Answers to

Exam in Modern Manufacturing Processes MPR 033

Date:	2008-10-24
Time:	14.00-18.00
Examiner:	Gustav Holmqvist, tel. 5026, 0709-393275
Ass. Devices:	Approved calculator, pen, pencil, eraser, ruler, and written dictionary.
Credit list:	The results will be reported in so that your results are available in the student portal on Nov 14.
Checking:	Checking of your exams can be made Nov 17, 12.30-13.15, in room Delta in the study-hall.
Grading	Fail: 0-19,5p, 3: 20-29,5p, 4: 30-39,5p, 5: 40-50p

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1. Functional surfaces and topography (4 p)

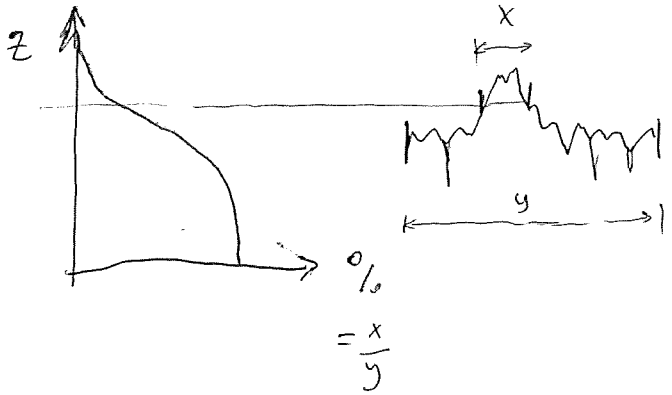
a) Give three different examples of functional surfaces produced by manufacturing processes. Name the functions and the processes. Many examples possible (1,5 p)

Engine cylinder & piston parts made by grinding or honing
Function: Low friction and lubricate

Sheet metal car part: Forming
Function: Have good apearance and/or be easy to paint

Medical implant: Metal cutting
Function: join with bone

b) What is the Abbot-Firestone curve? Answer by explaining how the curve is made up (you do not need to make a mathematical explanation). In what area is this a valuable way of analyzing a surface? (2,5 p)



Gives information on bearing capacity.

The length of a line intersecting a profile at a certain height z is the percentage

or "how large part of the surface that is over a certain height"

Metal forming

2. Drawing – tool design (5 p)

When a tool is to be designed for deep drawing there are some technical issues (geometrical for instance) that have to be taken into consideration. In the literature this is also denoted as drawing practice. List five of these important issues and discuss how they will affect the final result of the drawn part. (5p)

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3. Fine blanking (5 p)

Describe the technique fine blanking. Compare it to conventional punching and list its advantages and drawbacks. The answer should also contain information about when it is used. (5p)

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4. Hydroforming (4 p)

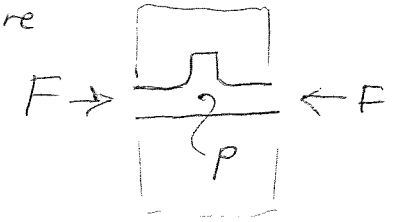
a) The process chain for a hydroformed part includes, besides hydroforming, two other steps. Which are the two other steps? Give also one example of process for each step. (1 p)

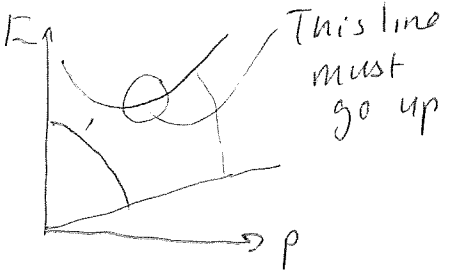
Pre-forming : Bending (to give basic shape / fit in die)

Post-processing: Laser cutting of ends

b) Why and how will wrinkling occur in hydroforming? Describe also how wrinkling is avoided or minimized. (3 p)

- High F leading to too fast inflow of material + low p.
- Explain what F is and p is either by picture or a limiting diagram





Unconventional machining methods

5. Abrasive Waterjet Cutting (5 p)

a) What should you consider when designing parts for abrasive waterjet cutting? Four different issues should be mentioned and explained. (4 p)

