Solutions-Keywords to Exam in Manufacturing Processes MPR 034

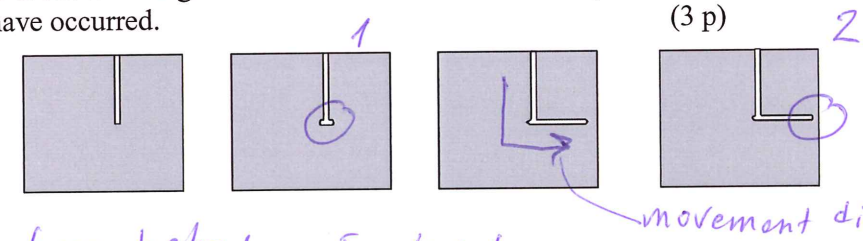
Date:	2011-10-19
Time:	14.00-18.00
Examiner:	Gustav Holmqvist, tel. 5026, 0709-393275 Will visit the exam about 15.00 and 16.30.
Ass. Devices:	Approved calculator, pen, pencil, eraser, ruler, and written dictionary.
Credit list:	**Will be sent out by e-mail 2011-11-09**
Checking:	Checking of your exams can be made 2011-11-14, 12.30-13.15, Room Gamma in the study hall.
Grading	Fail: 0-19,5p, 3: 20-29,5p, 4: 30-39,5p, 5: 40-50p

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 its answer. Write detailed answers and motivate and explain yourself. Write clearly and readable. Do not use ink pen. Good Luck!

Unconventional machining methods

1. Abrasive Waterjet Cutting (5p)

a. In below figure is shown two geometrical defects of an AWJ cut part. Point them out and explain in detail how they have occurred. (3 p)



- View is from below, Fig 4.6!
- 1 & 2 both are a result of the lag: At high (and constant) cutting speed
- 1: When turning the lag erodes extra material in the corner
- 2: When coming to a free edge the jet flips over

b. Mention two other geometrical (not corner defects, not surface topography) defects that an AWJ cut surface typically exhibits. (1 p)

Burrs, taper (concicity), edge rounding (2 of)

c. Mention and very briefly explain a method or way to overcome one of the defects you mentioned in question b. (1 p)

taper: tilting the cutting head.
(edge rounding: Go very close
burrs: backing of hard material under)

2. Laser cutting (4p)

a. Laser light needs to be transferred from the source to the cutting head. How is that made? Mention two major types of laser sources that use different methods for the light transfer. How and why are they different? How does this affect the automation solution? (2 p)

- CO_2 : tubes + MIRRORS (straight "lines")
- Nd YAG : Optical fibre
- Because different Wavelength
- Fibre ⇒ Much easier to use Industrial Robot

b. Why is the cutting speed for laser cutting typically much higher in ordinary mild steel than it is for cutting in stainless steels? Explain! (2p)

Exothermal reaction! $2Fe + O_2 \rightarrow 2FeO + Heat$
= adds heat = adds cutting speed

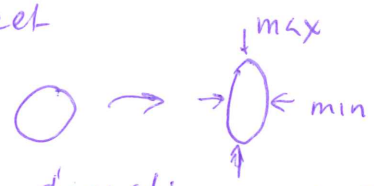
Stainless : Does not react in that way!

Metal forming

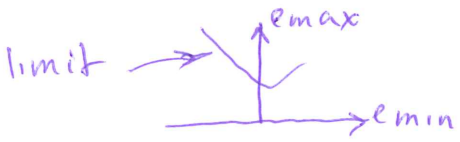
3. Deep drawing (6 p)

a. What is a forming limit diagram? Explain how the diagram is made as well as how it is used. Start with pointing out what you find on the x- and y-axis. (4 p)

- Circle grid pattern on sheet
- Forming test
- Cirles are deformed



- Strains in max and min - direction are plotted



- Sheet will crack/fracture at specific combinations of e_{max} and e_{min}
- under limit = safe zone

b. Explain how and why the lubrication affects the LDR in deep drawing. (2 p)

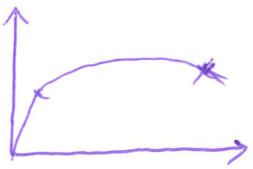
- LDR = Limiting Drawing Ratio
- With more lubrication you can have more blank holder force without risking fracture
- Or one can answer ≈ material will more easily "flow" into the die, but you must connect to blank holder for full point

4. High-strength materials and formability (3 p)

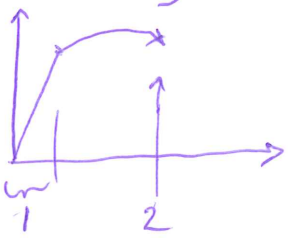
Light weight products can mean using more high strength materials. Point out and briefly explain <u>two</u> important disadvantages of high strength materials from a <u>formability</u> point of view. (Note: Do not confuse formability with high press forces).

σ-ε-Curves

"Normal material"



High strength



1: Larger elastic zone: more spring back

2. Lower max elong. Earlier fracture!

5. Hydroforming (4p)

- What conventional process chain does hydroforming "compete" with? (How would a hydroformed part be made with conventional technologies?)
- Compare and point out the main advantages and disadvantages of hydroforming compared to the conventional solution. Explain each point briefly.

