*Chalmers* *Kursnr.: MMK 072*
*Material och tillverkningsteknik*

# Exam in Material och tillverkningsteknik, May, 29th, 2008

**Examiner:** Uta Klement (772 1264 or 0730 794 281))
Antal Boldizar (772 1314)
Gustav Holmqvist (772 5026)
Anders Kinnander (772 5828)
Per Öhl (772 5771)
The answers will be posted on Friday, May 30th 2008.
The results of the exam will be available via studieportalen (3 weeks after the exam).
Checking (*granskning*) of the corrected exams: Wednesday, June 18th, between 10:30 and 11:30h at the department (next to *studiehallen*) and in September (date to be announced).

**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. Polymeric materials | 9 P |
| 2. Applications of thermoplastics | 6 P |
| 3. Metal Forming | 7 P |
| 4. Phase diagrams | 6 P |
| 5. Electrical properties | 3 P |
| 6. Atomic bonding | 5 P |
| 7. Mechanical properties | 3 P |
| 8. Electric Discharge Machining | 3 P |
| 9. Metal Cutting economy | 5 P |
| 10. Metal cutting theory | 3 P |
| | **Σ : 50 P** |

**Ranking :**
3 ≥ 40 % (20,5 P)
4 ≥ 60 % (30,5 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 (*ordbok eller ordlist*) is allowed. The periodic system and 4 pages with formulas are included in the exam handout **- nothing else is needed!**

Göteborg, May 26th, 2008

**Good luck !!**

**Uta & other teachers**

## 1. Polymeric materials (9 P)

a) Explain the interrelation between the concepts of monomer, mer and polymer (Swedish: monomer, repeterande enhet och polymer)! (1 P)

b) Show with a simple figure how a molecular mass distribution of a commercially available thermoplastic can be represented! Also, indicate in the figure where the number average and the weight average mean molecular mass can be located! (2 P)

c) Show with two simple sketches how the shape of a polymer chain in the melt state can change from a non-stressed shape to a stressed shape! Give two terms used for describing such a state of deformation of a polymer chain! (2 P)

d) Give the name of the two thermal transitions that can be found for polymeric materials! What happens with the polymer structure at each of these two transitions? For each of the four types of polymeric material, how can the basic temperature range of application be defined based on the transitions? (4 P)

## 2. Applications of thermoplastics (6 P)

a) Give five examples of thermoplastic polymeric materials used for packaging of food and drink products! (1 P)

b) Name and briefly describe four forming techniques, commonly used for such packaging products made of thermoplastics! ( 2 P)

c) Give six general properties that are in favour of thermoplastics commonly used for packaging of food and drink products! (3 P)

## 3. Metal Forming (7 P)

In the plasticity theory one mainly solves forming problems by firstly dividing them in one of three calculation groups. The first group includes all cylindrical symmetrical problems while in the last (third) group all "three dimensional problems" are included where the complete von Mises yielding criterion has too be used to calculate the effective stress.

a) Give the name of the second basic forming method group. (1 P)

b) Describe shortly what's so special with this second group considering especially the stress/(spänning) and strain/(töjning) situation. Be clear which directions you are referring too. (2 P)

c) Which two outer process requirements/(yttre förutsättningar/krav) (two out of three) have too be fulfilled to categorise this forming method to the second group. (2 P)