Discuss
- Avoid sharp inner & outer corners (radii) 1-2 p
- Material (also high-strength can be used)
- Surfaces (q=5 ⇒ expensive)
- Thickness (high t ⇒ -"-) Also: { Subsequent operations / Fixturing

b) Water mass flow rate is a parameter in Zeng and Kims formula. Mention one advantage of *increasing* this parameter as well as one disadvantage. (1 p)

⇒ More power and possibly more abrasive ⇒ higher speed

Negative: Larger more expensive pump / more abrasives ⇒ cost

6. Laser Cutting (4 p)

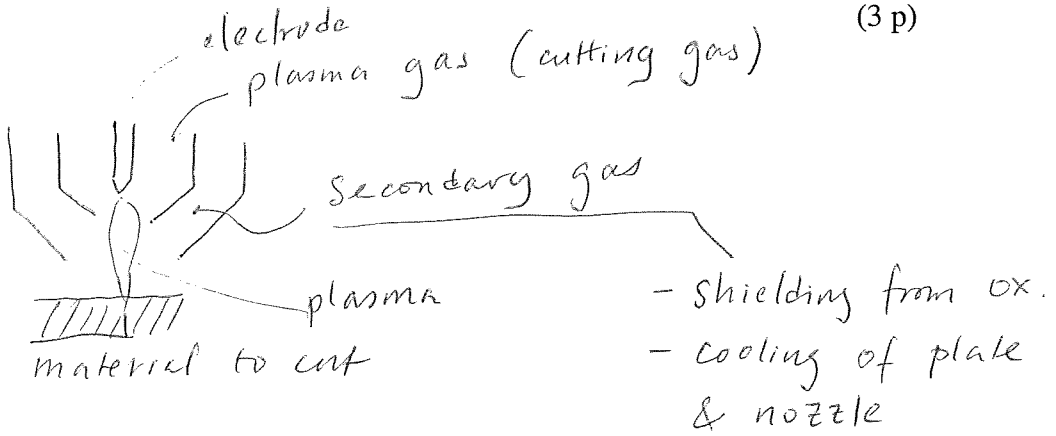
Laser light is different than ordinary light (from for instance a light bulb). Mention three characteristic properties of the laser radiation. Why are these characteristics important in the context of a laser in manufacturing? (4 p)

Monochromatic (same wave l.) } ⇒ Leading & focusing.
Coherent (in phase)
Directed (≈ parallell)

Leading from laser to movable lens Focusing To get high power/area ⇒ cut

7. Plasma cutting (3 p)

Explain the concept of dual gas plasma cutting. Also give at least two examples of gases that are used. (3 p)



Examples of gases

Air, Nitrogen, oxygen

Also accepted: Ar and other noble gases

8. Electrical Discharge Machining (4 p)

a) Mention at least four advantages of EDM. Each advantage should be formulated as a sentence. You can compare to a specific process or answer in general (as the literature does). (2 p)

- Very complex geometries can be produced
- No forces
- High degree of automation, can be run unmanned
- Not sensitive to conventional hard to machine materials as long as conductive

b) What are the functions (purposes) of the dielectric fluid in EDM? (2 p)

- Insulate: Control distance of break-down
- Cooling of material in workpiece & electrode
- Flushing of machined debris

Metal Cutting

9. Grinding and hard turning (7 p)

a) Grinding wheels will wear. Mention and explain the three main mechanisms of wear. (3 p)

Attritions: Flat wear of grains / dulling

Fracture of abrasive grains: Producing new sharp edges

Bond fracture: Dislodging of whole grains

b) Shortly explain truing and dressing of grinding wheels. Be sure to point out the difference between the two. (2 p)

Dressing: Removal of worn abrasives from a grinding wheel.

Truing: Restoring the original shape of the wheel. Shaping of profile is normally considered a part of truing (not in literature).

c) What advantages does grinding have over hard-turning? Shortly explain two advantages or mention four advantages. (2 p)

tolerances + surfaces better

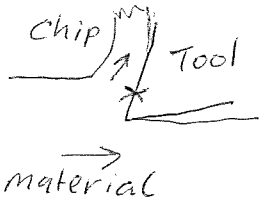
Reliability

Low tensile residual stresses

Also as on SKF slides: Lower cost at larger batch sizes (due to higher set-up cost but lower machining cost).

