

# Faculty of Engineering Prince of Songkla University

การสอบปลายภาคการศึกษาที่ 1

ปีการศึกษา 2553

วัน พฤหัสบดี ที่ 7 ต.ค. 2553

เวลา 13.30-16.30น.

วิชา 237-322 Metallic Materials

ห้อง R200

## คำสั่ง

- (1) เขียนคำตอบให้สมบูรณ์ทุกข้อเพื่อให้ได้คะแนนเต็ม
- (2) ให้นำกระดาษ A4 หนึ่งแผ่นที่เขียนด้วยลายมือตัวเองเท่านั้น ห้ามถ่ายเอกสารหรือพิมพ์
- (3) ให้เอา Calculator และ Dictionary เข้าห้องสอบได้
- (4) อ่านคำสั่งให้ละเอียด และตอบทุกคำถาม

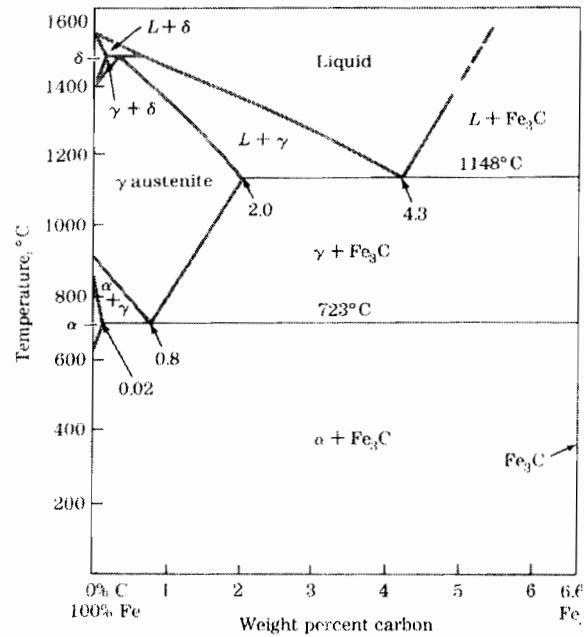
ทุจริตในการสอบโทษขั้นต่ำคือปรับตกในรายวิชาที่ทุจริตและพักการศึกษา 1 ภาคการศึกษา

**Part I of Dr. Jessada (40 points)**

**1. Microstructure and Phase Diagram (10 points)**

a) Draw the microstructure and identify all the phases of the **Fe-1.5%C** at **room temperature** (5 points).

b) From the given phase diagram, draw the microstructure of a **1.5-wt% carbon steel at 800°C**. Also, answer how much of each phase in the microstructure? Show your work clearly (5 points).



**2. Non-Ferrous Alloys (20 points)**

a) Explain clearly the differences between precipitation hardening and dispersion hardening (5 points).

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b) Give the alloying elements that give the following properties in copper alloys:

