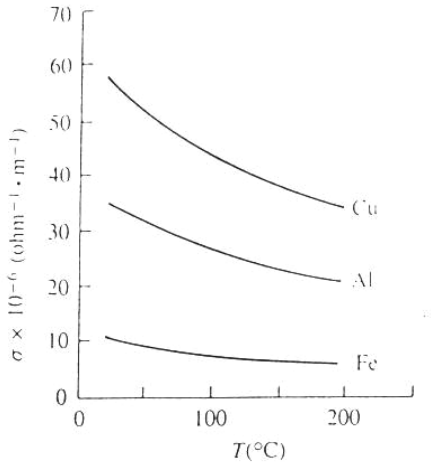


FIGURE 2 *Variation in electrical conductivity with temperature for some metals.*

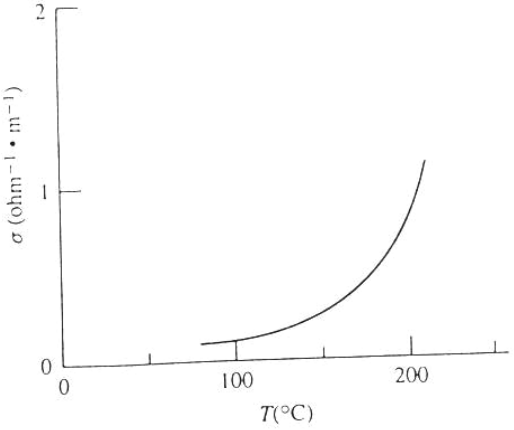


FIGURE 3 *Variation in electrical conductivity with temperature for semiconductor silicon.*

5. Plastic behaviour of metals (7 P)

Describe shortly plastically behaviour of metals by answering the following:

a) Describe shortly with clear sketches two simplifications of the true stress-strain curve (also called work hardening/strain hardening curve (deformationshårdnads kurvan)). (2 P)

b) When are these two simplification valid? What kind of plastic machining processes? (1 P)

c) What does the recrystallization temperature mean? (1 P)

d) Describe very shortly the principal differences between warm and cold metal forming when it comes too material behaviour which is controlled by the strain-hardening exponent (deformationshårdnads exponenten). (2 P)

e) Give a rough value of the exponent in these two forming methods. (1 P)

6. Unconventional machining methods: Abrasive waterjet machining (3 P)

Describe the function of the so called cutting head (skärhuvud) for abrasive waterjet cutting. Draw a figure of the cutting head. Also name at least three process parameters. (3 P)

7. Metal Cutting –Turning (4 P)

A shaft is to be turned from diameter 100 mm down to 86 mm (in several cuts). The length of the shaft is 300 mm. The specific cutting force for the material is to be found in the table below. An indexable insert with four cutting edges, rake angle (ställvinkel) of 45 degrees and nose radii of 1.2 mm is to be used. The recommended cutting data for this insert are; cutting speed (skärhastighet) 200 m/min and feed (matning) 0.35 mm/rev. These cutting data also corresponds to the required surface roughness on the final part. The maximum cutting force for this tool is limited to 2700 N in this case mainly due to the weakness of the machine and tool holder.

h_D [mm]	k_c [N/mm^2]
0,063	3150
0,100	2900
0,160	2700
0,250	2500
0,400	2350
0,630	2150

Calculate the minimum possible total engagement time (ingreppstid) for this turning operation. (5 P)

8. Metal cutting- theory (4 P)

Give the name and draw a sketch of the four (4) most common machining operations that can be performed on a lathe. (5 P)

9. The viscoelastic properties of polymeric materials (5 P)

a) A dominating aspect of the mechanical properties of polymeric materials is the viscoelasticity. What is usually meant by the context of viscoelasticity here? For a given polymeric material, what two aspects are most important for the rate of viscoelastic deformation? Answer with a few sentences, no need for long answer! (2 P)

b) Describe the context of creep and relaxation briefly! Also here, an answer in one to three sentences for each of the process should be enough! (3 P)

10. Glas transition and melting point of polymers (5 P)

a) Describe what happens at the glas transition temperature and the melting point of a polymeric material! Guidence: Focuse your desciption on what happent with the polymer molecule. (2 P)

b) Draw a figure describing the specific volume of an amorphous polymer! (1 P)

c) Give the names and make a simple sketch of the general crystal types that can be found in polymers! (2 P)

11. Plastics materials (5 P)

a) Which polymers are referred to with Commodity Plastics? Give full names for the polymer! (1 P)

b) Give full names of two engineering plastics and explain for each of the materials what material properties that motivates the substantially higher price! (3 P)

c) Give four products or applications made of the commodity plastics! (1 P)