

Name: _____ Student ID No: _____

Faculty of Engineering Prince of Songkla University

การสอบปลายภาคการศึกษาที่ 1

ปีการศึกษา 2552

วันพฤหัสบดี ที่ 1 ต.ค. 2552

เวลา 13:30 – 16:30 น.

วิชา 237-322 Metallic Materials

ห้อง R201

คำสั่ง

- (1) เขียนคำตอบให้สมบูรณ์ทุกข้อเพื่อให้ได้คะแนนเต็ม
- (2) ให้นำกระดาษ A4 ที่เขียนด้วยลายมือเข้าได้ 1 แผ่น
- (3) ให้เอา Calculator และ Dictionary เข้าห้องสอบได้
- (4) ข้อสอบมี 9 ข้อ ทั้งหมด 9 หน้า ให้ตรวจสอบให้เรียบร้อยก่อนสอบ
- (5) อ่านคำสั่งให้ละเอียด และตอบทุกคำถาม

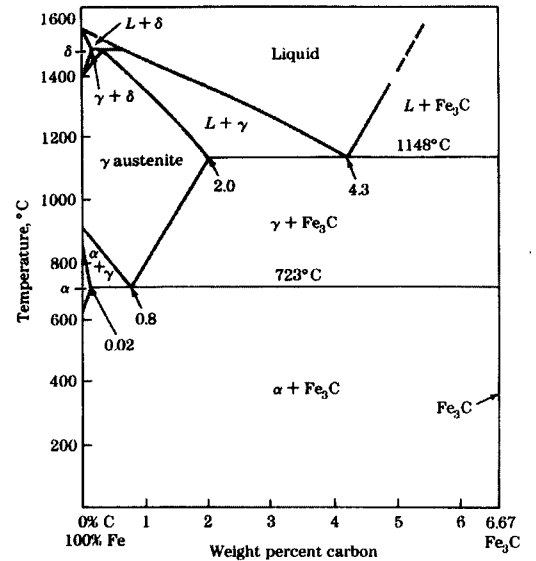
ทุจริตในการสอบโทษขั้นต่ำคือปรับตกในรายวิชาที่ทุจริตและพักการศึกษา 1 ภาคการศึกษา

Question No.	Point	Result
1	10	
2	25	
3	15	
Question No.	Point	Result
1	9	
2	18	
3	5	
4	3	
5	5	
6	10	
Total	100	

Part I of Dr. Jessada (50 points)

Question 1 (10 points)

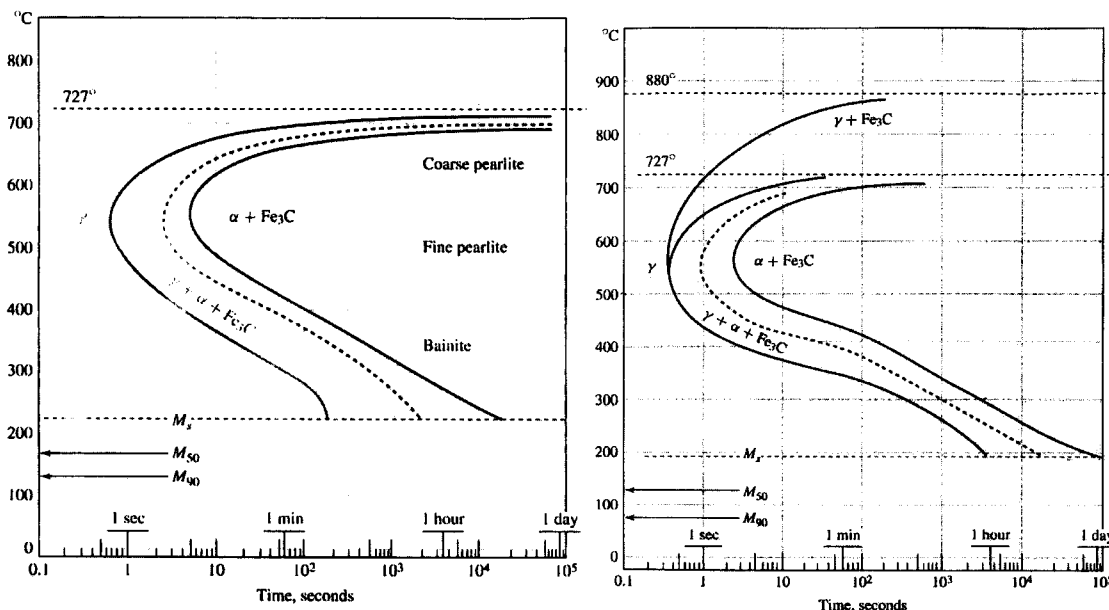
a. From the given phase diagram, draw the microstructure of a **0.8-wt% carbon steel at 600°C**. (5 points)