i. Give yellowish color (2.5 point): \_\_\_\_\_

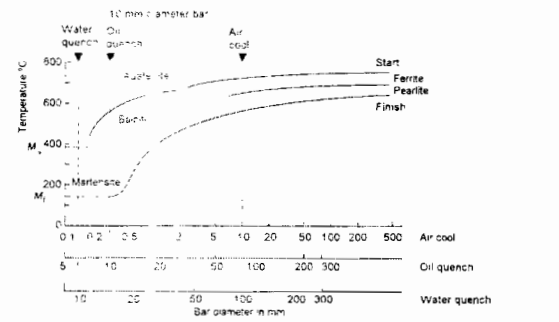
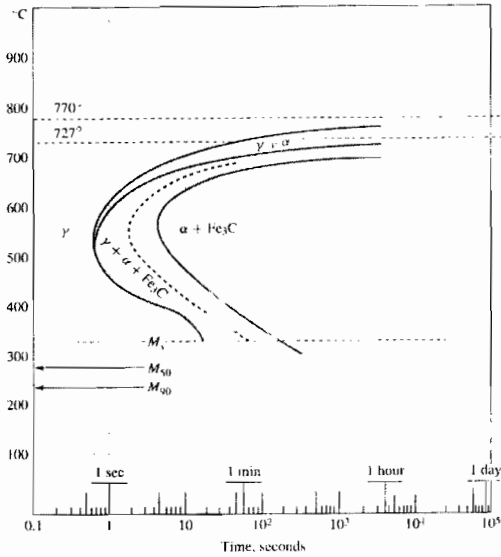
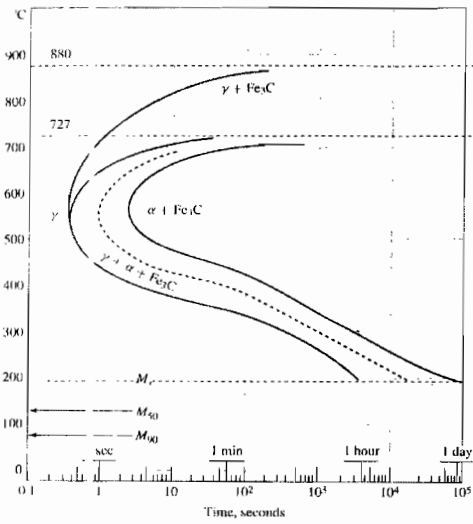
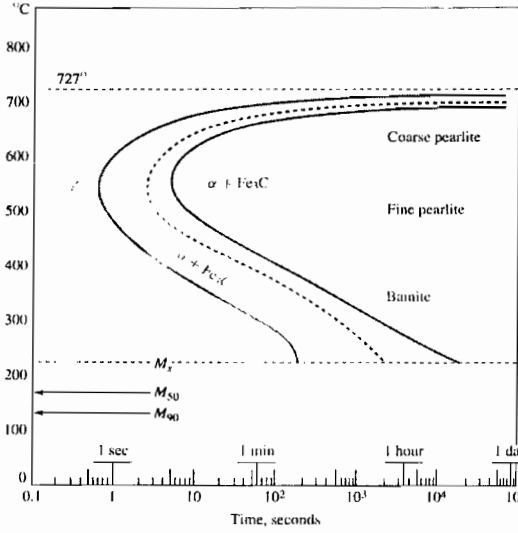
ii. Improve machinability (2.5 point): \_\_\_\_\_

c) Explain the T6 heat treatment procedure clearly (5 points)

d) Zinc will attack steel dies and crucibles. Explain how to solve this problem. (5 points)

**3. Heat Treatment of Steels (10 points)**

a) Your manager wants you to heat treat a 1.0 % plain carbon steel bar with 18 mm diameter to have 50% fine pearlite and 50% bainite. **Describe the heat treatment procedure** clearly by selecting the right diagram given below. Draw the lines also!



1. Continuous cooling transformation as a function of bar diameter of a 0.38% plain carbon steel

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**PART II: Aj.Weerawan (60 points)**

1. Explain the term “stainless steel” and its stainless mechanism. (3 points)

2. Stainless steel that is used in the coastal area or in chloride containing water can suffer from corrosion. Describe the following types of corrosion that may occur in stainless steel: (3 points each)

- Pitting and give 3 examples of alloy addition that would help to increase pitting resistance.

- Crevice and briefly discuss the environment/condition that would promote amount of crevice.

- Intergranular corrosion and briefly discuss in term of chemical composition how you would reduce intergranular corrosion.

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3. Fill in the following table to describe and compare main characteristics of three main classes of stainless steels (ferritic, austenitic and martensitic) including their major chemical composition, their advantages and limitations, also give an example of common AISI grade. (12 points)

Type of SS	Ferritic	Austenitic	Martensitic
Major chemical compositions			
Advantages			
Limitations			
Example of common AISI grade			

4. Your company is to order raw materials from A Stainless Steel Company. This company provides the following stainless steel grades:-

