

## Manufacturing Qualifier Exam

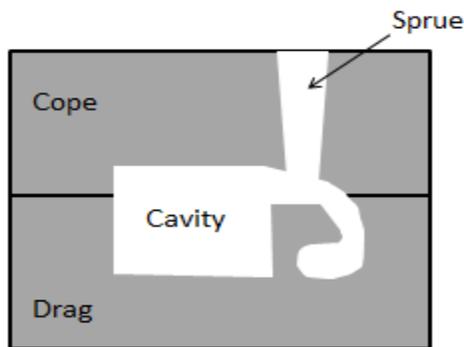
**Exam details:** Closed book, calculator allowed, answer 5 out of 6 questions. Key equations will be provided when necessary. Equations listed in chapter 2 and 3 of Manufacturing Processes for Engineering Materials (Kalpakjian and Schmid, 4<sup>th</sup> ed) will not be given, nor will the basic material removal related equations for machining (milling, turning).

---

### Sample questions:

**Q1:** A cylindrical product can be produced by (a) closed-die forging, (b) machining on a lathe, and (c) powder metallurgy techniques. Assume you have all the facilities for the three processes. Explain five factors you would consider before selecting one of the three processes.

**Q2:** The following sand cast process was designed by some UNCC engineers. Assume unit depth into the figure.



- Name 3 defects likely to occur and the reasons why.
- The sprue is tapered (this part they got right). Why? Support your answer with analysis. That is, what might happen if it were cylindrical?
- Will coring be required for this design? If so, where? If not, why not?
- Redesign the part and mold arrangement to improve expected process performance. Small changes to the part geometry are allowed if necessary. A sketch with simple explanation is expected.

**Q3:** A rectangular workpiece is to be reduced with original dimensions:  $a = 25.4$  mm,  $h = 25.4$  mm, and width = 254 mm to half height using open-die forging. The metal has a strength coefficient of 1015 Mpa and a strain-hardening exponent of 0.17. It will be forged in plane strain with  $\mu = 0.08$ .

- Name at least two possible defects in general forging.
- You are asked to purchase a hydraulic (50 MN capacity) or mechanical (25 MN capacity) press based on the need. Which one will you choose assuming the higher capacity unit is more expensive? Use the average-pressure formula and assume there is no sticking.

$$\text{Equation: } P_{ave} = \frac{2}{\sqrt{3}} Y_f \left( 1 + \frac{\mu a_f}{h_f} \right)$$

Average-pressure formula in open forging of a rectangular part:

(  $Y_f$ : flow stress,  $\mu$  coefficient of friction,  $a_f$  : final half workpiece length, and  $h_f$ : final height)

**Q4:** : You are reducing the diameter of metal bar stock from 62 mm to 58 mm along 50 mm of its length. The spindle speed is 600 rpm, the power consumption approximately 0.75 kW, and the feed rate is 45mm/min.

- What is the material removal rate in mm<sup>3</sup>/min? Show all calculations.
- Given the above information can you make any comment with respect to the type of material you are cutting? Provide supporting analysis as appropriate.
- If the turned section is then to be removed from the stock material what other machining operation(s) would be required? How long would it take to produce the final cylinder (Ø58 mm, length 50 mm)? Assume the additional operation(s) outlined earlier require 50% of the time required to turn the diameter down to 58mm.