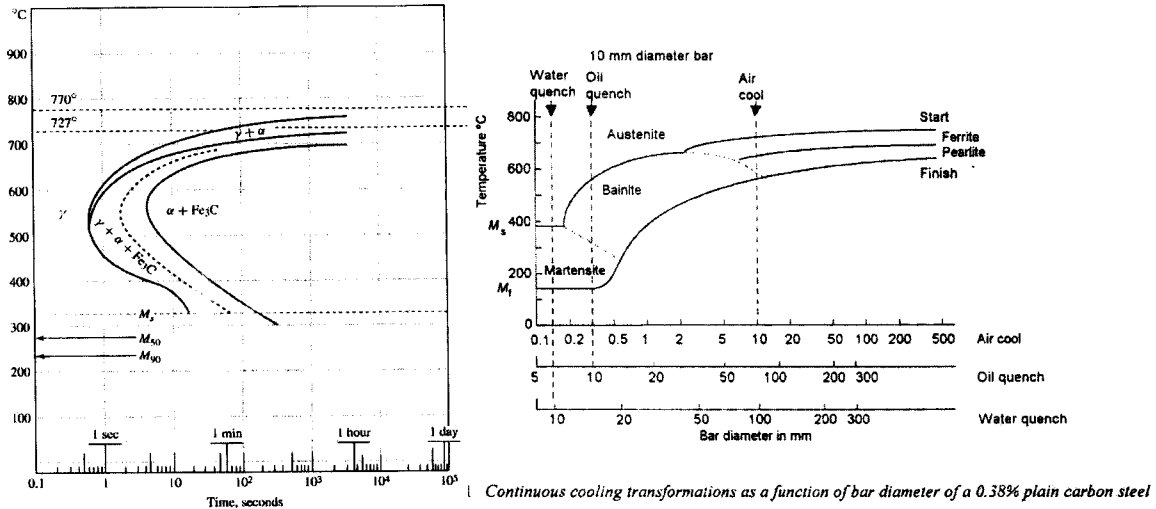


b. How much of each phase in the microstructure of a **0.5-wt% carbon steel at 750°C**. Show your work clearly (5 points)

Question 2 (25 points)

Answer using the following diagrams:





- a) For 0.5% carbon steel, explain how to get a structure consisting of 50% bainite, 25% coarse pearlite, and 25% tempered martensite. Also draw the process on the correct figure (10 points).
- b) For a 0.38% carbon steel, what is the microstructure of the 50-mm steel bar quenched in water. (5 points).
- c) If the center of a steel bar (0.4% carbon steel) has the hardness of 200 HV, answer the following questions:

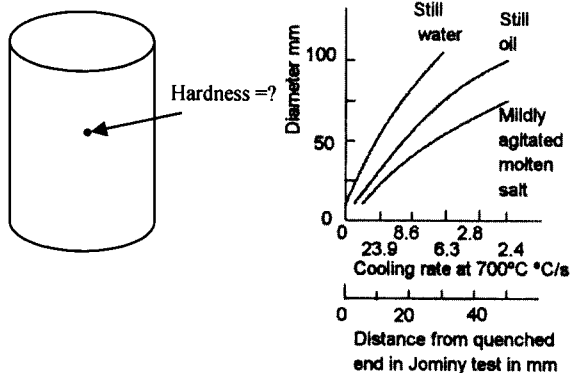


Figure 3.47 Cooling rates at the centres of different diameter bars

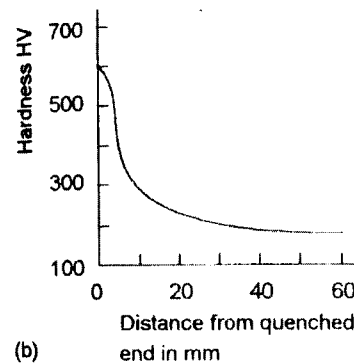


Figure 3.45 (a) Jominey test, (b) results for a 0.4% plain carbon steel

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I. What is the cooling rate at the center? (5 points)

II. What is the diameter of the steel bar (if quenched molten salt)? (5 points)

Question 3 (15 points)

a) Explain briefly the following terms:

a. Alloy 18-8 (3 points)

b. Martempering (3 points)

c. Jominy Test (3 points)

b) In the class, students presented various metallic alloys. List all the alloys that were presented by students in class (6 points).

