Prince of Songkla University

Faculty of Engineering

Final Examination: Semester I | Academic Year: 2011

Date: October 3, 2011 | Time: 9:00-12:00

Subject: 226-304 Heat Treatment Technology | Room: S201

ทุจริตในการสอบ โทษขั้นต่ำปรับตกในรายวิชานั้นและพักการเรียน 1 ภาคการศึกษา

Name ..... Last name .....student ID.....

Instruction:

1. There are 3 parts (total 135 points) and bonus part.

Part I	30 questions	100 points
Part II	16 questions	20 points
Part III	15 questions	15 points
Bonus part	10 questions	10 points

2. Attempt all questions.
3. Only a hand-written note on two-sided A4 and a dictionary are allowed.
4. Borrowing things form other students is prohibited.

Napisphon Meemongkol

Instructor

Part I: Answer all the questions (100 points)

1. (2 points) What are the two different methods of surface hardening?

   First method is.....

   Second method is .....

2. (3 points) Carburizing can be divided into three categories, what are they?

.....

.....

.....

3. (2 points) Compare solubility of carbon in austenitic state and in ferritic state

.....

4. (4 points) What is the purpose of $BaCO_3$ in Carburizing process?

$BaCO_3$ is used for .....

Complete the equations below and give an answer what the source of carbon in equation (4.2) is.

$BaCO_3 \rightarrow$ ..... + CO_2 (4.1)

$CO_2 + C \rightarrow 2CO$ (4.2)

$2CO + Fe \rightarrow$ ..... + CO_2 (4.3)

The carbon in equation (4.2) came from .....

5. (2 points) In pack carburizing, the depth of carbon penetration into the steel depends on .....

6. (2 points) What are the two stages of Vacuum Carburizing?

First stage is .....

Second stage is .....

7. (2 points) As compared to conventional atmosphere carburizing, how many percent of volume of gaseous hydrocarbon is required for identical carburizing?

.....%

8. (2 points) What are the **limitations** of vacuum carburizing?

..... and .....

9. (2 points) Why is **post carburizing heat treatment** necessary for case carburized parts?

..... and .....

10. (2 points) Why is cyaniding process **less time consuming?**

Because ..... . and

.....

11. (2 points) Compare **cyaniding** and **carbonitriding** case hardening processes

Cyaniding is ..... while

Carbonitriding is .....

12. (3 points) What are the **objectives** of **post carburizing heat treatment**?

.....

.....

.....

13. (4 points) What did the industries do in order to **reduce the cost of post carburizing heat treatment?** (ให้ตอบคำถาม พร้อมวาดภาพประกอบ)

.....

.....

14. (2 points) What kinds of steel using **carbonitriding process** for improving **wear resistance?**

.....

15. (2 points) Compare to **carburizing process**, the **carbonitriding process** are better than carburizing process in ....., ..., and .....

16. (2 points) What is the material used to cover the portion not to be nitrided in **Nitriding process**?

.....

17. (3 points) What are the advantages of the **Nitrocarburizing process**?

1) .....
2) .....
3) .....

18. (2 points) Give two examples of the applications of **boronizing process**?

..... and .....

19. (4 points) What are the benefits of **flame hardening**?

1) .....
2) .....
3) .....
4) .....

20. (4 points) List the **disadvantages of flame hardening**.

1) .....
2) .....
3) .....
4) .....

21. (3 points) In **induction hardening**, the degree of current flow on the outer surface of the component depends on

1) .....
2) .....
3) .....

22. (4 points) The quantity of **gaseous hydrocarbon** using in **vacuum carburizing** depends on

a) .....

b) .....

c) .....

d) .....

23. (2 points) What is the basic aim of **heat treatment of aluminum alloys**?

.....

24. (2 points) What are the two stages of **age hardening of aluminum alloys**?

.....

.....

25. (4 points) Fill in the alloying element in the table below

Alloy No.	**Aluminum wrought alloys (major alloying element)**
4xxx	
5xxx	
6xxx	
7xxx	
8xxx	

26. (5 points) Effects of alloying element on properties of Aluminum

Alloying	Properties of aluminum alloy
Ferrous	
Zinc	
Titanium	
Chromium	

27. (2 points) Give two examples of non-heat treatable aluminum alloys.

..... and .....

28. (2 points) what are the **objectives of heat treatment of titanium** and titanium alloys?

.....

.....

.....

29. (5 points) What are the **five principal types of heat treatment of nickel** and nickel alloys?

.....

.....

.....

.....

.....

