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CONFIDENTIAL

SET A

UNIVERSITI KUALA LUMPUR

MALAYSIA FRANCE INSTITUTE

FINAL EXAMINATION

SEPTEMBER 2013 SESSION

SUBJECT CODE	:	**FTB32303**
SUBJECT TITLE	:	**WELDING METALLURGY 2**
LEVEL	:	**BACHELOR**
DURATION	:	**2 ½ HOURS**
DATE / TIME	:	

INSTRUCTIONS TO CANDIDATES

1. **Please read the instructions given in the question paper CAREFULLY.**
2. **This question paper is printed on both sides of the paper.**
3. **Please write your answers on the answer booklet provided.**
4. **Answer should be written in blue or black ink except for sketching, graphic and illustration.**
5. **This question paper consists of TWO (2) sections. Section A and B. Answer ALL questions in Section A. For Section B, answer TWO (2) questions only.**
6. **Answer all questions in English.**

THERE ARE 4 PRINTED PAGES OF QUESTIONS, AND 1 PAGE OF FORMULA EXCLUDING THIS PAGE.

SECTION A (Total: 60 marks)

Please use the answer booklet provided.

INSTRUCTION: Answer ALL questions only.

Question 1

(a) Define the weld preheating.

(4 Marks)

(b) List **TWO (2)** objectives of preheating.

(4 Marks)

(c) Discuss the advantages of using as gas flame as preheating method.

(4 Marks)

(d) Your task is to weld a 150 mm thickness mild steel plate without risk of cracking. Material compositions were given as below;

C = 0.22%	P = 0.03%
Mn = 1.0%	S = 0.03%
Si = 0.9%	Balance is Fe

Determine the preheating and interpass temperature by susceptibility grouping method. The mild steel plates are to be butt welded by using gas metal arc welding (GMAW) process under medium constrain.

(8 Marks)

Question 2

(a) Predict the minimum and maximum percentage of hydrogen which it able to remove from weldment. Welding parameter and condition were given as below;

Plate Thikness	= 20 mm
Joint Design	= Butt
Preheating and Interpass Temperature	= 200°C
Preheating and Interpass Duration	= 5 hour

(6 Marks)

(b) Based on question 2(a), without appling any preheating and interpass temperature, the amount of hydrogen entrapped in weldment as 80ml. Assume 10ml is maximum allowable hydrogen entrapped in weldment for prevention of weld cracking. Design a PWHT process that need to be carried out after preheating and interpass temperature as in question 2(a).

(14 Marks)

Question 3

(a) Give **TWO (2)** differences of DeLong compare to Schaeffler diagram.

(4 Marks)

(b) Explain the important of ferrite number (FN) in DeLong diagram.

(2 Marks)

(c) By aided of constitution diagram given in appendix 2, select the most suitable filler metal for welding plate SS320 and SS 316. Assume 25% dilution was occurred and Nitrogen pickup was 0.08%

(12 Marks)

Table 1: Base and filler metal compositions

	Base metal (%)		**Filler Metal (%)**	
	SS316	**SS320**	**ER309L**	**ER2209**
Carbon	0.08	0.02	0.3	0.02
Manganese	2.0	2.0	2.00	1.5
Chromium	19.00	20	23.5	22.5
Silicon	0.6	0.7	1.5	1.0
Nickel	12.0	34	13.5	9
Molybdenum	2.0	2.5	0.2	-
Nobium	-	0.3	-	-
Sulphur	0.030	0.035	0.030	-
Phosphorus	0.045	0.035	0.030	-

(d) State your reason for your selection in question 3(c).

(2 Marks)

SECTION B (Total: 40 marks)

INSTRUCTION: Answer TWO (2) questions only.

Question 1

Welding may produce metallurgical modifications that can be increased the susceptibility to corrosion attack. Welding unstabilize austenitic stainless steel may cause metallurgical modification towards susceptiblilty to intergranular corrosion or weld decay.

(a) Sketch the weld decay region for tee joint.

(4 Marks)

(b) Explain how weld decay occurs.

(8 Marks)

(c) Weld decay able to prevent by avoiding the formation of chromium carbide. Is it effective method to prevent weld decay by reduce carbon content (maximum carbon 0.03 wt%). Discuss and give your opinion.