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PART II: Aj. Weerawan (50 points)

1. Stainless steel is not always stainless, especially when used in unsuitable condition, for example, stainless steel grade 304 is corroded when used in the coastal area and chloride containing environment. (9 points)

1.1 Give two examples of corrosion that would occur when stainless steel grade 304 is used in the coastal area or in chloride containing water for non-load bearing application and explain them.

1.2 Describe what would happen to stainless steel grade 304 when it is used in the oil rig and it is welded at 600-700°C.

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2. Choose an appropriate stainless steel grade **from choices given** below for the following applications and explain your reason: (18 points)

304	347	409L	440C	E-Brite 26-1
321	201	302	430	410
439	316	403	15-5 PH	17-4 PH

2.1 Suggest an austenitic stainless steel grade for an aircraft exhaust manifold or welded tank for chemical at service temperature around 700°C and explain your reason.

2.2 Suggest an austenitic stainless steel grade to be used in the coastal area or in chloride containing water for non-load bearing application. Explain your reason

2.3 Suggest a ferritic stainless steel grade that is suitable for automotive trim, drums and tubs for washing machine and kitchen appliances. Explain your reason.

2.4 Suggest a ferritic stainless steel grade for automotive exhaust pipes and manifold and explain your reason.

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2.5 From question 2.4, would this stainless steel of your choice be suitable for an exhaust system and catalytic converter in a truck which operates at higher temperature? If not, suggest other suitable ferritic stainless steel grade and explain your reason.

2.6 Suggest a martensitic stainless steel grade that has high hardness and excellent abrasive wear resistance for ball bearings or high quality butcher knives and explain your reason in term of composition.

3. Why do precipitation-hardenable (PH) stainless steels have such a high tensile strength compared to others stainless steels? Explain in term of composition and strengthening mechanism. (5 points)

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4. What are shape memory alloys? Briefly discuss three applications of shape memory alloys and explain your reason why they are suitable. (3 points)

5. Your company is to produce high quality kitchen sinks and deep drawing containers for diluted sulfuric acid by a **cold deep-drawing process**. The raw material is high quality stainless steel sheet which is to be order from Thainox Company. However, Thainox Company produces three grades of stainless steel sheet, which compositions and mechanical properties are provided in the following table. From given information, **select an alloy that is most suitable** for your company and carefully **explain your reason**. (5 points)

Name	AISI grade	Cr	Ni	C	Mn	Si	UTS (MPa)	%Elongation	LDR
TNX 1	403	12-13	<0.6	<0.15	<1	<0.5	483	25	1.9
TNX 2	304	18-20	8	<0.08	<2	<0.75	660	50	1.95-2.0
TNX 3	304	18-20	9-10	<0.08	<2	<0.75	610	55	2.0-2.1

* LDR is limit drawing ratio which is capability for material to deep draw into cup-shaped container.

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6. State whether the following statement is **True or False**. If the statement is false, correct it and explain your reason. (10 points)

1. Stainless steels are iron-based alloys that contain at least 11%Al by weight to provide Al_2O_3 oxide film on the steel surface.

2. Stainless steel grade 409 has better weldability and better resistance to weld decay than 409L.

3. Duplex stainless steel has a mixed microstructure of ferrite and martensite and has poor corrosion resistance especially to stress corrosion cracking compared to austenitic stainless steel.

4. Ni-base superalloys are most widely used in advanced aircraft engines and gas turbine because of their outstanding strength and surface stability at high temperature and excellent corrosion and oxidation resistance.

5. Nickel-Iron base superalloys (i.e. Inconel 718) generally have higher strength and can be used at higher temperature (upto 1000°C) than Ni-base superalloys.