Answers

KEYWORDS

Exam in Modern Manufacturing Processes MPR 033

Date:	2010-10-19
Time:	14.00-18.00
Examiner:	Gustav Holmqvist, tel. 5026, 0709-393275 Will visit the exam about 15.00 and 16.30.
Ass. Devices:	Approved calculator, pen, pencil, eraser, ruler, and written dictionary.
Credit list:	Will be sent out by e-mail 2010-11-09 ← Note: In 3 weeks !
Checking:	Checking of your exams can be made 2010-11-12, 12.30-13.15, Room Gamma in study hall.
Grading	Fail: 0-19,5p, 3: 20-29,5p, 4: 30-39,5p, 5: 40-50p (Extra points based on your group assignment report will be added to your exam result)

General instructions: For full point you must make clear that you have understood the meaning of your answer. You must show the teacher that you have understood the question and it's answer. Write detailed answers and motivate and explain yourself. Write clearly and readable. Good Luck!

Unconventional machining methods

1. Waterjet Cutting (5p)

a) For abrasive waterjet cutting, point out and very briefly explain three general advantages as well as three general disadvantages. (General means that it can be in comparison to any other method, not only thermal processes).

(3 p)

(+) No HAZ (cold method, small-scale erosion)
Can cut thick dimensions (as long as speed is lowered)
Small jet diam & can move in any direction ⇒ flexible

(−) Low cutting speed
Expensive (pump techn.)
Oxidation due to water

b) For pure waterjet cutting (without the abrasives) how is the jet interacting with the material and thus how is material removed for a non-brittle material as for instance plastics or wood?

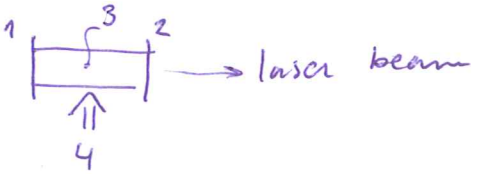
(2 p)

Jet has kinetic energy
⇒ pressure build up on surface on impact
Pressure exceeds material's (shear) strength

2. Laser and Plasma cutting (6p)

a. Explain how a laser source is typically designed. The important thing is that you point out what the main functions are.

(2 p)



1 : Fully refl. mirror
2 : Semi —"—
3 : Laser media
4 : Input energy (excitation)

b. Why are pulsed laser used? In what way can quality of the cut be better with pulsed laser?

(2p)

- In corners at high cutting speed machine will retard (slow down)
- Too much heat
- Pulsing → control of power

c. What purposes do gases have in dual plasma cutting? (2p)

- Inner gas creates plasma = cutting
- Outer is for shielding (from oxidation) &/or cooling

3. Electrical Discharge machining (4p)

a. Describe the function of a wire EDM machine including al necessary functions. You do not have to explain the electrical circuit in detail. (2,5p)

See slide or EDM in binder 6-2-2 – 6-2-3

CNC control of wire (small), wire from spool, Diel. (water) flushing

b. Briefly compare wire EDM to AWJ. Give some disadvantages and advantages of wire EDM. (1,5p)

wire EDM: + Smaller diameter
+ Better tolerance
- Slower in many cases
- Some HAZ (recast layer)

Metal forming

4. Deep drawing (5p)

The table below shows some typical results from the lab. Outgoing from this table…

a. What is the limiting drawing ratio of Mild steel (using oil as lubrication)? Motivate your answer. (1p)

Between 2,08 and 2,2 No cracks
2,08 is ok as long as blank holder force not too high

b. Can we say that the LDR is different for other lubricants and then why is it different? (1 p)

Yes Plastic: higher LDR 2,2-2,4
Material can move easily "flow" in to die
(~~draw~~ Blank hold force ⇒ less tension on part)

b. Make three well-motivated comparisons: (3p)

- Each comparison should be made in between two tests and be regarding the difference in result. You must *explain* the difference in result for each comparison.
- At least 5 different tests must in total be included in your answer.

Can

2-3 Too low Bl. h. Force ⇒ wrinkles …

3-4 Too high —"— ⇒ crack …

9-10 Lower pressforce in 10 even though Bl. h force higher since μ ~~smaller~~ lower.

(for example)

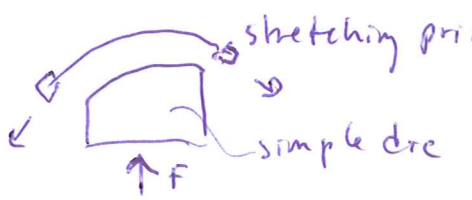
Can	Sheer material	Diameter of blank	Drawing Ratio D/d	Lubrication	Blankholder force (kN)	ok	crack	Max Press force (kN)	Earing	Wrinkling
1	Mild steel	90	1,8	Oil	4	X		44	x	
2	Mild steel	104	2,08	Oil	0			75		X
3	Mild steel	104	2,08	Oil	6	X		63	X	
4	Mild steel	104	2,08	Oil	Max		X	65		
5	Mild steel	110	2,2	Oil	7		X	64		
6	Mild steel	104	2,08	Plastic	18	X		52	x	
7	Mild steel	110	2,2	Plastic	20	X		55	x	
8	Mild steel	120	2,4	Plastic	26		X	60		
9	Stainless steel	90	1,8	Oil	10	X		89		
10	Stainless steel	90	1,8	Plastic	30	X		70		
11	Aluminium	90	1,8	Oil	3	X		15		

Using plastic as a lubrication the blankholder force risis to compensate the lower friction coefficient.

