

ORDRE DES INGÉNIEURS DU QUÉBEC

NOVEMBER 2014 SESSION

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

**14-MT-B3 METAL FABRICATION**

- *The exam contains a maximum of 100 marks.*
- *Please, answer all questions.*

**Question 1. Metal Shaping (5+5+5+5 points)**

- a) Is the angle of attack of any importance during hot rolling? What is the importance of this angle when compared to cold rolling?
- b) What metal properties must be considered for its usage in a deep drawing operation?
- c) Would a component process by direct or indirect extrusion have the highest toughness?
- d) What is planetary rolling, and why is it used?

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

- a) Can we consider welding to have a near-equilibrium or an out-of equilibrium solidification? List the hypothesis used to explain your choice.
- b) What information can be obtained from the code designation of stick electrodes?
- c) What is the relationship between welded structure and impact properties?
- d) Describe the electron beam welding process. How can this process be used to weld to thick steel sections?
- e) It was observed in YAG laser beam welding of AISI 409 stainless steel that under the same power the beam size affected the depth-width ratio of the resultant welds significantly. Describe and explain the effect.

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

- a) For a given powder, the density achieved at any pressure is slightly higher for isostatic compression than for uniaxial die compaction. Explain the difference.
- b) What is additive manufacturing?
- c) Differentiate between the functions of a lubricant and a binder.
- d) A sponge powder has small internal pores and large interparticle pores. Describe the possible effect of the bimodal pore size distribution on sintering.
- e) Explain why the flow time in the Hall flowmeter is observed to increase with the ratio of the tap density to apparent density?

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

- a) How does solute alloying elements influence the solidified grain size?
- b) Is the addition of inoculants a proper method to reduce segregation in castings?
- c) What are the main characteristics determining the size and position of a riser used in the casting of a complex component?
- d) Explain solidification cracking.

**Question 5. Calculations on shaping process (10 points)**

Determine the maximal % of reduction that can be achieved during wire drawing of a steel wire through a die in which the half-angle was machined to  $10^\circ$ .