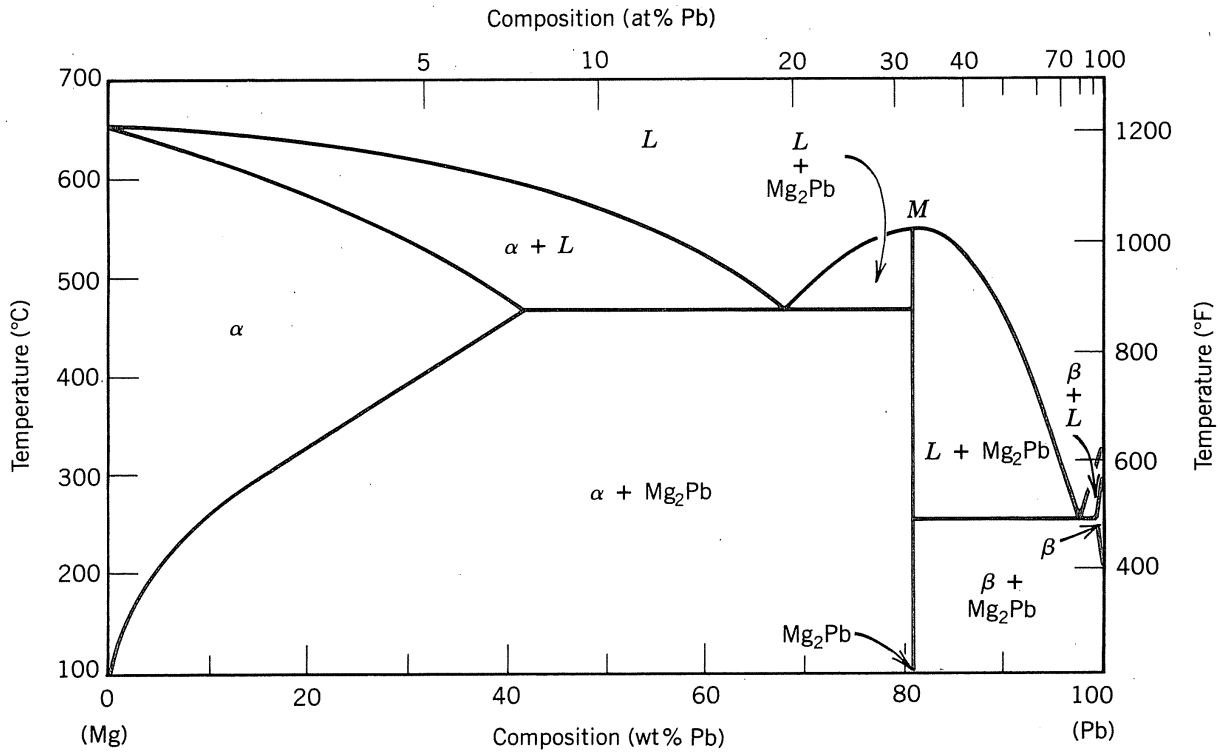
d) Give examples of two (out of three) metal forming methods that fits into this second group. (2 P)

## 4. Phase diagrams (6 P)

a) Below you find the Mg-Pb system. What type of reactions do you find in the phase diagram? Name them (for example peritectic reaction) and describe the reaction (for example ($\alpha + L \leftrightarrow \gamma$)! (1 P)

b) Make sketches of the microstructure at 200ºC with
   (i) Mg – 40wt.% Pb
   (ii) Mg – 75wt.% Pb
   (iii) Mg – 82wt.% Pb
   (iv) Mg – 90wt% Pb (2 P)

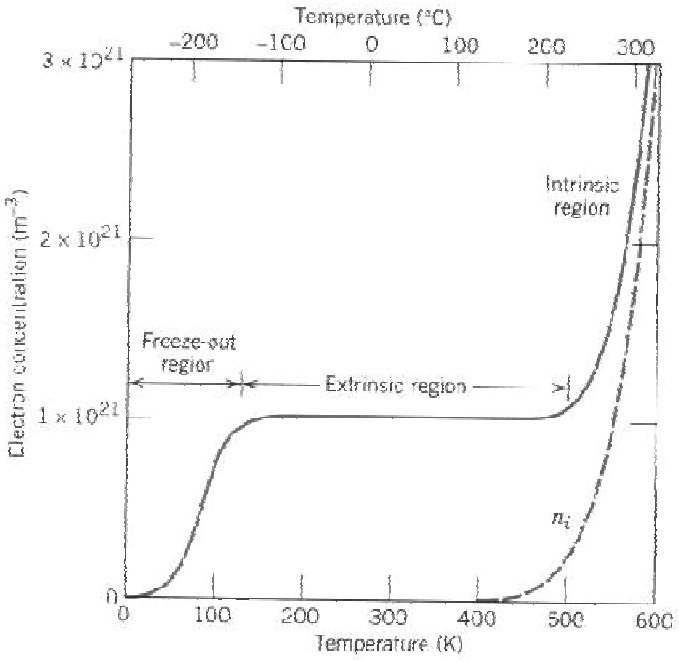
c) Determine the phases present, their composition and their phase amounts
   (i) for Mg – 50 wt.% Pb at 500°C (1 P)
   (ii) for Mg – 50 wt.% Pb at 400°C (1 P)
   (iii) for Mg – 90 wt.% Pb at 200°C (1 P)




