

Institutionen för Ingenjörsvetenskap

## TENTAMEN

Kurs: **Moderna tillverkningsteknologier och tillämpningar A1N**

Delkurs: *Skriftlig tentamen*

Kurskod: *VP772A*

Datum: *02 juni 2026*

Högskolepoäng för tentamen: *4 hp*

Skrivtid: *14.15-18.30*

Ansvarig lärare: Rohollah Ghasemi

Berörda lärare: Rohollah Ghasemi, Tobias Andersson, Mahdi Eynian

Examinator: Tobias Andersson

Tillåtna Hjälpmedel: Skrivhjälpmedel och miniräknare

- Anvisningar
- ☒ Alla svar ska skrivas på svarsbladet i tentamenstesen.
  - ☒ Skriv namn och personnummer på samtliga inlämnade blad.
  - ☒ Endast i undantagsfall görs kompletteringar på numrerade lösblad.
  - ☒ Använd inte röd penna.
  - ☒ Markera med kryss på omslaget vilka uppgifter som är lösta.

Poänggränser:

| Betyg | Poäng     | Procent    |
|-------|-----------|------------|
| A     | 18–20 p   | 90–100 %   |
| B     | 16–17.5 p | 80–89 %    |
| C     | 14–15.5 p | 70–79 %    |
| D     | 12–13.5 p | 60–69 %    |
| E     | 10–11.5 p | 50–59 %    |
| F     | 0–9.5 p   | Under 50 % |

Svar kan ges på svenska eller engelska! Totalt innehåller tentamen 12st frågor!

**Skrivningsresultat offentliggörs inom 18 arbetsdagar!**

*Lycka till!*

Antal sidor totalt 19

### **Crystal Structures**

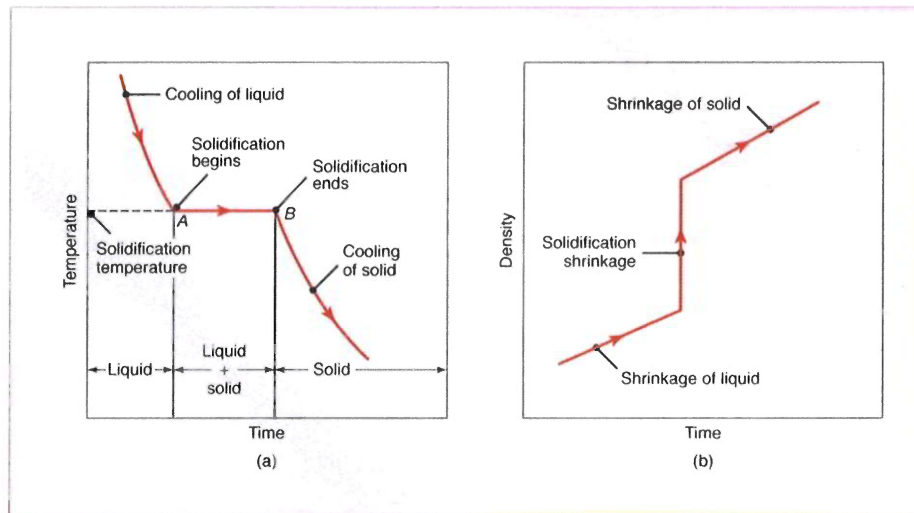
1. Crystal structure defines the properties of the materials.
  - a) Draw the unit cells for Body-Centred Cubic (BCC) and Face-Centred Cubic (FCC) structures
  - b) Briefly explain what is the coordination number in the atomic unit cells
  - c) Calculate the atomic packing factor (APF) of these two metallic lattices

### **Hardening Mechanisms**

2. Sketch a vacancy point defect and a substitutional impurity defect. In your sketch, illustrate the concept of "stress fields" created by these defects in the surrounding lattice?

### **Metal Casting**

3. In metal casting after pouring the molten metal into a mould shaped, allowing it to harden, and removing it from the mould.
  - a) Sketch a standard metal casting gating system, labelling the pouring cup, sprue, runner, and riser.
  - b) State the two main fluid flow principles used to design these gates
  - c) Which casting method is normally used for jewellery production and why (advantageous and disadvantageous)?
4. Compare expendable mould casting and permanent mould casting. What is the key difference between them? Give two examples of each type.
5. The diagrams below illustrate the solidification behaviour of a pure metal. Diagram (a) shows the temperature-time cooling curve, while Diagram (b) tracks the corresponding changes in density over time during the same cooling process.



- Describe the connections between these two plots?
- Why does the temperature remain constant Along the horizontal plateau between Point A and Point B despite continuous heat extraction?

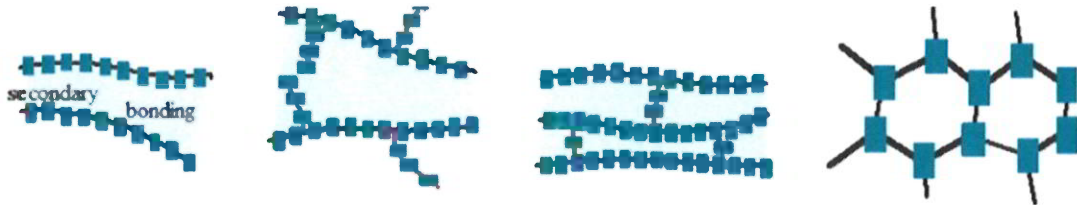
### Heat Treatment

- Heat treatment is one of the important process technologies used in industries.
  - Name the three processes of heat treatment for steel alloys.
  - Select one process and describe the process in details and mention the general purpose of this process?
- After heating the steel alloys to the austenitic region, the cooling rate “slow cooling”, “moderate cooling”, and “rapid quenching” significantly affects the final microstructure and properties of the heat-treated steel. Identify and make a sketch of the microstructures formed under slow, moderate, and rapid cooling from austenite.

