ANSWERS (Mostly not complete answers but guidance)

CHECKING
Exam in Modern Manufacturing Processes MPR 033

Date: 2007-10-26

Time: 14.00-18.00

Examiner: Gustav Holmqvist, tel. 5026, 0709-393275

Checking: Checking of your exams can be made 2007-11-15, 12.30-13.15, at the department, 2nd floor, staircase A, M-building.

Grading Fail: 0-19,5p, 3: 20-29,5p, 4: 30-39,5p, 5: 40-50p

ECTS grading: Fail: 0-19,5p, E: 20-22p, F: 22,5-28p, C:28,5-34p, B: 34,5p-43,5p, A: 44-50p

1. Surface Topography

a) How can the tip of a stylus be used as a mechanical filter? Lecture slide 48 (1,5 p)

b) What is *skewness* (Rk) and how can that give complementary information to the average roughness (Ra) of a surface topography? (2,5 p)

a) Stylus has a radius: will not go down into the deepest vallies, narrow features

Increasing stylus Radius ⇒ Decreasing Roughness values.

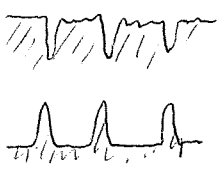
Metal forming

2. Drawing is one of the fundamental processes within sheet metal forming.

a) What type of parts can be manufactured by this process? Exemplify! (1p)
b) Explain the principle for a typical drawing operation (with a sketch!). (2p)
c) Which material properties are the most important for the drawability? (2p)

See encl. page last ⇒...

→ 1b) Measures the assymetry of a surface
Negative value indicates good bearing property.



3. Bending

There are some important factors to consider when bending is used to form sheet metal. Describe briefly the practical meaning of the following five factors. Also describe which parameters (such as material and process parameters) that may influence each of them and/or how these effects can be minimised.

a) Springback (1p)
b) Workpiece length (1p)
c) Crack initiation at the outer edges (1p)
d) Minimum permissible bend radius (1p)
e) Bending near holes (1p)

See encl. page last →

4. Hydroforming

a) What are the *advantages* of hydroforming? For full scoring three different areas of advantage should be mentioned and explained shortly. (3 p)

Economy: Nr of operations, nr. of parts, tooling cost

Design: Flexibility, Complex shapes

Weight/Strength/Quality:
- Design, uniform deformation/plastic
- Nr of parts, optimised design

b) What are the *disadvantages* of hydroforming? Mention four different disadvantages or explain shortly two different disadvantages. (2 p)

Cycle time

Further joining

Lubricants – cool..

Not general when it comes to shapes

Limited knowledge

Limited nr of equipm.

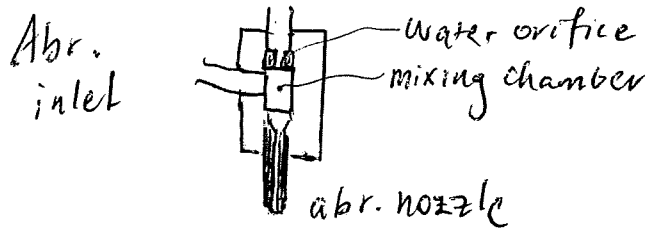
5. Abrasive Waterjet Cutting

a) Define and explain at least three geometrical defects one might find on an abrasive waterjet cut part. For two of the errors you should also explain its cause.

(Explanation of *geometrical defect*: form errors or geometrical errors which are NOT part of the surface topography). (3 p)

Conicity / Taper
Burrs
Edge (top) rounding due to jet spreading
Jet lag defects ≠ Corners / Entry exits
Lower part of jet →

b) Describe how the abrasive waterjet is formed, using the traditional (injection) technique. Make a sketch of the cutting head. The pump unit does NOT need to be explained. Also shortly describe what constitutes the jet (what does it contain?) after leaving the nozzle. (2 p)



The jet contains
water droplets
abr. particles
air (= most part)

6. Laser Cutting

Laser light has to be transmitted from the laser source to the cutting head. There are two different laser types, commonly used for cutting, which use two different methods for transmission of the laser light.

a) Which are the laser types (laser media)? (1 p)

CO_2 Nd YAG (or YAG)

b) What two different methods (technologies) of transmission of the light do these laser types use, and how does this influence the possibility of automation? Also – what basic property of the laser light is the cause of this difference? (3 p)

CO_2 : Tubing + Mirrors
Nd YAG : Opt. fiber → Easier to use Irb
Nd YAG : λ = smaller

Flame cutting:

c) What specific role does oxygen have when cutting in mild steel? (1 p)

Exothermal reaction → increased energy / speed.

