UNIVERSITY
OF SKÖVDE

School of Engineering Science

# WRITTEN EXAMINATION

Course: Material Processing Technology

Sub-course: Written Examination

Course code: MT508G

Credits for written examination: 2 ECTS

Date: 2024-02-23

Examination time: 08.15-12.30

Examination responsible: Dr Lennart Y. Ljungberg (Assoc. Professor)

Teachers concerned: Mahdi Eynian

Aid at the exam/appendices: A "mathematical formula table" or a "table for mathematics combined with chemistry and/or physics" and a "language dictionary"

The answers to the questions can be found in the related areas in the course book or the handouts given in the brackets after each question.

Note: L.Y. Ljungberg and M. Eynian can be contacted by telephone through the examination attendants.

Instructions:

- ☐ Take a new sheet of paper for each teacher.
- ☐ Take a new sheet of paper when starting a new question.
- ☒ Write only on one side of the paper.
- ☒ Write your name and personal ID No. on all pages you hand in.
- ☒ Use page numbering.
- ☒ Don´t use a red pen.
- ☒ Mark answered questions with a cross on the cover sheet.

Grade points:
Maximum: 18p

Passed (G): 10 p or more
Not Passed < 10p

Examination results should be made public within 18 working days!

*Good luck!*

Total number of pages 5

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## Part A. Quantitative problems. Motivate and show your calculations. 3 p per task! See the formulas in the end of this examination!

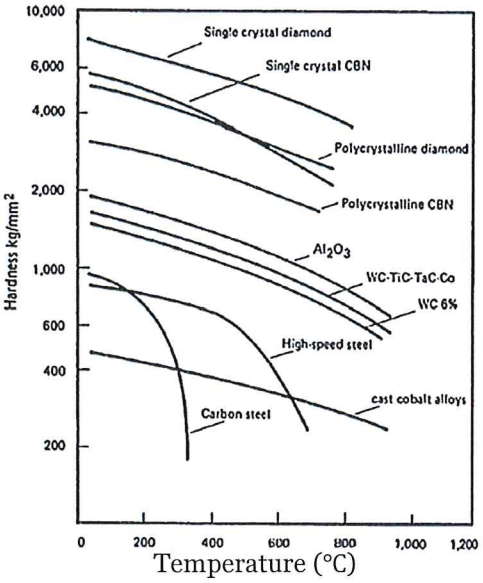
1. Let n = 0.25 in the Taylor equation for tool wear for cutting cast iron at a depth of cut of 3 mm and feed rate of 0.1 mm. Calculate the change of **a)** the tool life and **b)** the volume of material that can be removed before the end of tool life if you use condition 2 instead of condition 1 in machining:
   a. Condition 1, the cutting speed is 100 m/min.
   b. Condition 2, the cutting speed is 125 m/min.

   (S3)

2. Estimate the cutting temperatures for machining of
   **a)** steel with a cutting speed of 200 m/min,
   **b)** titanium Ti6Al4V with a cutting speed of 30 m/min, and
   **c)** titanium Ti6Al4V with a cutting speed of 200 m/min.

In all cases, the uncut chip thickness $t_0$ of 0.08 mm and tungsten Carbide tools (WC for titanium and WC-TiC TaC Co for steel) are used. **Make sure that you use compatible SI units.**

**What is your conclusion?** Explain considering the plot on the right that shows the hardness of cutting tool materials versus cutting temperature. (S3)




The relevant material properties for steel and Ti6Al4V is also shown.

| | **Steel** | **Titanium Ti6Al4V** |
|---|---|---|
| Flow stress $Y_f$ [MPa] | 325 | 250 |
| Thermal diffusivity $K$ $\left[\frac{\mathrm{m}^2}{\mathrm{s}}\right]$ | $14 \times 10^{-6}$ | $2.87 \times 10^{-6}$ |
| Volumetric specific heat $\rho c$, $\left[\frac{\mathrm{N}}{\mathrm{m}^2 {}^{\circ}\mathrm{C}}\right]$ | $3.3 \times 10^{6}$ | $2.33 \times 10^{6}$ |

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## Part B. Qualitative problems. Motivate your answers and if possible draw figures, even when this is not required! 3 p per task!

3. Describe briefly six tool life criteria in production. (Handout 4 )
4. Explain with figures the following three machining operations: Chamfering, facing and knurling. (Handout 1)
5. Draw simple figures and briefly explain the following three processes: Plasma cutting, EDM (Electrical Discharge Machining) and EBM (Electron Beam Machining). (Handout 2)
6. Explain with three examples how you can reduce Machine Tool Vibrations. (Handout 3)
7. Chose three common metals that can be easily cut by traditional turning operations. Describe the typical properties of the metals and possible problems to be aware of during the cutting process. (Handout no 5)

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**APPENDIX**:

SOME FORMULAS AND FIGURES RELATED TO MATERIAL PROCESSING

Taylor tool life equation $VT^n = C$

Mean temperature increase considering workpiece material properties:

$$T = 3.8 \frac{Y_f}{\rho c} \sqrt[3]{\frac{V t_0}{K}}$$

( with units: $T = 3.8 \frac{Y_f[\mathrm{Pa}]}{\rho c\left[\frac{\mathrm{N}}{\mathrm{m^2 {}^\circ C}}\right]} \sqrt[3]{\frac{V\left[\frac{\mathrm{m}}{\mathrm{s}}\right] t_0[m]}{K\left[\frac{\mathrm{m}^2}{\mathrm{s}}\right]}}$ )

Mean temperature vs. feed and cutting speed $T_{mean} \propto V^a f^b$

| **Cutting Tool Material** | $a$ | $b$ |
|---|---|---|
| Tungsten-Carbide | 0.2 | 0.125 |
| High-Speed Steel | 0.5 | 0.375 |

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