(8 Marks)

Question 2

Recently aluminum alloys uses in industry are increase due to good corrosion resistance and good strength per weight ratio. However, a number of problems associated with welding of aluminum alloys such as porosity, solidification cracking and lost of strength make it low or moderate weldability compared to steels.

(a) Classify the groups of aluminum alloys and give **ONE (1)** example for each.

(4 Marks)

(b) Explain how loss of strength occurs in welded non heat treatable aluminum alloys.

(4 Marks)

(c) Briefly explain your opinion how to reduce the porosity in aluminum welding that caused by entrapped hydrogen.

(12 Marks)

Question 3

Nickel base alloys are generally used in harsh environments that demand either corrosion resistance or high temperature strength.

(a) List **TWO (2)** typical problems in welding nickel base alloys.

(4 Marks)

(b) Explain how reheat cracking occurs in nickel alloys.

(6 Marks)

(c) Refer to Figure 1, explain the loss of hardness for point 1 and 2 compare to base metal at point 3 and 4.

(10 Marks)

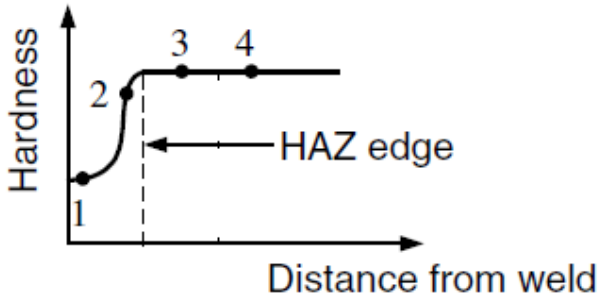


Figure 1: Hardness distribution after weld of heat treatable nickel alloy

END OF QUESTION

Appendix1

Table 1: Susceptibility Index grouping

Hydrogen Level (H)	*Pcm*				
	< 0.18	< 0.23	< 0.28	< 0.33	< 0.38
H_1	A	B	C	D	E
H_2	B	C	D	E	F
H_3	C	D	E	F	G

Where, H_1 = 5 ml/100g of weld metal
H_2 = 10 ml/100g of weld metal
H_3 = 30 ml/100g of weld metal

