ORDRE DES INGÉNIEURS DU QUÉBEC

November 2010 SESSION

Open-book examination
Calculators: only authorized models
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) Identify main defects found during the extrusion of a component and explain their origin.

b) Explain the difference between direct and indirect extrusion and provide an example of a component manufactured through this process.

c) Is it possible to create residual stresses during cold heading and if so, how the process can be modified to avoid their formation?

d) What is a planetary rolling mill and for what material(s) is this used?

Question 2. Metal Welding (5+5+5+5 points)

a) The diameter of the electrodes to be used in SMAW depends on factors such as the workpiece thickness, the welding position and the joint design. Large electrodes, with their corresponding high currents, tend to produce large weld pools. When welding in the horizontal position, do you prefer using large or smaller electrodes?

b) Explain the four common weld pool convection phenomena and describe if they increase or decrease weld penetration.

c) Based on what principle are the solder alloys developed?

d) Sketch the grain structure in the arc produced by the last three pulses of a pulsed electron beam welding process.

Question 3. Powder Metallurgy (5+5+5+5 points)

a) What is the major problem occurring during sintering of magnesium-based PM components?

b) Indicate if the mechanical properties of a PM component will be higher, lower or similar to it's wrought counter part: hardness, resilience, elongation, creep strength, yield strength.

c) Discuss the influence of a large particle size and a broaden particle size distribution on the apparent and tap density. Briefly, describe a utilisation of such type of powders.

d) What are the precautions necessary to weld stainless steel components fabricated by powder metallurgy (porous structure)?

Question 4. Metal Casting (5+5+5+5 points)

a) How does solidification of an alloy going through a peritectic reaction occurs?

b) Identify the three sources of contamination in a metal casting during pouring.

c) What is the difference between sand casting and lost wax casting?

d) Explain the foundry properties of Zn alloys.

Question 5. Strength and Deformation of Metals (5+5 points)

Strengthening of a steel through cold working is given by the following equation:

$$\sigma = 100\,000\ \varepsilon^{0.2}\ \text{psi}$$

a) Knowing that this steel bar has been cold worked to 10% and that she had experienced an additional deformation of 20%, calculate the new yield strength of this bar.

b) A second bar of the same steel has been annealed and cold worked to a certain degree prior to a 10% deformation through cold working. If the final yield strength of the bar is 75 000 psi, calculate the initial cold deformation experienced by the bar.