Conv. = Formed parts (conv. stamping) + joining typically by spot welding

Hydro + Fewer parts (see above)
+ Elimination of weld. oper. (see above)
+ Lower weight (no flanges)

- Long cycle time (filling time)
- Restricted to tubes (obvious)
- Further joining more tricky (typically good with a flange)

Metal Cutting

6. Grinding and hard turning (6p)

a. The resulting surface from grinding is much dependent on how worn the grinding wheel is. Explain:
- How will grinding wheels and abrasive wear?
- How does the abrasive act on the surface? How does a ground surface look like?
- Correlate the first two points: How will the surface change as abrasives wear?

(4p)

- Most important: Abrasives will get "dull", not-sharp
- Surface a result of the process, plastic deformation and chip and friction. One can make a figure of this!!
- More dull abrasives ⇒ more plastic deformation and friction less cutting. Can also comment that friction ⇒ heat.

b. Briefly compare hard turning to grinding. Point out the difference on how the surface is produced. Also comment briefly on energy consumption and flexibility/set-up time for the two processes.

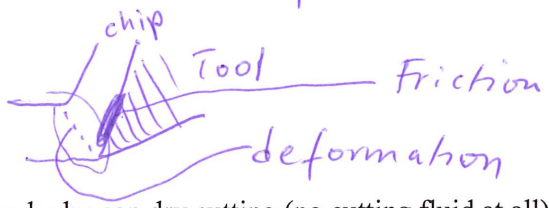
(2 p)

- Turning creates chips, much less deformation and friction
- Generally turning is more flexible: A programmed point-tool.
- Turning = more energy efficient (since k_c is lower) because of first point above.

7. Metal Cutting Fluids (5p)

a. Why is heat created in metal cutting? There are several causes for the heat generation. Explain by making a figure of where the heat is generated. (2 p)

Friction & Deformation



Secondary shear zones etc ~~etc~~ do not need to be included.

b. When and why can dry cutting (no cutting fluid at all) make sense? Examplify! (2 p)

- Milling! Espec. HSM
- In milling especially at low a_p or a_e the tool is only engaged a short time you might get thermal cycling / fatigue

c. Why might dry cutting not be an economical way to machine parts in ordinary turning of steel for example? Give some comment on whether you therefore think dry cutting is a sustainable solution. (1 p)

- Much lower cutting speeds might be necessary in dry cutting to not get too ~~short~~ short tool life.
- Better environment, worse economy therefor not obviously sustainable!

8. High-Speed Machining (4p)

a. Why is safety (for operators etc) a problematic question in HSM? What measures are typically taken in HSM to avoid problems? (2p)

High v ⇒ High energy in loose parts from tool.

Solutions: - Contain the machining space with safety walls, Safety glass
- Tool length shortened, tool quality and cleanliness.

b. Some factors mentioned in the literature on HSM and computer numerical control (CNC) are: "Data transfer speed", "NURBS", and "Look-ahead function". Select two of these and briefly explain what they mean and why they are important in HSM (2p)

See lit.

9. Metal cutting - Micro machining (3p)

a. One can say that the material properties are of more importance in micro machining. What "type" of material properties is that, and why is it important? (2p)

Material on the micro-scale meaning individual grains can affect more. "Composite" materials can affect more.

b. Give some <u>other</u> example of factor where micro machining is different than conventional metal cutting. (1p)

- Tool must be sharper, otherwise rake angle very neg. or
- Cutting environment must be more stable

Joining

10 Soldering (3p)

When soldering electronics components to PCB:s *<u>fluxes</u>* can be added in different ways. Describe how and when flux is added in:

-hand soldering
-wave soldering
-surface mount technology (mechanised)

You must show *when* the flux is added with respect to the soldering.

Hand: Before soldering by tube or in solder wire

Wave: In machine first step is to spray the board from below, (then preheating), the in to solder pot

SMT: Flux is a part of the solder past put on the pads before components.

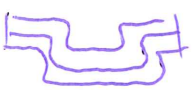
11. Clinching compared to spot welding (3p)

The literature gives in total 9 advantages for clinching. Mention at least three where clinching has an advantage over spot welding. Also mention three other advantages. *Very briefly* explain each point.

Over spot welding: + Different materials (welding needs ≈ same T_m)
+ Clean / no fumes as from welding
+ NO HAZ as a cold proc.

other:
+ Different thicknesses
+ No filler material
+ Several sheets

} these are obvious from the function.



12. Surface Topography (4p)

a. A machined surface typically contains three features: Roughness, waviness and form error. How are these three features typically produced? Use grinding, turning or milling as an example. (2 p) *)

From lit, part I, p4:

Waviness: Individual machine, vibrations, Tool feed irregul.

Form: Lack of rigidity, bad clamping

Roughness: Tool/Grit marks = a result of the process

b. How can one in practice distinguish these three features? Your answer should for full scoring include the term "cut-off". (2 p)

- Filtering!
- Takes away unwanted frequencies
- Form: take away high freq, Roughness: take away low f.
(- Waviness: take away the highest freq + lowest freq).
- Cut off is what determines where you filter. (at what f).

*) Here one can make an own reasoning not based on literature. It must be (very) good to give full points.