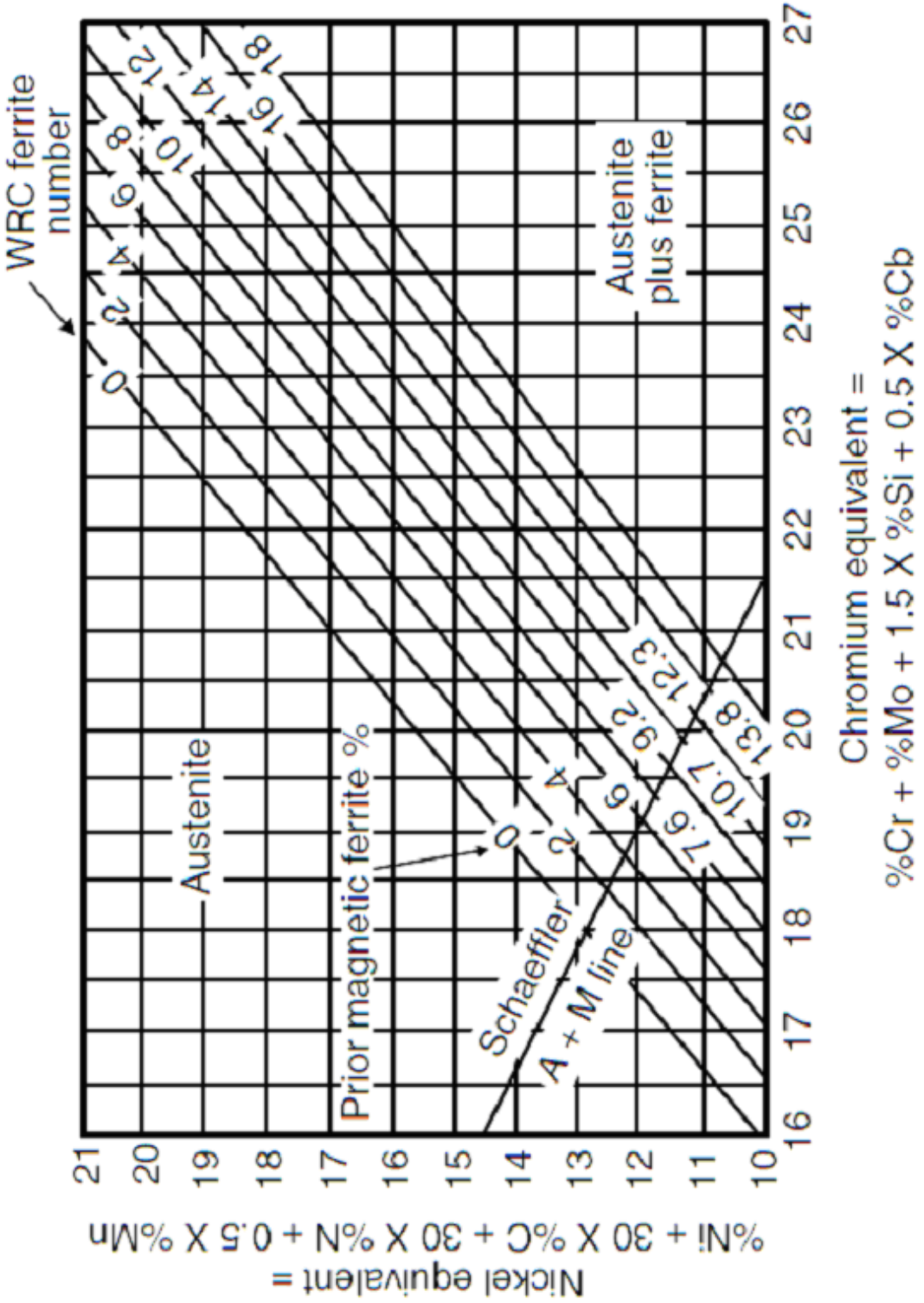
Table 5.3. Minimum Preheat and Interpass Temperatures (Above the Ambient) for Fillet and Butt Welds for Three Levels of Restraint (°C)

Level of Restraint	*Thickness* (mm)*	*Susceptibility Index Grouping*						
		A	*B*	*C*	*D*	*E*	*F*	*G*
Low	10	< 20	< 20	< 20	< 20	60	140	150
	10–19	< 20	< 20	20	60	100	140	150
	19–38	< 20	< 20	20	80	110	140	150
	38–75	20	20	40	95	120	140	150
	> 75	20	20	40	95	120	140	150
Medium	10	< 20	< 20	< 20	< 20	70	140	160
	10–19	< 20	< 20	20	80	115	145	160
	19–38	< 20	20	75	110	140	150	160
	38–75	20	80	110	130	150	150	160
	> 75	95	120	140	150	160	160	160
High	10	< 20	< 20	< 20	40	110	150	160
	10–19	< 20	20	65	105	140	160	160
	19–38	20	85	115	140	150	160	160
	38–75	115	130	150	150	160	160	160
	> 75	115	130	150	150	160	160	160

