

## Exam Production of Aerospace Systems

Code: AE 2207 - **Closed Book Exam**

Date: Friday, July 5, 14.00-17.00

6 Open questions and 10 Multiple Choice questions

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

### Multiple Choice Questions

(1 alternative per question)

#### **Question 1**

Composites are the most dominant structural material for new aircraft. What statement is true about the transition from metal dominated aircraft to composite dominated aircraft?

- A similar transition took place in the 50s of the previous century from propeller to jet engines
- Composites can readily replace metals, using the same designs and production methods
- A similar transition took place in the 1st decade of the previous century from wood & linen to metal
- The change from composites to metal has significant impact on all aspects of aircraft production

#### **Question 2**

The trinity concept involves:

- That you need three different options or solutions for one problem
- That there is a strong relationship between materials, design and manufacturing methods
- That three parties are required for the manufacture of an aircraft: the manufacturer, airline and authorities
- None of the three alternatives a, b or c is correct.

#### **Question 3**

There are four forming mechanics for the deformation of materials. What statement is false?

- All materials have elastic deformations but not all materials can have plastic deformations
- Plastic deformations are typical for metals, in-plane shear or Trellis effect is typical for composites
- Plastics can be deformed by plastic or viscous flow and by superplastic forming
- Plastic deformation in metals is dominated by dislocation movements; superplastic forming is not dominated by dislocation movements.

#### **Question 4**

Which of the following four statements about the differences between thermoset and thermoplastic composites is false?

- At room temperature (20<sup>0</sup> C) a thermoset has a high viscosity and a thermoplastic has a low viscosity
- Curing of a thermoset is irreversible; thermoplastics can be softened more frequently
- Cured thermoset polymers are made of large molecular networks with strong bonds; thermoplastics are chainlike molecules with weak bonds between the chains
- The strength and stiffness of thermoset and thermoplastic composites is dominated by the fibres

#### **Question 5**

What is the main reason for the pre-loading of bolts? A pre-load is applied to a bolt to...

- ... increase in the shear load of the bolt
- ... increase the (tension) fatigue life of the bolt
- ... increase the load transfer by friction
- ... remove the tolerance (play/space for motion) in the joint

#### **Question 6**

Which one of the following statements about adhesive bonding is true?

- The shear stress distribution in an adhesively bonded joint is constant
- The increase in bond strength is proportional to the increase in overlap length
- When the axial stiffness of two adherents are not the same, the bath tub curve is not symmetric
- Pre-treatment of surfaces is performed primarily to increase the strength of the bond.

### **Question 7**

Assembly jigs need to have several features. What alternative gives the best combination?

- a. Accessibility, strength, positioning points, easy to disassemble, low weight
- b. Stiffness, strength, accessibility, small floor area, easy to remove assembly
- c. Capable to rotate, easy to be moved, low weight, stiffness, stability
- d. Low weight, accessibility, positioning points, easy to disassemble, simple

### **Question 8**

Which of the following statements about Lean Manufacturing (LM) is true?

- a. The lean principle is more important for manufacturing companies than for support activities like administrations, banks, etc.
- b. Waste is related only to those activities that spoil materials, fuels or other products
- c. Creating value and eliminating waste are the key elements of LM
- d. To obtain a perfect lean process takes many years, often decades.

### **Question 9**

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

- a. NDT techniques are used for flaw detection during production and in service
- b. Some NDT techniques are capable of detecting flaws inside the material, others to detect flaws at the surface
- c. The Dye penetrant technique is capable of detecting flaws inside the materials, like pores and inclusions
- d. The X-ray technique is based on detecting differences in density and thereby not capable to detect delaminations.

### **Question 10**

"All the planned and systematic activities implemented within the quality system, and demonstrated as needed, to provide adequate confidence that an entity will fulfil requirements for quality".

This is a definition of

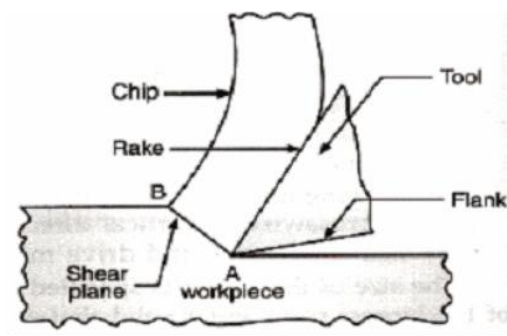
- a. Quality policy
- b. Quality management
- c. Quality assurance
- d. Quality planning

## Open Questions

### **Question 11**

Machining is one of the manufacturing processes to produce components/parts.

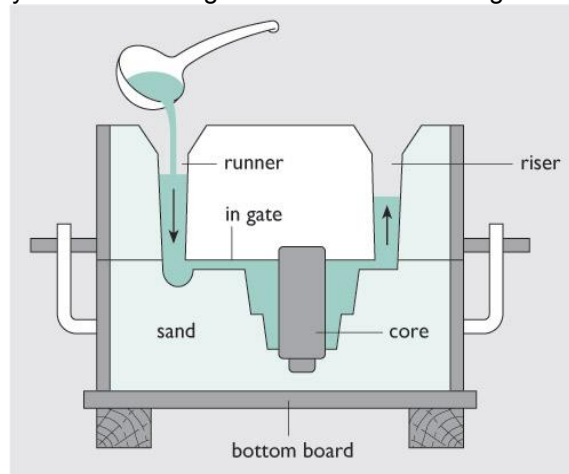
- a. Mention at least three different machining processes and describe briefly (or make a sketch), how these processes remove the material.
- b. In the figure below you see the tip of a cutting tool removing some material. What are the three important angles in this figure?
- c. What are the limits/boundaries for each of the angles? Explain why they are a limit or boundary.
- d. Mention at least one difficulty for the machining of composites. Explain your answer.



### **Question 12**

The figure below shows a casting process.

- What is the name of this casting process?
- What is the purpose/function of the riser, the runner, the gate and the core?
- Is this a process for a large or a limited product series? Explain your answer.
- "The product has clearly visible draft angles". What are draft angles?



### **Question 13**

Assembly of aircraft.

- Mention four reasons for the assembly of aircraft.
- The structural breakdown of an aircraft results in manufacturing and mounting divisions. What are "manufacturing divisions" and "mounting divisions" and what are the main differences (2)?
- "Assembly adds weight to an aircraft". Give a brief explanation of this statement.

### **Question 14**

Riveting and bolting

- Riveted joints may fail in at least 4 different ways. Mention two failure modes and describe them briefly.
- Mechanical fastened joints can be made by solid rivets (aluminium) or by Hi-lok bolts (titanium). Mention two differences between these types of fasteners and explain these differences briefly.
- Which dimension of a riveted joint would you change when the joint is changed from one to two rivet rows? Explain your answer.

### **Question 15**

Organisation

- What is the "learning curve"? Explain briefly the principle of the learning curve.
- In an aircraft factory there are two main domains: the part manufacture and the assembly lines. Describe at least two key features which are different for these two domains.
- Give the definition of the BEP (Break Even Point)?

### **Question 16**

A producer wants to make a complex, thin-walled product made of a short fibre (<1mm) reinforced thermoplastic polymer.

- What is the best process for this: filament winding, rubber forming, die casting or injection moulding? Explain the motivations of your choice.
- Does it make a difference whether the producer aims for 1000 products or for 100.000 products? Explain your answer?
- In what situation is the product cheaper: in small series or in large series? Why?