



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: 2026-02-24

Examination time: 08.15-12.30

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

Teachers concerned: Mahdi Eynian and Tobias Andersson

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!



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Good luck!

Total number of pages 4

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

1. Let $n = 0.625$ in the Taylor equation for tool wear for cutting of steel at a depth of cut of 3 mm and feed rate of 0.25 mm. Compare the volume of material that can be removed before the end of tool life in two cases,
 - Case 1, the cutting speed is 200 m/min
 - Case 2, the cutting speed is 300 m/min(S3)
2. In an orthogonal cutting operation F_t (Trust Force, Passive Force) is measured at 300 N and F_c (cutting force, tangential force) is measured at 1000 N. The uncut chip area A_c is 2 mm² and the rake angle is $\gamma_{ne} = 10^\circ$. Assuming the theory of Ernst and Merchant,
 - a) evaluate the friction angle β
 - b) estimate the shear plane's angle ϕ (in degrees) based on Ernst and Merchant's theory
 - c) estimate the shear plane's area A_s in mm²
 - d) calculate the resultant force F_r
 - e) estimate the shear force at the shear plane F_s .
 - f) estimate the shear stress at the shear plane τ_s in MPa.

Reminder: if your calculator calculates trigonometric functions (sine, cosine, tan,...) using **radian**, make sure that you convert your variables from degrees to radians by multiplying to $\pi/180^\circ$, alternatively, you can often change your calculator settings to work with degrees.

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

3. List reasons that machining operations may be required, and provide an example for each reason. (S1)
4. Tool life can be almost infinite at low cutting speeds. Would you then recommend that all machining be done at low speeds? Explain. (S1)
5. Explain the consequences of allowing temperatures to rise to high levels in cutting.



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6. Advanced machining methods.

- a) Explain the main principles of Chemical milling. (Ch 27.2)
- b) Draw a simple sketch showing the principles for an Electrochemical Machining process (Fig 27.6).
- c) Explain in what kind of machining area “MEMS” refers to. (Ch 29.1)

7. Tools.

Draw a simple picture of a cutting tool and show three wear problems (out of four):

- Flank wear
- Crater wear
- Notch wear
- Nose radius wear

(H4)



Appendix: Formulas in material processing

Taylor tool life equation $VT^n = C$

Mean temperature increase considering workpiece material properties:

$$T = 3.8 \frac{Y_f}{\rho c} \sqrt[3]{\frac{Vt_0}{K}}$$

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 |

Figure related to question A2:

| | |
|---|--|
| $\tan(\beta - \gamma_{ne}) = \frac{F_t}{F_c}$ $\Rightarrow \beta = \gamma_{ne} + \tan^{-1}\left(\frac{F_t}{F_c}\right)$ | |
| $A_s = \frac{A_c}{\sin \phi}$ | |
| $\theta + \frac{\pi}{2} - \beta + \gamma_{ne} = \frac{\pi}{2} \Rightarrow \theta = \beta - \gamma_{ne}$ | |
| <p>Ernst and Merchant's theory In radians</p> $\phi = \frac{\pi}{4} - \frac{\beta}{2} + \frac{\gamma_{ne}}{2}$ <p>In degrees</p> $\phi = 45^\circ - \frac{\beta}{2} + \frac{\gamma_{ne}}{2}$ | |
| $F_c = F_r \cos(\beta - \gamma_{ne})$ $F_r = \frac{F_s}{\cos(\phi + \beta - \gamma_{ne})}$ $F_s = \tau_s A_s$ | |