Exam in Manufacturing Processes MPR 034

Answer - keywords

Date: 2012-10-25

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 2012-11-14

Checking: **Checking of your exams can be made 2012-11-16, 12.30-13.15, Room Gamma** in the study hall. + second occasion announced later (see course home page).

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

Unconventional machining methods

1. Abrasive Waterjet Cutting (5 p)

a) From the perspective of a designer (of mechanical parts) – what optimisation/adaption should you make to your design so that it is cut quickly? Point out at least four things and explain how and why they affect manufacturing time. (4 p)

Three are "obvious":
- Geometry - avoid sharp corners, these require descaleration - acceleration to get good corner geom.
- Thickness - thicker material = slower, though from design point of view stronger material might be needed
- Quality of cut - avoid high q - speed will be slower, avoid especially if machining after.

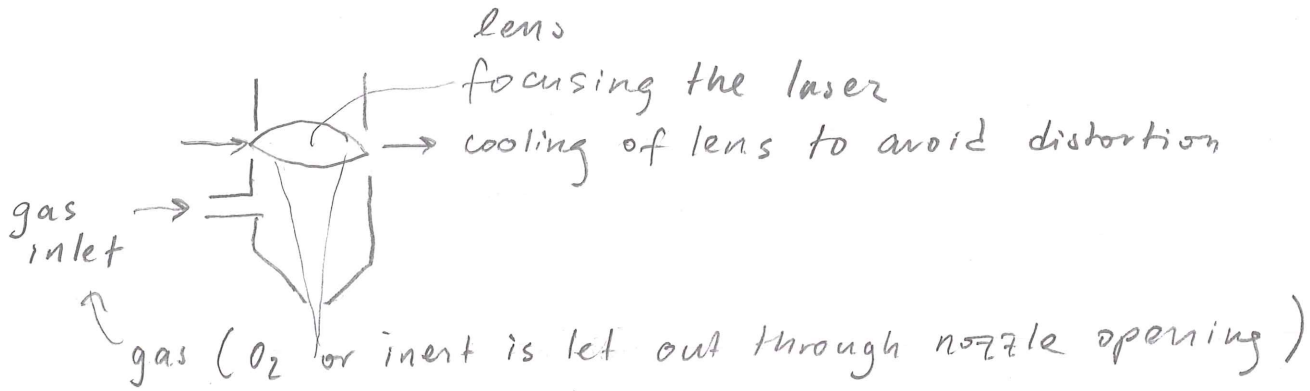
See list for additional point: Stacking, Piercing, nesting etc.

b) From the same perspective point out two disadvantages of AWJ and very briefly explain them (do not just give the disadvantages; write at least a sentence on each thing). (1 p)

- As a designer you might need a thick material = slow.
- Taper = angle of surface (needs particular machine to avoid.)

2. Thermal methods - Laser cutting and EDM (5 p)

a) LASER: Descibe a cutting head for laser cutting (make a sketch). There are typically three separate "functions" or parts in a cutting head. What are these and what are the functions of each. Details on the interactions with the work-piece are not necessary. (3 p)



b) EDM: Briefly discuss how the machined surface is "made" (what produces the surface "pattern") and also give some example of how the surface finish could be controlled in EDM. (2 p)

- Each discharge makes an individual crater. Surface = numerous craters
- Discharge ⇒ high temp, small amount mtrl is melted & flushed away
- Control by frequency of disch. shorter on time gives finer surface. (see fig. 6-2-17 B)

Metal forming

3. Sheet metal forming (6 p)

a) Two "types" of anisotropy is of importance in forming. Which are these? Define them and discuss their role and importance. (4p)

Normal & Planar anisotropy ← The material will deform more / less easy in different direct.

- Simply put normal anisotropy is how much easier the material will deform in the plane than in the thickness direction = this is good ⇒ better formability
- Planar anisotropy is when deformation in one or several directions in the plane deforms more easily ⇒ earing

b) Lubrication plays an important role in forming. How was that noted in the lab (or how is that noted in a deep drawing application)? Why do we find this effect of lubrication? (2p)

- With better lubr. μ is lower.
- At a certain blankholder force (to prevent wrinkling) the material can still move inwards

⇒ Deeper cups can be made (Higher LDR)

4. High-strength materials and shearing (blanking/punching) (5 p)

a) How will the sheared surface of a high-strength steel be different from that of a mild steel? Point out making a sketch of a surface and briefly explain. (2p)

Most importantly the fracture zone will be larger since the material is more brittle / less ductile

b) Discuss the particular attention that comes with high-strength steels when selecting *die clearance*. How does the die clearence affect the wear of the dies and the surfaces? (3 p)

- In general tool wear is more of a problem in HSS.
- Wear depends on clearance but not obvious:
  - Too small ⇒ galling (adhesive wear)
  - Larger typically ok for HSS since bending / roll-over is lower = part will look nice anyway
  - However at too large clearance stress from bending on die edge very high ⇒ chipping

5. Hydroforming (3 p)

For hydroforming (with a tubular starting object) describe *in words:*
- Why and how wrinkling occurs
- Why and how fracture (cracks) occurs.

(You may of course add some figure to your answer if you want to).