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Grade	Chemical composition							%Elongation
	C	Cr	Ni	Ti	Mo	Al	Mn	
304 type1	≤0.08	18-20	8	-	-	-	-	50
304 type2	≤0.08	18-20	8.5	-	-	-	-	52
304 type3	≤0.08	18-20	9-10	-	-	-	-	55
316L	≤0.03	18-20	10-14	-	2-2.5	-	-	50
409L	≤0.03	10.5-11.75	-	0.48-0.75	-	-	-	25
430	<0.12	16-18	-	-	-	-	-	22
439	≤0.03	17-19	-	0.48-1.0	-	-	-	25
440C	1.07	17	-	-	-	-	-	10
17-7PH	0.07	17	7.1	-	-	1.2	-	10
201	0.15	17	4.5	-	-	-	6	55

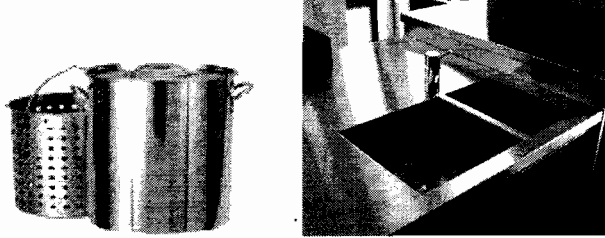
From the above table, choose most suitable stainless steel grade for the following applications and explain your reason:-

4.1 Choose most suitable stainless steel grade to produce an automobile exhaust manifold?  
Explain your reason. (3 points)

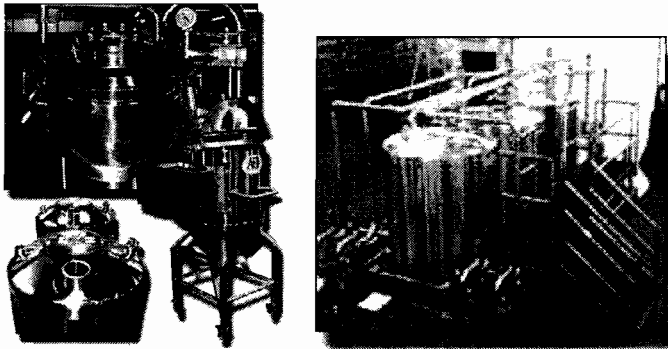


4.2 From question 4.1, suggest other suitable stainless steel grade for an exhaust system and catalytic converter in a truck which operates at higher temperature than 4.1 and explain your reason. (3 points)

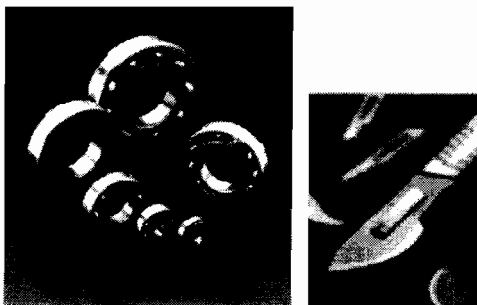
4.3 Austenitic stainless steel grade 304 generally have around 8%Ni which is widely in many applications, however, this company provides 3 types of 304 stainless steel (from table above). Which of these has excellent cold formability and is most suitable to be used to produce deep drawing container i.e. stock pots, sinks? Explain your reason. (3 points)



4.4 Choose most suitable stainless steel grade to produce a chemical vessel used in pharmaceutical and pulp industries? Explain your reason. (3 points)



4.5 Choose most suitable stainless steel grade for ball bearings or high quality surgical knives and explain your reason. (3 points)





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4.6 “409L” is a type of stainless steel. What does the 'L' designation mean? And what is its advantage compare to grade 409? (3 points)

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

6. Why would ferritic stainless steel not suitable to be used in cryogenic temperature while austenitic stainless steel doesn't have this problem? Explain in term of microstructure. (3 points)

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7. What are shape memory alloys? Briefly discuss three applications of shape memory alloys and explain your reason why they are suitable. (5 points)

8. Ni-based superalloy normally consists of  $\gamma$  phase (matrix of FCC austenite),  $\gamma'$  (gamma prime) phase and metal carbides. (5 points)

8.1 What are the structure and the role of  $\gamma'$  in the Ni-based superalloys?

8.2 What are advantages of single-crystal over polycrystalline Ni-base superalloys?