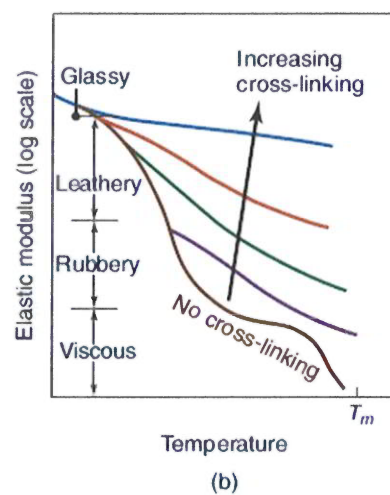
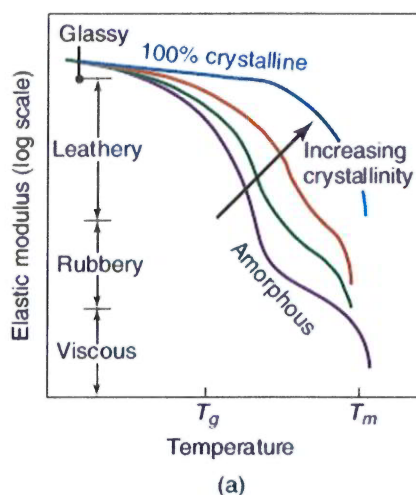
### Polymer Materials

- The diagram below outlines the four primary types of polymer structures based on molecular shape: Linear, Branched, Crosslinked, and Network polymers.

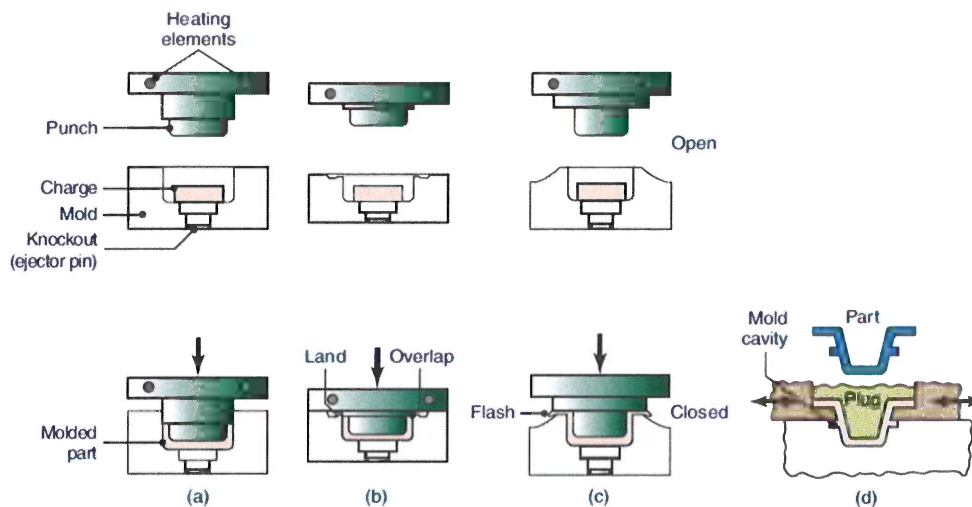
Using your knowledge of polymer chemistry and materials science, answer the following questions:



- Briefly describe the structural characteristics of each of the four polymer types shown in the image. For example, in your description, highlight the nature of the bonding (e.g., covalent vs. secondary van der Waals forces) that holds the individual chains or units together.
- Compare and contrast how these four molecular shapes influence the physical properties of the material such as density, melting temperature, mechanical properties, corrosion resistance.
- Provide one real-world material example for one of the four categories and explain how its specific molecular shape directly makes it suitable for its commercial application
- What do the following diagrams show and how it affects your decision to select the proper polymer materials for higher temperature engineering applications?



9. This image presents the operational sequences and different configurations of a process used in polymer manufacturing technology.
- Describe the process in details including both advantageous and disadvantageous?
  - From a manufacturing efficiency standpoint, why might a process engineer select a flash mould over a positive mould despite the material waste?
  - What additional secondary manufacturing operation must be performed on the part before it can be delivered as a finished product?



## Machining

10. About machining:

- Define conventional machining
- List the reasons that machining operations may be required.
- Describe the tool-workpiece relative movements for the following machining operations: Turning, Drilling, and Milling. Include simple sketches with your answer

## Laser welding

11. What are the two primary modes of laser welding, and how do they differ in terms of power density and energy absorption?

### **Mechanical Testing**

12. A cylindrical metal specimen with an original diameter of 12.8 mm is subjected to a tensile force of 5,000 N. If the material is operating within its elastic region and has a Modulus of Elasticity (E) of 200 GPa, calculate the resulting yield strength ( $\sigma$ ) and elastic strain ( $\epsilon$ ).

$$E = \sigma / \epsilon$$

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**ANSWER SHEET FOR:** (Name) \_\_\_\_\_

(Pers-nr) \_\_\_\_\_ (Program/Independent) \_\_\_\_\_

**1.**  
**(3p)**

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**2.**  
**(1,5p)**



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**3.**  
**(1,5p)**

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**4.**  
**(1,5p)**



HÖGSKOLAN  
I SKÖVDE

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**5.**  
**(1,5p)**

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**6.**  
**(1,5p)**

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**7.**  
**(1,5p)**

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**8.**  
**(2p)**

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**9.**  
**(1,5p)**



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**10.**  
**(1,5p)**





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**11.**  
**(1,5p)**

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**12.**  
**(1,5p)**