10. Metal Cutting Fluids (5 p)

a) Explain briefly how heat is created in a metal cutting process such as turning. Also make a sketch including a tool edge and indicate the point of highest heat. Be sure that the sketch is understandable in terms of material and chip direction. (2 p)



x = highest heat

Heat is created through
- deformation in shear zones
- friction

b) What does the medium used in MQL contain? (No exact amounts need to be mentioned). (0,5 p)

air + oil

c) Discuss briefly how MQL can have an influence on
- temperature
- cutting force (2,5 p)

Temp: Cooling by air but Low effect

Force: Lowering of friction, some but Low effect
(Can also mention effect on chip up-curl and avoiding BUE)

11. High-Speed Machining (4 p)

HSM should be considered as a system; a number of different things need to be changed, as compared to conventional machining, in order to make HSM a productive method. Discuss what different parts of the system must be altered, how and why. (4 p)

Discuss to some extent at least three "parts"

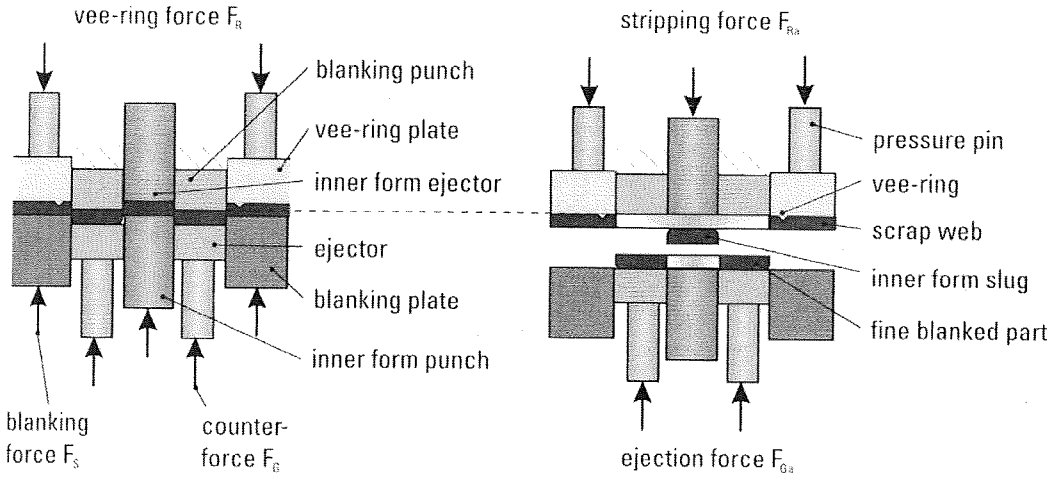
Machine tool (milling machine)
- Stability / vibrations
- Spindle speed (and type)
- Safety

Tools
- Carbide
- Balance, short ...

CAM
- Tool paths for even tool engagement ...

Competence

2) Answer



Description:
Shearing with small cutting clearance + counter force diminishing bending + hold down force ("vee-ring") minimizing in-flow of material

Pros:
High accuracy of edges,
smaller angle error
(and more burnished surface).

Cons:
Stable and special presses as well as tooling
Also particular material in sheet

Used for
Punching/shearing of parts with
Higher demands on tolerances
Functional surfaces
Thins sections

3) Answer:

Clearances and radii
Drawing clearance:
Plate thickness (1,07-1,14t)
Wall thickness required (ironing)
The requirements of the drawing ratio and drawing force.
Die edge radius:
Small radius causes high stresses in the material and requires high drawing forces. Can lead to fracture.
Higher radii allow higher drawing ratio but with the risk of creasing, wrinkling and poor form accuracy.
Punch edge radius:
Punch edge radius can be estimated as > 4t.
If the punch edge radius is more than 3t the limiting drawing ratio will not be negatively affected.
For relatively deep components together with a radius smaller than 3t multi-stage forming normally has to be carrried out with successively decreasing radii.

Draw beads (are used):

- To control the material flow during a press operation
- In stretch-forming to retain the material entirely
- In drawing to be able to control degree of stretching or material flow.

Blankholder pressure
Too small wrinkling
Too high fracture

Redrawing
Number of forming stages:
Larger depths together with smaller diameters (High drawing ratio) will result in multiple-stage forming.
The possible drawing ratio is not a fixed value for all forming stages. It depends on the work hardening in the material.

Also included in the literature:
Drawing without blankholder
Tooling and equipment
Lubrication