See lift / slide

Metal Cutting

6. Grinding (5p)

a. What is the G-ratio in grinding? And why is it of economical importance? (1,5 p)

$G = \frac{Q_{material}}{Q_{wheel}}$ large = good = lower wheel cost and high MRR

b. What is dressing and truing? Briefly explain what it is and how it is made. Point out the difference. (You do not need to explain all different mechanisms). (2,5 p)

See lit / slides

c. Comment on the relationship between dressing/truing and G-ratio. How would you include dressing and truing in the G ratio? (1 p)

- The material removed from either truing or dressing should be included in Q wheel.

(A more advanced answer would be that the G-ratio can continuously change during grinding and drop suddenly when dressing / truing.)

7. Metal Cutting Fluids (5p)

a. What are the functions of cutting fluids? Explain briefly each point/function (one sentence per function). (2,5 p)

See lit / slides

b. In what ways can alternative cutting fluids have advantages from a sustainability approach? Are there as well disadvantages?
"Alternative" means not flooding with conventional cutting fluids. One or several types or different ways of applying the fluids may be discussed. (2,5 p)

- For instance high pressure, cryo-, or MQL could be discussed.
- Point out that sustainability entails not only environm. but also productivity.
- Env. ≈ Energy consumption, CO_2 ..
- Productivity = Possible V_c without excessive wear

8. High-Speed Machining (5p)

a) When implementing HSM one can not just buy some machine with high rotational speed and hope for the best. Describe at least two different things that have to be considered and how those "things" should be changed - before starting to work with HSM. Think for example of the tool, of parameter settings or things to check when buying the machine. (2 p)

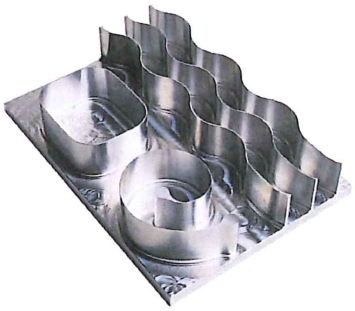
Tools: Balancing, cleanliness, quality
Machine: Stability, possible feed-speed, acceleration, rotational speed and rotational accelaration.
Possible parameter level adapted to the material & geom. (HSM = different v_c in different mtrl.)

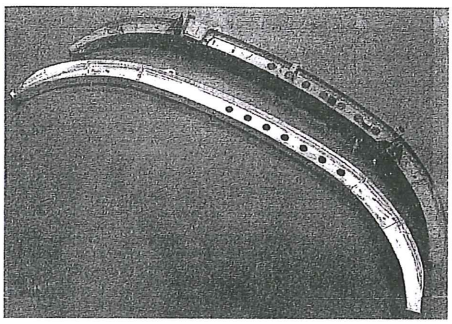
b) Which type or types of cooling is recommended for HSM? Explain very shortly why this is the case. (1 p)

- Heat generated quite small or
- ("Moving away" from heat zone rapidly
- Intermittent cutting

} ⇒ Dry / Air / MQL

c) Below pictures examplify an advantage of HSM in aluminium. What is the advantage and how is this beneficial? Explain also why we get this advantage! (2 p)





Low T_c due to small chip thickness ⇒
thin walls in for instance Al possible ⇒
⇒ design advantage
and/or
less assembly of sheet parts

Joining

9 Soldering of SMT-components (4p)

Describe the full sequence for assembly of surface mount components to PCB:s. Describe all parts of the sequence (starting with a PCB without any components).

- Solder paste put on PCB using
  - Stencil — thin sheet with pad openings. Paste forced into openings
  - Syringe dispensing — Dots or string put individually on pads
- components put on (pads with paste on) using "pick-and-place" machine
- Then passed through oven where flux in paste is activated and solderparticles melts and re-solidifies.

10. Laser welding (4p)

a) Point out a main important technical difference of welding as compared to cutting with laser. How does the cutting head set-up differ? (1 p)

- Main one: Gas when welding at lower pressure and not through nozzle. Do not want to blow away molten mtrl.

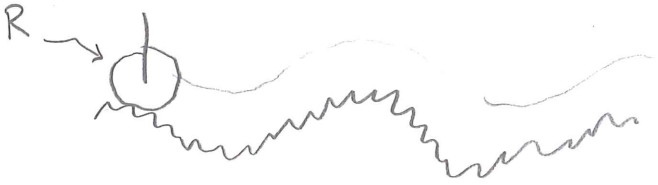
(There are other differences in speed and focusing).

b) Point out some (about three) important advantages of laser welding as compared to other joining methods. Try to point out over which process it has these advantages. (3 p)

- Single sided processing as compared to spot welding or clinching ⇒ more freedom in design
- Flange width lower than spot w or clinch ⇒ weight
- High concentration of energy + fast ⇒ less total heat

11. Surface Topography (3p)

a) If measuring with a stylus - How can the tip of a stylus be used as a mechanical filter? (1,5 p)



large R

⇒ roughness is filtered out but waviness (and form) is measured

= low-pass filter

b) What is the Abbot-Firestone curve (also called bearing ratio curve)? Answer by explaining how the curve is made up (you do not need to make a mathematical explanation). (1,5 p)

See 4-II - fig 2.6 or last slide.