

## Exam Production of Aerospace Systems

Code: AE 3321-II - **Closed Book Exam**

Date: Monday April 11, 2016, 9.00-12.00; Drebbelweg, Exam Hall 2

15 Multiple Choice questions and 4 Open questions

**Read carefully - write in clear script – give concise answers**

**Text of the reader & slides is leading**

### Multiple Choice Questions

(1 alternative per question – 3 points per MC question)

#### Question 1. Specific properties

Performance/weight ratio is one of the key drivers for aircraft development. Which of the following statements about specific properties is true?

- a) Each material has one specific strength and one specific stiffness that can be used for comparison
- b) The specific properties of a structure depend on the material only
- c) For different structural concepts one should apply the proper specific properties
- d) Specific properties depend on the load case only.

#### Question 2. Family concept

Aircraft manufacturers tend to develop new aircraft into a family of related versions/models (e.g. A320-series). What is the attractiveness of this concept for an airline?

- a) The airline is able to operate differently sized aircraft on the same routes
- b) The training of pilots for the different aircraft is identical
- c) There is a large commonality in maintenance programs of the different aircraft
- d) All three options mentioned in a–c are true.

#### Question 3 Punching

One of the following statements about punching is false. Which one?

- a) The slug can be the product as well as the discarded material
- b) Nesting is a typical procedure used for optimum material use
- c) Punching is a universal process, used for small product series ( $O(100)$ )
- d) Punching results in net shape parts that don't require further processing

**This question has been eliminated because of ambiguity**

#### Question 4. Compression moulding

One of the following statements about compression moulding is true. Which one?

- a) Compression moulding uses one rigid and one soft die
- b) Compression moulding is a typical process for unreinforced polymers
- c) In contradiction to injection moulding, compression moulding does not have knit lines
- d) When fibres are used in compression moulding, the fibre orientation will be random

#### Question 5 Forging

Forging is a bulk forming process. The process is usually performed at elevated temperatures. Why? Select the best answer!

- a) The material volume to be deformed is much larger than in sheet forming processes.
- b) Elevated temperatures reduces the required forces during the forging process
- c) The formability of the material is significantly improved by the temperature increase
- d) During forging the material is also transformed into the right microstructure

### Question 6 Superplastic forming

Superplastic forming is based on another deformation principle than plastic forming. Which of the following statements about superplastic forming is correct?

- a) During superplastic forming there is no strain hardening
- b) During superplastic forming there is no spring back
- c) The “super” in superplastic forming is related to the low forces required
- d) One requirement for superplastic forming is about the crystal structure inside the grains

### Question 7 Lay-up techniques

Why is hand lay-up of fabrics replaced by automated lay-up of tapes? Which answer is false?

- a) Automated lay-up is preferable for larger product series
- b) Automated lay-up is preferable for larger products
- c) Using UD-tapes may result in better alignment of the fibres
- d) Creating 3D parts is easier for fabrics than by using tapes

### Question 8. Adhesive bonding

Which of the following statements is true?

- a) Load transfer in adhesive bonding becomes more difficult when the adherents' thickness increase
- b) Adhesive bonding could be a joining method for assembly if the cure time was short
- c) Welding does not require surface treatments
- d) Welding of metals and thermoplastics is based on the same principle

### Question 9. Riveted joint

A double lap joint has rivets of 4 mm in diameter, sheet thickness of  $t_1=t_3 = 0.6$  mm and  $t_2= 1.0$  mm. The joint load per rivet is 2500 N. What is the largest shear stress in the rivet?

- a) 99,5 MPa
- b) 199 MPa
- c) 625 MPa
- d) 284 MPa

### Question 10 Riveted joint

What happens with the net section stress and the bearing stress if a riveted joint is enlarged from one to two rivet rows?

- a) The net section stress is divided by two and the bearing stress is divided by two
- b) The net section stress does not change; the bearing stress is divided by two
- c) The net section stress does not change; the bearing stress does not change
- d) The net section stress is divided by two; the bearing stress does not change

### Question 11 Non Destructive Testing

Which of the following statements about Non Destructive Testing (NDT) is false?