30. (20 points) Summarize all surface hardening techniques for steels as a table, in the detail of **types of surface hardening techniques, diffused atoms, hardening temperatures, hardening thickness, hardening time**, level of **hardness, types of steel, benefits and limitations**. (นักศึกษาไม่จำเป็นต้องตอบครบทุกหัวข้อ เลือกเอาหัวข้อที่คิดว่าสามารถให้รายละเอียดได้มากที่สุด ให้เขียนสรุปที่คิดว่าดีที่สุด แสดงไว้ในตารางหน้าถัดไปเท่านั้น หน้า 7 ของข้อสอบ)

PART II: Fill in the blanks using the letter (a-mm) provided in the next page that is related to the questions (1 point each) 20 points

1. **Liquid carburizing** is also known as.....
2. The most widely used method of **carburizing** is.....
3. The advantages of **liquid carburizing** are ..... and.....
4. Temperature and case depth control in ..... is less than liquid and gas carburizing
5. Recent development of **Gas carburizing** technique is the use of ..... as a carrier gas
6. Main advantage of **Vacuum Carburizing** is.....
7. In **Vacuum carburizing** the gaseous hydrocarbon is introduced into the furnace, give two examples of gaseous hydrocarbon ..... and .....
8. **Sub-zero treatment** is also called "....." process.
9. In Nitriding process, ... gas is passed into the furnace at about 550^{o}C, it dissociates into nitrogen and hydrogen
10. The **Boronizing process** can apply to any ferrous material but adopted for ..... **steels** and ..... **steels**
11. In **Boronizing process**, boron diffuses inwards and .....layers are formed
12. In ..... process, the components are packed with chromium powder and additive and put in the furnace.
13. Aluminum alloys can be divided into two forms, which are ..... and .....
14. **Age hardening** of aluminum is also called as .....
15. Most frequently, aluminum parts are quenched by immersion in .....
16. When annealing copper that contains oxygen, the hydrogen in the atmosphere must be kept to a minimum to avoid .....

Answers for part II

a) hot water
b) gas Carburizing
c) solid carburizing
d) liquid carburizing
e) ethane
f) methane
g) propane
h) heat transfer is rapid
i) freeze treatment
j) very small furnace
k) energy saving
l) warm water
m) cold water
n) hardening
o) embrittlement
p) salt bath carburizing
q) carbon
r) mild
s) alloy
t) tool
u) iron boride
v) heating time is short
w) diffusion
x) hydrogen
y) carbon dioxide
z) iron carbide
aa) minus treatment
bb) cryo treatment
cc) boronizing
dd) chromizing
ee) cast
ff) wrought
gg) precipitation hardening
hh) oxygen
ii) nitrogen
jj) butane
kk) octane
ll) hydrogen sulfide
mm) ammonia
nn) rapidly cooling

Part III : Right-Wrong examination (15 points)

Put (/) in front of correct statements and (X) in front of false statements, the right answer will get 1 points, the wrong answer will get -0.5 points and no answer will get 0 point.

.....1 In **liquid carburizing** Heating time is short and heat transfer is rapid

.....2 **Pack carburizing** is the Most widely used method of carburizing

.....3 **Nitriding** carried out in a ferritic region below 590°C, no phase change after nitriding

.....4 **Cyaniding process** is less time consuming because of high heat transfer coefficient in liquid bath and uniform bath temperature, distortion of pieces is less

.....5 In **Nitrocarburizing process**, surface hardenability, wear resistance and corrosion resistance are better than carburizing process but time required for heat treatment is longer than that of carburizing

.....6 **Carbonitriding** is carried out at temperatures substantially higher than plain nitriding but slightly lower than carburizing and for shorter times

.....7 In **Nitriding process**, the portions not to be nitrided cover by **zinc**.

.....8 Two Types of salt bath Nitrocarburizing are **cyanide** and **cyanide- free**

.....9 **Boronizing** applied to any ferrous material but adopted for **carbon steels** and **tool steels**

.....10 The **TD process** produces a smooth, thin, non-porous layer of extremely hard tungsten carbide (WC) on the surface of steel.

.....11 In **Induction hardening**, the steel part is placed inside a electrical coil which has alternating current through it.

.....12 In **Induction hardening**, heating of the component is achieved by electromagnetic induction

.....13 **LASER** is abbreviated from **L**ight **A**mplification by **S**imulated **E**mission of **R**adiation

.....14 One of the benefit of **Laser hardening** is Minimal distortion due to low thermal load

.....15 **Laser hardening process** is very precise in applying heat selectively to the areas that need to be heat-treated.