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Cover sheet with information to the invigilator

School of Engineering Science

Course: Material Processing Technology

Sub-course: Written Examination

Course code: MT508G

Credits for written examination: 2 ECTS

Date: 2024-01-10

Examination time: 14.15-18.30

Available teacher: Assoc. Prof. L.Y.Ljungberg and Assoc. Prof. M. Eynian

Available on phone number: 0500-448514, or 070 932 1984 L.L. and 0720070325 M.E.

Visiting the examination ☐ Yes ☐ No

Aids and other information for invigilators:

- "Mathematical handbooks" or a table for "mathematics/chemistry/physics" and a
- "Language dictionary" are OK to use for the students!

Calculator ☒ Provided by the University ☐ Student's own calculator ☐ Not allowed

Writing paper ☒ Lined ☒ Squared

If you copy the exam papers yourself, provide the number of copies

Instructions to examinations responsible

All examination documents are to be handed in at Reprocentralen.

- **For copying of examination papers** the originals must be handed in no later than 6 workdays before the examination. The number of copies is filled in by Reprocentralen in the field below.
- **Copied examination papers** must be handed in no later than 3 workdays before the examination. Please notify the examination administration in due time when the papers will be handed in. Examination papers are to be handed over directly to the staff at Reprocentralen (not through mail). If you copy the exam papers yourself, provide the number of copies in the field above.

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WRITTEN EXAMINATION

Course: Material Processing Technology

Sub-course: Written Examination

Course code: MT508G

Credits for written examination: 2 ECTS

Date: 2024-01-10

Examination time: 14.15-18.30

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 4

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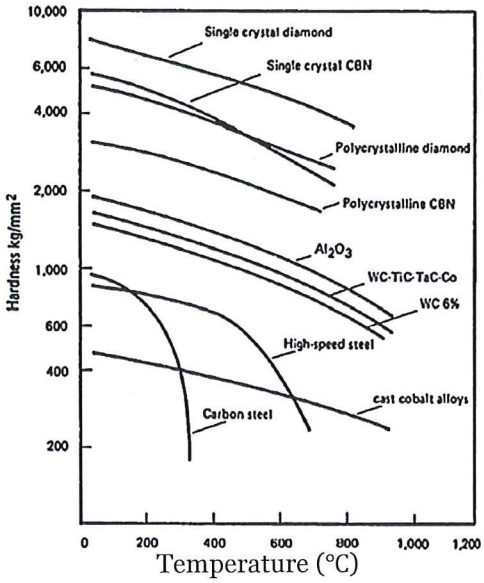
Part A. Quantitative problems. Motivate and show your calculations. 3 p per task! See the formulas in the end of this examination!

1. Let n = 0.5 in the Taylor equation for tool wear for cutting steel at a depth of cut of 5 mm and feed rate of 0.2 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 for material removal:
   a. Condition 1, the cutting speed is 150 m/min.
   b. Condition 2, the cutting speed is 200 m/min.

   (S3)

2. Estimate the cutting temperatures for the cutting of
   a) steel with a cutting speed of 150 m/min,
   b) titanium Ti6Al4V with a cutting speed of 25 m/min, and
   c) titanium Ti6Al4V with a cutting speed of 150 m/min.



In all cases the uncut chip thickness of 0.1 mm is used.

What is your conclusion? Explain. (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 $\left[\frac{\mathrm{m}^2}{\mathrm{s}}\right]$	14×10^{-6}	2.87×10^{-6}
Volumetric specific heat ρc, $\left[\frac{\mathrm{N}}{\mathrm{m}^2{}^\circ\mathrm{C}}\right]$	3.3×10^{6}	2.33×10^{6}

A plot showing the strength of various cutting tool materials at various temperatures is shown below:

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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. Explain how a cutting fluid is built up (composed) and explain how it is possible to prolong the lifetime for a cutting fluid. (Handout 4 and Ch 22.12)

4. Explain the three cutting forces with a simple figure related to e.g. a turning process. Also show the *Resulting force*! (Handout 1)

5. Draw a simple curve describing the measure of tool flank wear vs time. Show especially the *Steady state region*, *Break-in period* and the *Failure region.* (Handout 4)

6. Advanced machining methods.
   a. Describe one specific type of a Hybride Machining System. (Ch 27.10)
   b. Draw a simple sketch showing the principles for Electrical Discharge Machining (Ch 27.5).
   c. In Electrochemical Machining processes, the Material-Removal Rate: $MRR = C \times I$ is sometimes used. Explain the meaning of C and I. (Ch 27.3)

7. Tools.
   Explain/Describe:
   a. Stable vs Unstable zones in order to avoid chatter/vibrations in a cutting process with cutting tools. (Handout no 3)
   b. Two examples of tool fracture types. (Handout no 4)
   c. The main differences between traditional Steel and High speed steel (HSS) in cutting tools. (Handout no 4)

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

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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