- a) NDT techniques are used for flaw detection during manufacturing and operation of the aircraft
- b) Some NDT techniques are capable of detecting flaws inside the material, others to detect flaws at the surface
- c) Ultrasonic testing is used for the detection of porosity and surface cracks in composites
- d) The X-ray technique is based on detecting differences in density and therefore able to detect thickness steps

### **Question 12 Non-Conformance Report**

When is it not required to make a non-conformance report?

- a) When the number of parts in the batch is smaller than planned
- b) When the thickness of the product is too large
- c) When a scratch only damaged the surface layer, not the substrate
- d) Any time a flaw is detected beyond the limits set by the Effect of Defects program

### **Question 13 Certification**

In order to get a certified company, which items should be certified?

- a) The organisation, the workforce, the equipment (machines & tooling)
- b) The workforce, the equipment (machines & tooling), the product
- c) The equipment (machines & tooling), the product, the used standards
- d) The product, the used standards, the organisation

### **Question 14 Break Even Point (BEP)**

What is the Break Even Point?

- a) The aircraft number for which all investments equals the accumulated revenues
- b) The aircraft number for which the accumulated costs equals the accumulated revenues
- c) The aircraft number for which the costs and revenues (price) are equal
- d) The moment in time for which all investments equals the accumulated revenues

### **Question 15 Part manufacturing and assembly**

What statement about part production and assembly is false?

- a) The workshops for part manufacturing and the assembly lines are virtually separated by storage facilities
- b) Part manufacturing is mainly performed by individual specialists; the assembly is performed by specialized teams
- c) Part manufacturing is using batches; assembly is adopting and joining the parts one by one.
- d) In part manufacturing the workers stay at their machine; in assembly the workers move with one aircraft.

## **Open Questions**

(4 points each sub-question)

### **Question 16 – Milling**

- a) Milling is a chip removing process. Make a sketch of the general lay-out of a cutting tool (incl. chip, cutting tool, work piece). Give names to the different items and angles.
- b) Edge milling of composite laminates is more difficult than edge milling of metal sheet. What (mention at least 2) are the difficulties encountered at milling of composites? Explain your answer.
- c) Water jet cutting and laser jet cutting can be regarded as alternatives for the edge milling process. Describe briefly one advantage and one disadvantage for each process.
- d) What adaptations (2) in the milling process are feasible to improve the milling process of composite laminates? Explain your answers.

### **Question 17 – Resin infusion processes**

Figure 1 shows a sketch of a thin-walled product ( $\pm 200 \times 300 \times 60$  mm). This product can be made of a metal sheet or of a composite laminate.

- Mention at least one manufacturing process for metals which cannot be used for this product and give the reason(s) why not?
- Mention at least one manufacturing process for composites which cannot be used for this product and give the reason(s) why not?
- Which process would you select for this product if it was made of metals and why?
- Which process would you select for this product if it was made of composites and why?
- Would the size of the products series make a difference in your choices in c and d? Explain your answer.

PS. Make assumptions when necessary.

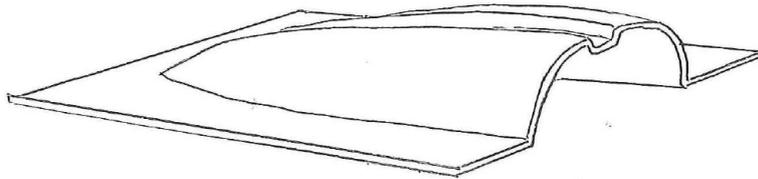


Figure 1

### Question 18 Assembly of structures

- For the structural breakdown of an aircraft structure, there are different ways how to divide the entire aircraft into smaller sections. Describe at least 2 ways/methods how to do this.
- “During assembly the delivery interval is dominating the pace of the assembly line”. Explain this statement.
- For the assembly of aircraft the learning curve is very important. What is the learning curve and what parameters have an influence on this curve?
- Describe and explain two methods to increase the output of an assembly line.

### Question 19 – Lean Manufacturing (LM)

A definition of Lean thinking is: *“Lean thinking is the dynamic, knowledge driven, and customer-focused process, through which all people in a defined enterprise continuously eliminate waste with the goal of creating value”*

- Give a brief description/explanation of at least two of the following features mentioned in this definition: dynamic, customer-focused, all people, continuously.
- With respect to the waste, there are three waste categories. Describe these categories briefly.
- “Cellular Manufacturing” is one of the tools one can use in a LM program. Explain briefly how this concept can help to have a leaner production.