University of Saskatchewan
College of Engineering
Dept. of Mech. Engineering
ME 330.3 Final Exams
April 2004

Time: 2 Hours **Instructors: Chris Zhang**
Open Book Exam.

Name: _____

Student Number: _____

This exam question set consists of **two** parts. Part I consists of **10** questions. Part II consists of **3** questions.

Attempt all questions**.**

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Part I. (40 marks)

Question I.1
Why is the increase of the carbon content in the iron-carbon alloy responsible for the increase of the hardenability?

Question I.2
Figure 1 shows the iron-carbon phase diagram. Please indicate: (1) the range of carbon content for the steel, (2) the range of carbon content for the iron, (3) eutectic composition, and (4) eutectoid composition.

Question I.3
For the iron-carbon alloy with the carbon content more than 4.1%, is it possible to strengthen the alloy by applying the quench process? Why?

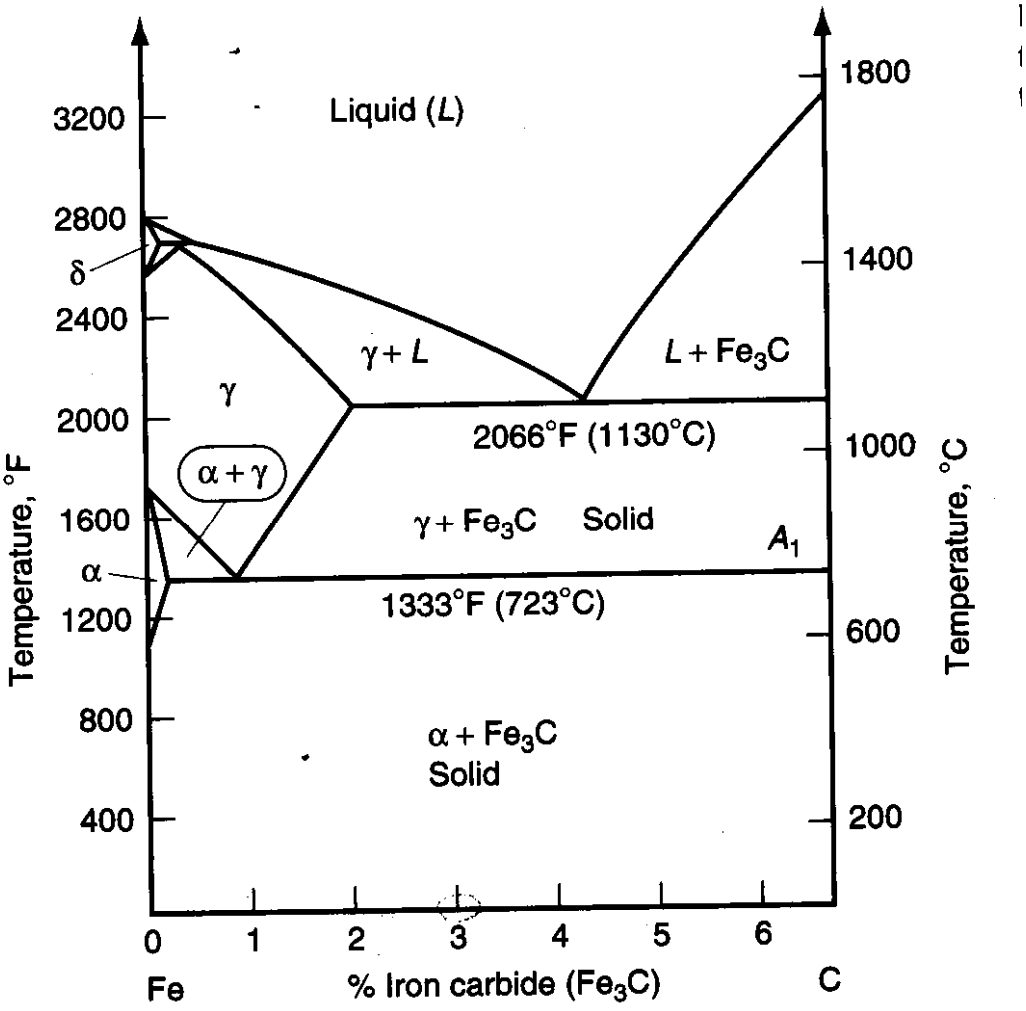

Figure 1

Question I.4
What assumptions were made when using Chvorinov's rule to calculate the size of a riser in the manner presented in the text?