## 5. Electrical properties (3 P)

a) What is affecting conductivity in metals? Give 3 influencing factors and state which one is least/most affecting conductivity. (1 P)

b) Explain the figure below and describe what it means for the use of intrinsic/extrinsic semiconductors in our computers. (2 P)




## 6. Atomic bonding (5 P)

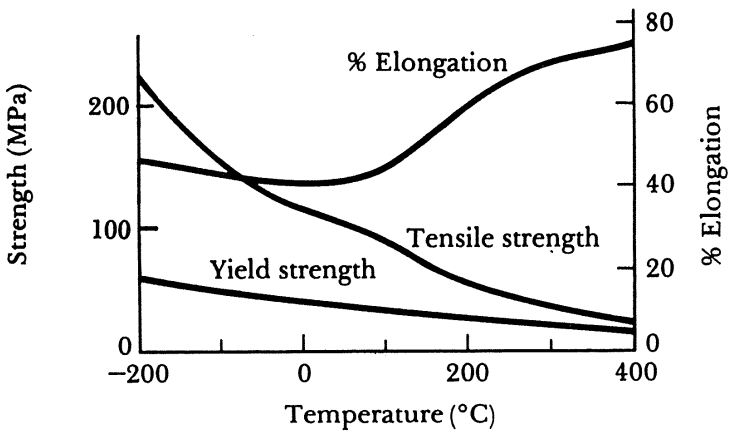
a) Describe briefly ionic and covalent bonding and give an example of a material having that type of bonding! (2 P)

b) What is the difference to van-der-Waals bonding? For which of material(s) do we find that type of boding? (1 P)

c) Sketch the curve of potential energy versus interatomic spacing for materials with (i) ionic and (ii) van-der Waals bonding. Briefly explain the difference! (2 P)

## 7. Mechanical properties (3 P)

Below you find a figure where for an Al alloy strength/elongation is related to temperature. Describe what it meant with yield strength and tensile strength and describe the figure! (3 P)



**8. Unconventional machining methods: Electric Discharge Machining (3 P) (Gnistbearbetning)**

In Electric Discharge Machining are used dielectric fluids (dielektrikum). What purposes does the fluid have, or what specific properties are suitable for the fluid? Also include in your answer some example of a fluid used in EDM (3 P)

**9. Metal Cutting economy (5 P)**

Your company is going to do external turning (svarvning) of steel rings. The unmachined (obearbetade) rings have an outer diameter of 350 mm. The rings shall be turned (svarvade) in one cut (i ett snitt) to an outer diameter of 345 mm. The length of the rings is 175 mm. The feed rate (matningshastigheten) is set to 0,3 mm/rev. after a recommendation from the tool supplier. At this feed rate, a cutting speed of 300 m/min gives a tool life of 15 min. The triangular indexable (vändbara) insert have a cost of 140 kr each. The tool holder has a cost of 1500 kr and has a lifetime of 500 cutting edges.

Other information given is:

$\alpha = 0{,}25$
Machine cost: 800 (sek/h)
Time to change cutting edge: 1 min
Time to set up and take down rings: 30 s

Your task is:

a) If the cutting speed is reduced from 300 m/min to 250 m/min, how will the machining cost change? (3 P)

b) Calculate the minimum machining cost. (2 P)

**10. Metal cutting theory (3 P)**

Define the six angles of a turning tool and describe how they effect the machining and the properties of the tool.