7. Electrical Discharge Machining

a) Describe how conventional EDM works. Include the important parts of the machine and explain how the process works. You do NOT need to explain the electric circuit or the removal mechanisms in detail. (4 p)

Description of
- Tool - workpiece -> Geometry, Control of gap through servo.
- Tool is sinked on to w.p.
- Discharges high frequency AC or DC : Mat removal through heat mostly
- All in dielectric fluid, Isolat. / control of el. break-down / flushing.

+ PLC

b) If comparing EDM and USM: What material property typically explains why a material which can be machined with USM can not be machined with EDM? (1 p)

Electrical conductivity

Metal Cutting

8. Grinding

a) What is difference between conventional grinding and creep-feed grinding? How can creep-feed grinding be more economical? (2 p)

Much larger depth of cut
Much lower feed
Time is saved by diminished nr of stops & reversal.

b) Define the grinding ratio, G. Why is it of economical importance? (1 p)

$G = \frac{MRR\ W.P}{MRR\ Disc}$ ⇒ Cost of gr. discs..

c) Which of the two processes *grinding* and *hard turning* has the highest energy consumption per unit volume removed? In your motivation you should include chip thickness and specific cutting force. (2 p)

Gr. : Small chip thickness
⇒ High spec. cutting force (F_c/A_0) } Grinding highest energy cons.
Loses energy in plowing & rubbing

d) CBN (or PCBN) is a material found as an abrasive in grinding discs, and also in metal cutting tools. Mention one advantage of CBN compared to diamond. (1 p)

- Diamond is heat sensitive especially when maching Fe-based mtrls.

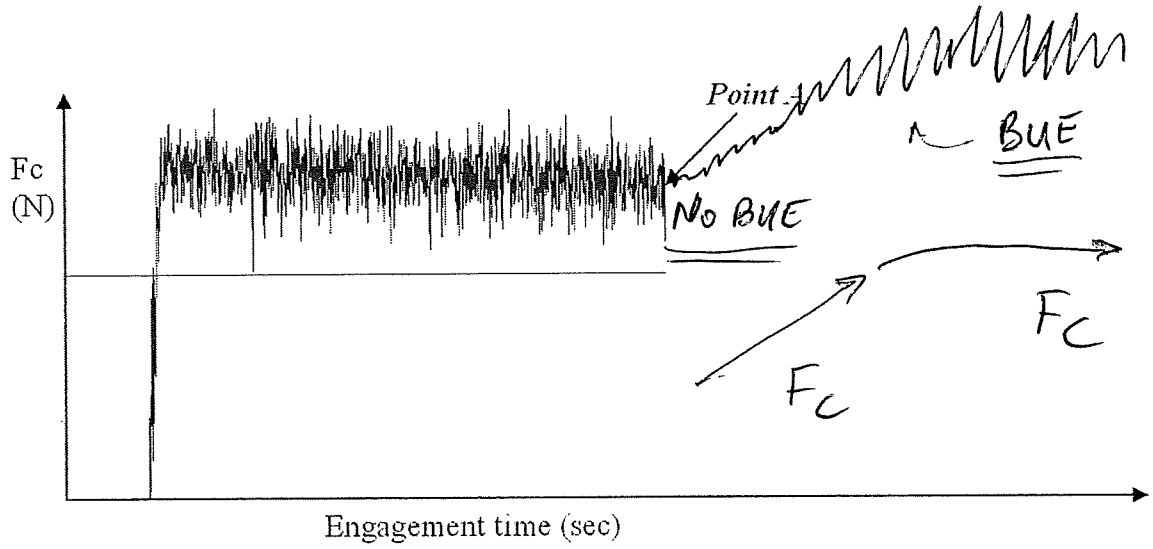
(- Cost)

9. Metal Cutting Fluids

a) What is an emulsion? What ingredients do you always find in an emulsion? (1 p)

oil + water + emulsifier Two phase "system"

b) See figure in below. At ***Point A*** the coolant is switched off by the programme in a CNC machine. Continue to draw the force behavior after point A. Make a new sketch in the hand-in. Explain the mechanism behind what happens. (*Hint:* Think about the tests that you performed in the lab). It does not matter if you use MQL or emulsion in your reasoning. (4 p)