Question I.5
What is the chill zone of a casting, and why does it form?

Question I.6
List at least two design goals for the riser design in casting and explain how to achieve them.

Question I.7
What is the role of carbon in quenched and tempered low-alloy steels? What is the rule of thumb in regards to carbon content when selecting heat-treated steels?

Question I.8
Aluminum is a non-ferrous metal. Please outline some particular manufacturing processes on the aluminum, one for each of (1) how to strengthen it as a whole, (2) how to harden its surface.

Question I.9
Figure 2 shows a part for casting. Decide the parting line for the part and give the rationale for your decision.

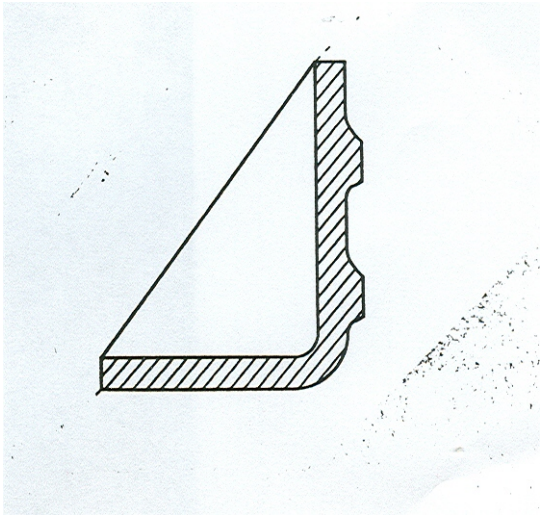

Figure 2

Question I.10
The following is the tolerance specification: 50 G7 /h8. Please indicate (a) whether it is the basic hole system or the basic shaft system, and why; (b) whether it is the clearance fit or interference fit, why?

Part II (60 marks total)

Question II.1

Define the **yield** of a casting as the casting weight divided by the total weight of metal poured (sprue, gate, riser, and casting). Using Chvorinov's rule as presented in the text with n=2, calculate the dimensions of an effective riser for a casting that is a 2 in. by 4 in. by 6 in. rectangular plate with further consideration of two situations: (1) the riser and casting are not connected, except through a gate and runner, and (2) the riser sits on the top of the flat rectangle with its bottom circular surface being part of the surface of the casting. For these two situations, also calculate the **yield** of them, respectively, and comment on which situation (1) or (2) is more efficient.

Question II.2

An extruder has a barrel diameter=5.0 in. and length=12 ft. The extruder screw has channel depth=0.30 in. and flight angle=17.7^o. The plastic melt has a shear viscosity=100 $\times$ 10^{-4} lb-sec/in^2. The die characteristic is Q_x=0.00150*p*. At a point of time, the operating melt flow Q=3.55 in^3/sec. Please find:

(a) The rationale for the procedure to determine the operating point;
(b) The extruder characteristic;
(c) The operating head pressure p;
(d) The extruder screw rotation speed;
(e) The maximal melt flow;
(f) The maximal head pressure; and
(g) If the viscosity of the melt flow increases, discuss what should be done to maintain the same operating melt flow, i.e., Q=3.55 in^3/sec.

Question II.3

In the metal forming, we have the concept called the **average flow stress**. The average flow stress is calculated by

$$\overline{Y}_f = \frac{K\varepsilon^n}{1+n} \qquad (1)$$

Please do the following:

(a) Derive the flow stress equation, equation (1);
(b) In the case of the rolling process, what is the definition of the true strain in equation (1) above, and why?
(c) In the case of the drawing process, what is the definition of the true strain in equation (1) above, and why?

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