The friction of plastic is approx. a third of that with oil.

5. Stretch forming (5p)

a. Describe and explain the stretch-forming technology, including the tooling. (2,5p)



stretching prior to the forming ⇒ low spring-back

simple die

* Also figures as 7.52 in literature is ok. The important is that material is "locked" and can not flow in to the die.

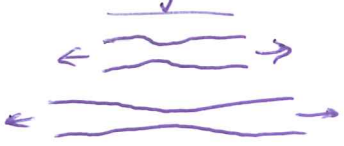
b. How does the strain-hardening of the material (the strain-hardening exponent) influence the formability of the material (that is how soon/easily does the material fracture for different strain-hardening)? (2,5p)

Formability increases with n

Higher n gives an elongated necking

Low n

High n



Because material is strengthened by deform.

6. Hydroforming (4p)

Draw a diagram with internal pressure as the x-axis and axial force as the y-axis. Point out what problem areas there are and thus where the working range (or processing window) is. For two main problems also give a brief explanation in words why you get the problems.

se slide

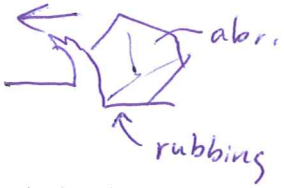
wrinkles : At a combination of high F and too low p

fracture At too high internal pressures

Metal Cutting

7. Grinding (4p)

a) In the grinding process the consumed energy can be divided into three parts. Or in other words – what consumes the energy in grinding? Make a sketch to explain the three different parts. (2,5p)



- cutting chip
- rubbing / sliding
- plastic def

b) Shortly describe the advantages of high-speed grinding (high-efficiency grinding) and also tell what the main limiting factor for high speeds is? (1,5p)

chip thickn reduced - lower force
or increase removal rate
- Limiting = the strength of the wheel binder (& machines)

8. Metal Cutting Fluids (5p)

a) What is a "straight oil" and when and why might that be of use in metal cutting? (2 p)

Also called cutting oil or neat oils. Almost only oil, some additives. No water. Used where no cooling is needed but much lubrication = slow processes (as broaching ...)

b) Describe the technology MQL. Describe what it is, briefly how it is created and the thinking behind the use of MQL. For full scoring your answer must include some detail regarding for instance "percentage" or "size" (concerning the cutting fluid). (3p)

See binder 11 - II - Ch. 3.1
(or slides + lab)

9. High-Speed Machining (5p)

HSM offers the possibility to get a lower cutting force.

a) Why? (For a full scoring you need to show that you have understood what parameters there are in milling and how these are affected or altered.) (3p)

- $v_f = f_z \cdot z \cdot n$ f_z = feed per tooth ∝ chip thickness
- n higher ⇒ v_f can be maintained with ~~constant~~ f_z
  smaller f_z ⇒ F_c lower as chip thickness lower

b) Why is this low force most often of interest when milling in Aluminium? (1p)

Thin walls. Lightweight products

c) Why is this low force most often of interest when milling in hardened steel? (1p)

(Low tool force. Smaller chip thickness ⇒ lower F_c)
F_c can be very high since very hard material.
With small f it can work & be economical

10. Metal cutting and metal cutting tools (3p)

What is the rake angle of a cutting tool? Define what a positive and a negative rake angle is and also comment on the problems (disadvantage) of a too positive or too negative rake angle.

strong edge

Low force

- too positive = too fragile
- too positive = high force

11. Surface Topography (4p)

a) Two ordinary types of surface measurement devices are: *stylus profilometer* and *optical interferometer*.

- Give a very brief description of the function and at least one advantage and one disadvantage of each method. (NOTE: The exact function of the optical interferometer's way of detecting surfaces does not need to be explained) (2p)

See slides or binder 4 - II - 2.2

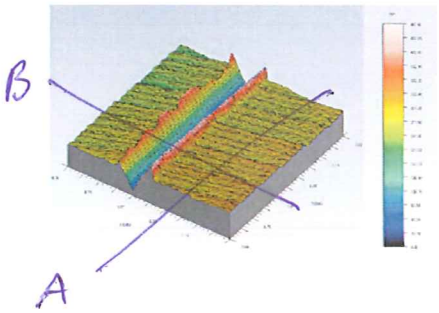
Only basic principles necessary

stylus = Large surfaces but slow Optical = fast but small surf

b) Outgoing from the below picture (which shows a defect on a surface)

- Why is there a need for a 3D measurement instead of just a 2D measurement? Could you get enough information from just a 2D measurement? (Different answers might be possible depending on your way of reasoning).
- The area is 1,5x1,5 mm and the scratch/groove depth is about 100 µm.

(2p)



Some different reasonings are ok

- If you measure a profile as A you get incorrect information (2D)
- However if you measure B and take an amplitude param. you get correct info

But 3D gives better understanding and a visualisation