10. High-Speed Machining

a) In HSM one can not just increase the rotational speed and hope for the best. Mention at least *three different things that have to be considered/changed – and how - before starting* to work with HSM. Think for example of the machine, the tool and of parameter settings. (1,5 p)

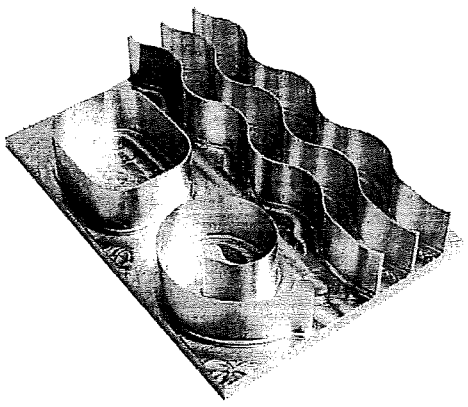
Machine: Stability (vibr.) & Rot speed.
Tool: Balancing, strength (carbide)
Param: cutting depth, Entrance strategies

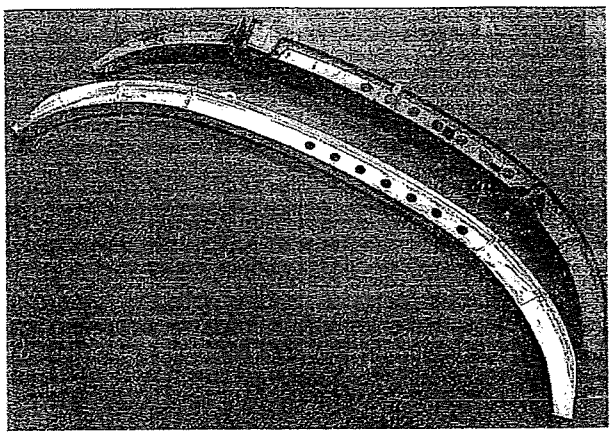
b) Which type of cooling is recommended for HSM? Explain why this is the case. (1,5 p)

Heat generated ⇒ small } Dry / Air or MQL
Intermittent ⟹ }

c) Below pictures exemplify an advantage of HSM in aluminium. What is the advantage and how is this beneficial? (2 p)

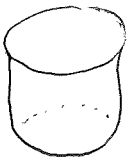
Low F due to small chip thickn.
⇒ thin walls ⇒ design advantages
+ process chain can be shorter.



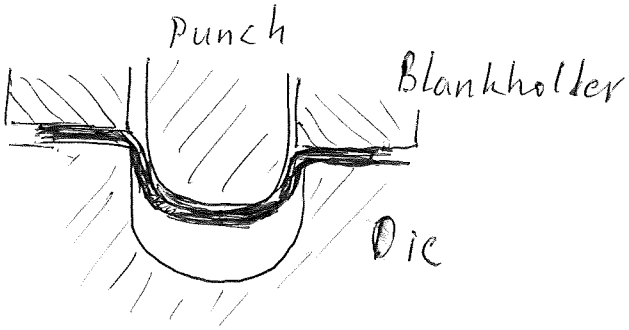


2. Drawing

a) Relatively simple sym. shaped geometries
Cups, Lids, Shells



b)



Blankholder force controls wrinkling but lets the material slide in to the die

c)
- Low yieldpoint in all planar directions of the sheet
- High yieldpoint in the thickness direction.
- High n and m affects positively

- Higher n ⇒ starting necking will be stronger, thus this area will be less deformed than with a lower n.

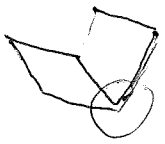
3)

a) Strength of the material (yield point)
Full plastic deformation (bottoming)

b) By bending the workpiece becomes longer
Needs calculation of design & sheet.

c) Tensile
Strain + Burrs ⇒ Cracks
(Burrs: from previous shearing operation)

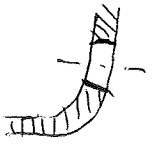
Bending



not good to have burrs here

d) A small radius produces greater strain in the outer fibres of the material. → Try to place the bend perpendicular to the rolling direction.
Min R also depends on thickness.

e) - Shape will be altered



- Punch hole after bending
- Bend R, thickness & distance to bend though important
- Can also chose to change part design.