ORDRE DES INGÉNIEURS DU QUÉBEC

MAY 2013 SESSION

Open-book examination
Calculators: authorized models only
Duration: 3 hours

Metal Fabrication
98-MET-B5

- *The exam contains a maximum of 90 marks, which will be converted to 100.*
- *Please, answer all questions.*

Question 1. Metal Shaping (5+5+5+5 points)
a) What is the metal dead zone occurring during extrusion? In which extrusion configuration is this zone developing?

b) What are the main characteristics required from a material to be considered a good candidate for deep drawing forming?

c) If the design criteria for the selection of a component is fatigue resistance, would you prefer a forged or a machined component? Explain why.

d) What are the main metallurgical differences between cold, warm and hot rolling?

Question 2. Metal Welding (5+5+5+5 points)
a) Describe the procedure you would use to fabricate a 40 feet long "I" beam using welding as the process to join the different components.

b) What GMAW metal transfer mechanism would you use to weld thin stainless steel sheets?

c) What are the main differences between a flux core and a metal core filler wire in terms of fabrication, geometry and characteristics during deposition?

d) Describe the hot wire GTAW process.

Question 3. Powder Metallurgy (5+5+5+5 points)
a) What is the major problem occurring during sintering of magnesium PM components?

b) Describe sub-surface fatigue, a failure mechanism often found in PM components exposed to a sliding wear environment.

c) What are the limitations of ultrasonic atomisation to fabricate high quality metal powders?

d) What is transient liquid phase sintering and for which metal system(s) this process is attractive?

Question 4. Metal Casting (5+5+5+5 points)
a) How does one calculate the cooling rate using micrographs of dendrites?

b) If the solidification front velocity is accelerated beyond the point of forming equiaxed dendrites, what solidification structure would you obtain and why?

c) Explain why a dendrite develops and why it possesses a branched structure.

d) Explain solidification cracking in high strength aluminum alloys and how can it be prevented.

Question 5. Strength and Deformation of Metals (5+5 points)
You are given a 3cm diameter metallic rod and you are asked to manufacture a 1cm diameter rod with it. The stress-strain curve of the given material is found below. You decide to manufacture the rod by extruding the rod down to a diameter of 2.5cm, cutting the cold rolled product into the desired length and end the sequence with the lathing down to the desired diameter. What will be the maximum stress the rod will support without experiencing plastic deformation? Could you suggest a manufacturing sequence to maximise strength of the requested rod? Describe your hypothesis and calculation.