University of Portland
EGR 221 - Materials Science
Exam 3 (CLOSED BOOK, CLOSED NOTES)
November 30, 2012, Dr. K. Lulay

Name: _____

1) (15pts) The word "eutectoid" means "eutectic like." Briefly explain what eutectoid and eutectic reactions are. How are the resulting microstructures similar or dissimilar? What does the word "eutectic" mean?

2) (10pts) Based on the Fe-C phase diagram provided elsewhere in this exam, consider steel with 0.2wt% carbon that has been heated to 1000°C. It is cooled relatively quickly to 727°C (note, this will not form martensite). Will coring occur in the α-ferrite phase as it cools through the α–γ region? Briefly explain your answer. Use sketches if you think that will help communicate.

3) (15 pts) Select the best answer:
   a) Which of the following microstructures is the least ductile:
      pearlite bainite martensite spheroidite

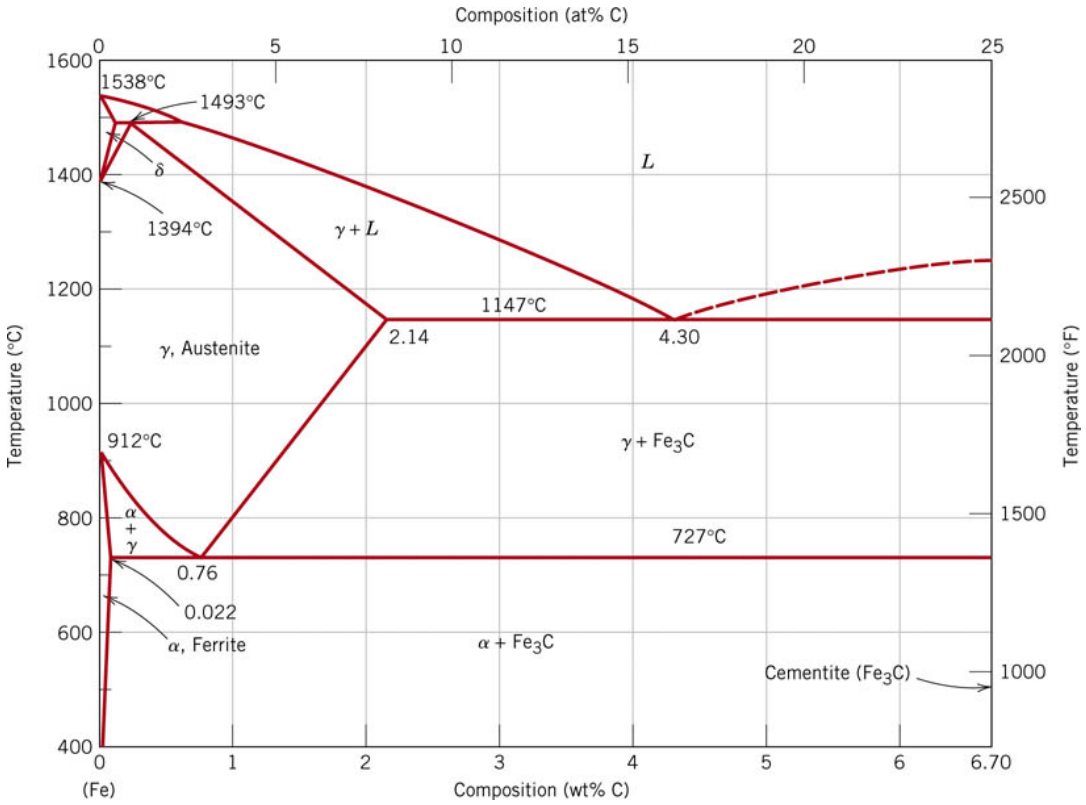
   b) Which of the following microstructures is the most formable (most ductile):
      pearlite bainite martensite spheroidite

   c) Which of the following microstructures would make a good wear surface (hint: harder materials provide a better wear surface):
      pearlite bainite martensite spheroidite

   d) By weight, what is the composition of cementite (Fe_3C) at 700°C?
      0wt%C 6.7wt%C 25wt%C cannot determine with information provided

4) For an iron-carbon alloy (plain carbon steel) containing 1.0 wt% carbon, answer the following questions. Use the space provided below and on the next page to show all calculations and to answer the questions. **For full credit, the phase diagram on the next page must be clearly marked to help communicate your answers where appropriate.**

   a) (5pts) Circle the best answer. This is alloy is:
      hypoeutectoid, hypereutectoid, proeutectic, proeutectoid
   b) (5pts) Upon slow cooling from 1000°C, what is the first phase to transform from austenite?
   c) (10pts) What phase(s) will be present at 730°C upon slow cooling from1000°C and what is the composition of each of these phases?
   d) (10pts) What microstructure(s) will be present and how much of each microstructure (mass fraction) will be present at 720°C upon slow cooling from austenite?
   e) (5pts) Regardless of alloy composition or temperature, what is the maximum solubility of carbon in austenite? What is the maximum solubility of carbon in α-ferrite?
   f) (5pts) What critical but basic assumption is necessary to answer the above questions regarding reading a phase diagram?



The examination is continued on the next page….

5) (20 pts) Plain carbon steel with eutectoid composition has been fully austenitized. What is the final microstructure of the specimens for the following the time-temperature treatments? Choices include: *pearlite, bainite, martensite, austenite, spheroidite,* and *tempered martensite* – or combinations of these. **FOR FULL CREDIT**, **CLEARLY** mark on the appropriate attached TTT diagram to support your answers. Label the marks with "5a" "5b" etc. corresponding the problem number. **USE A STRAIGHT EDGE** and **READ** the diagrams **CAREFULLY!** Provide an explanation if you wish.

a) Austenitize, quickly cool to 700°C, hold for 15 seconds, quickly cool to room temperature by water quenching.

b) Austenitize, quickly cool to 600°C, hold for 15 seconds, quickly cool to room temperature by water quenching.

c) Austenitize, quickly cool to 600°C, hold for 15 seconds, slowly cool to room temperature by air quenching.

d) Austenitize, quickly cool to 300°C, hold for 15 seconds, quickly cool to room temperature by water quenching.

Extra credit (10pts max): of the four conditions above, which one is the least likely to be used in practice and explain why. Assume it is equally "easy" to quickly quench to 300°C, 600°C, and 700°C.