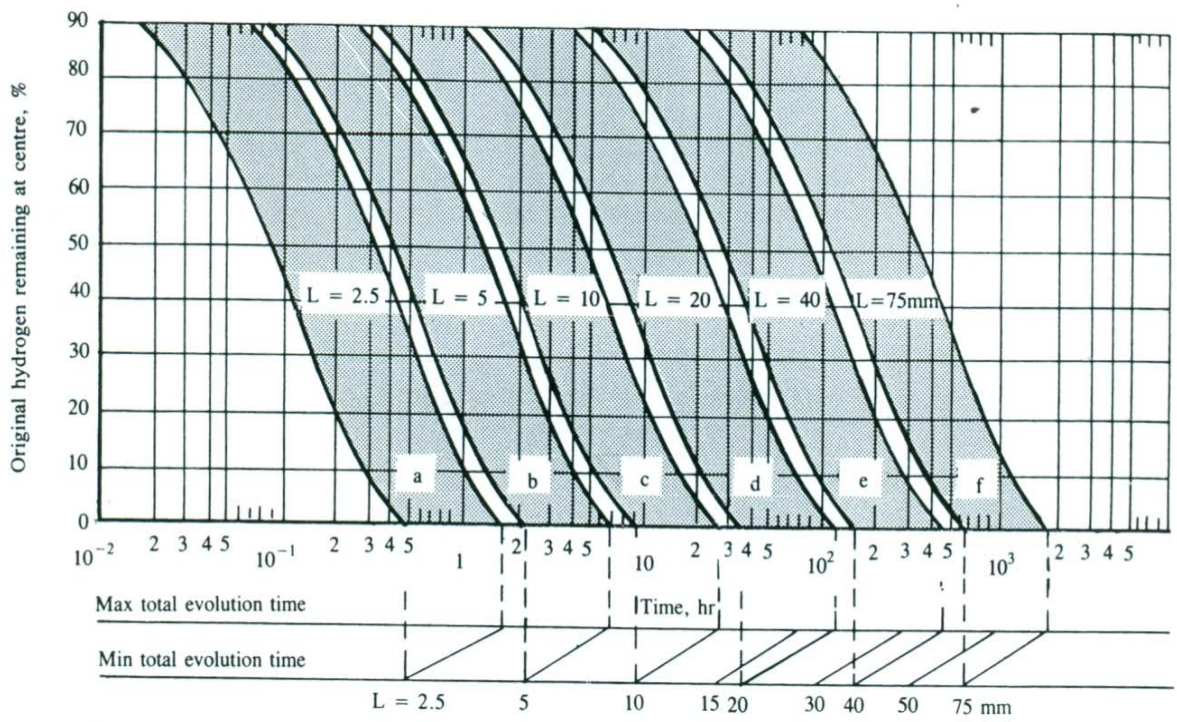
* Thickness refers to thicker part.

$$P_{cm} = C + \frac{Si}{30} + \frac{Mn}{20} + \frac{Cu}{20} + \frac{Ni}{60} + \frac{Cr}{20} + \frac{Mo}{15} + \frac{V}{10} + 5B$$

Appendix 2

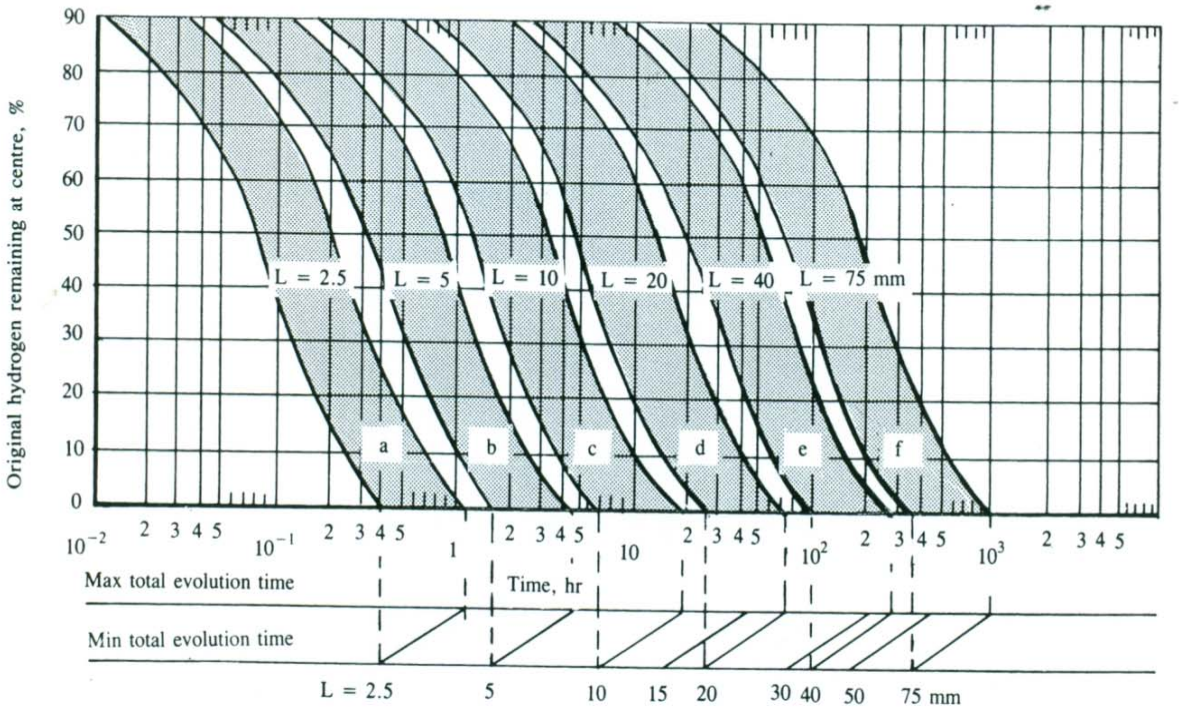

WRC ferrite number
Austenite
Austenite plus ferrite
Prior magnetic ferrite %
Schaeffler
A + M line
Nickel equivalent =
%Ni + 30 X %C + 30 X %N + 0.5 X %Mn
Chromium equivalent =
%Cr + %Mo + 1.5 X %Si + 0.5 X %Cb

Appendix 3

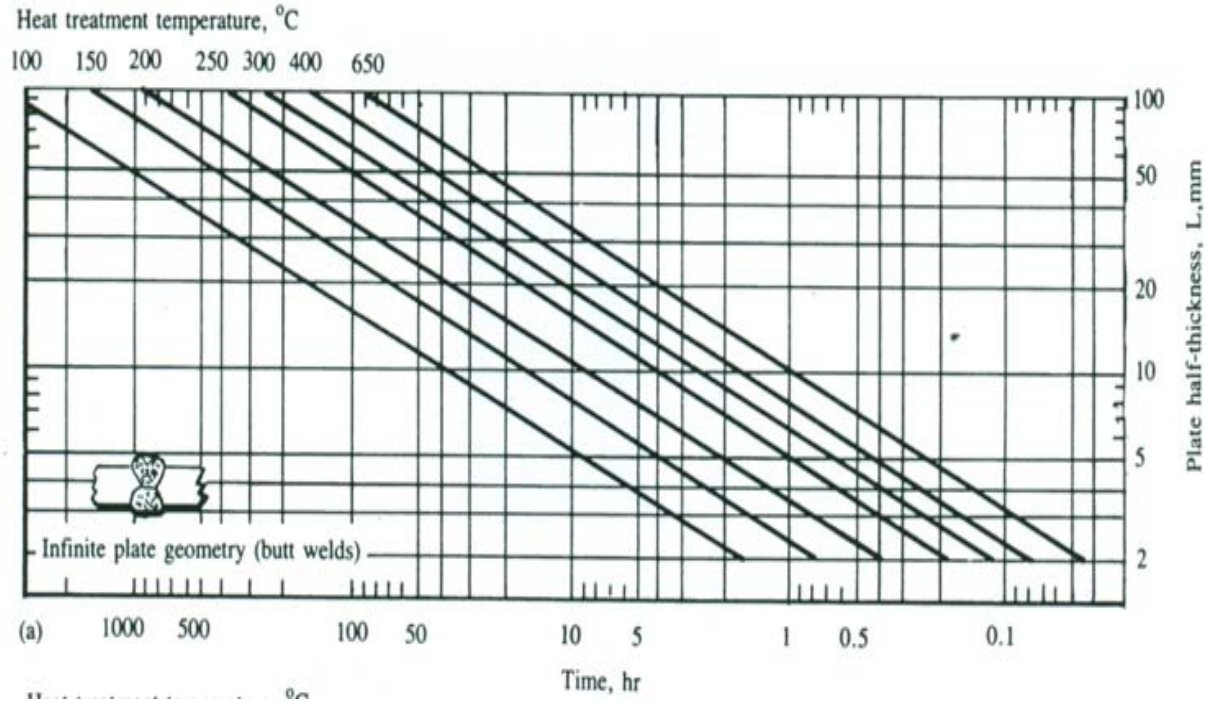


5.4 Infinite plate 200 °C.

5.5 Infinite plate 250 °C.



Appendix 4



Approximately time for removing 75% of original hydrogen for butt weld