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CONFIDENTIAL

SET A

UNIVERSITI KUALA LUMPUR

MALAYSIA FRANCE INSTITUTE

FINAL EXAMINATION

JANUARY 2014 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 5 PRINTED PAGES OF QUESTIONS, AND 2 PAGE OF APPENDIX EXCLUDING THIS PAGE.

SECTION A (Total: 60 marks)

Please use the answer booklet provided.
INSTRUCTION: Answer ALL questions only.

Question 1

The main objective of welding heat treatment process is to improve the weldability. The heat treatment can be divided into before, during and after weld.

(a) List **TWO (2)** methods for measure the temperature of preheating.

(4 Marks)

(b) One of the objectives of preheating is to reduce welding cooling rate. Explain the benefits of reduce cooling rate to weldment.

(4 Marks)

(c) Discuss the relationship between combine thickness and formation of final weld microstructure.

(6 Marks)

(d) Your task is to weld a 100 mm thickness mild steel plate without risk of cracking. Material compositions were given as below;

C = 0.12%	P = 0.03%
Mn = 0.60%	S = 0.03%
Si = 0.4%	Balance is Fe

Determine the preheating temperature by susceptibility grouping method. The mild steel plates are to be butt welded by using Gas Metal Arc Welding (GMAW) process under medium constrains.

(6 Marks)

Question 2

(a) Refer to welding parameter and condition were given as below, predict the maximum, minimum and average remaining hydrogen at center of weldment.

Plate Thickness	= 20 mm
Joint Design	= Butt joint
Preheating and Interpass Temperature	= 300°C
Preheating and Interpass Duration	= 1 hour

(6 Marks)

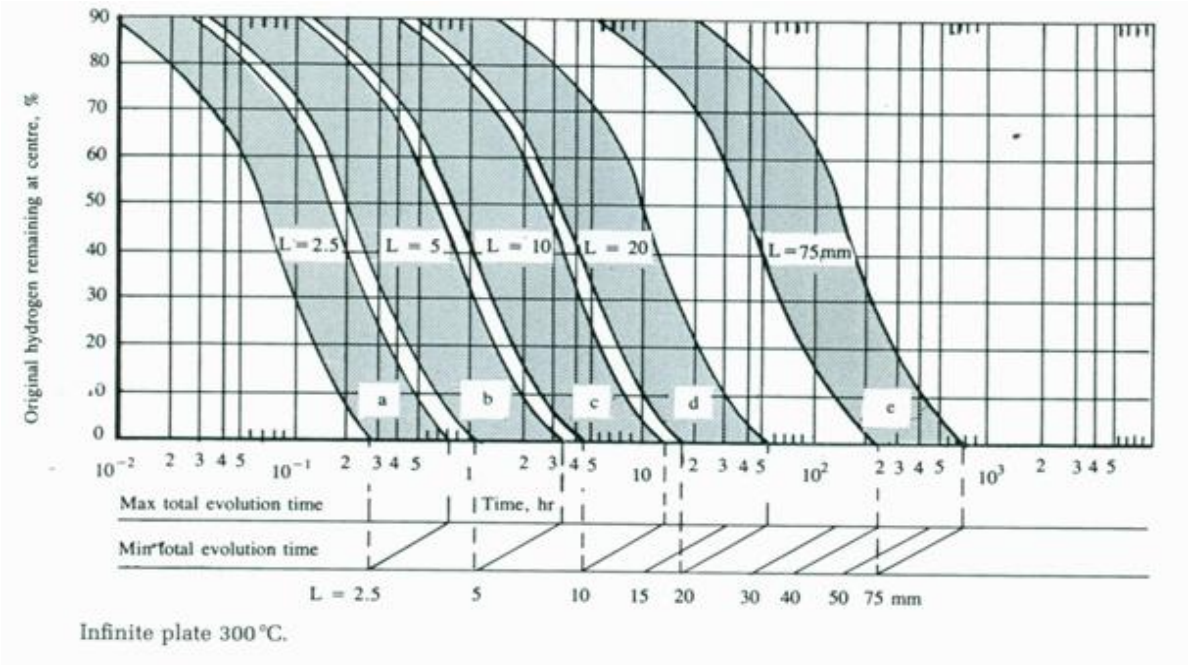

Figure 1: Remaining hydrogen as preheating or interpass temperature for 300ºC.

(b) Assume the amount of hydrogen entrapped in weldment is 20ml. The maximum allowable hydrogen entrapped in weldment for prevention of weld cracking is 10ml. Based on diagram in Figure 2, design a suitable temperature and time for Post weld heat treatment (PWHT) process to prevent weld cracking. Other welding and PWHT process parameter as below.

Plate thickness	= 40mm
Joint Design	= Double V butt weld
Room temperature	= 30ºC
Maximum heating and cooling rate for PWHT	= 200ºC/hr
Maximum time for PWHT process	= 8 hours

(14 Marks)

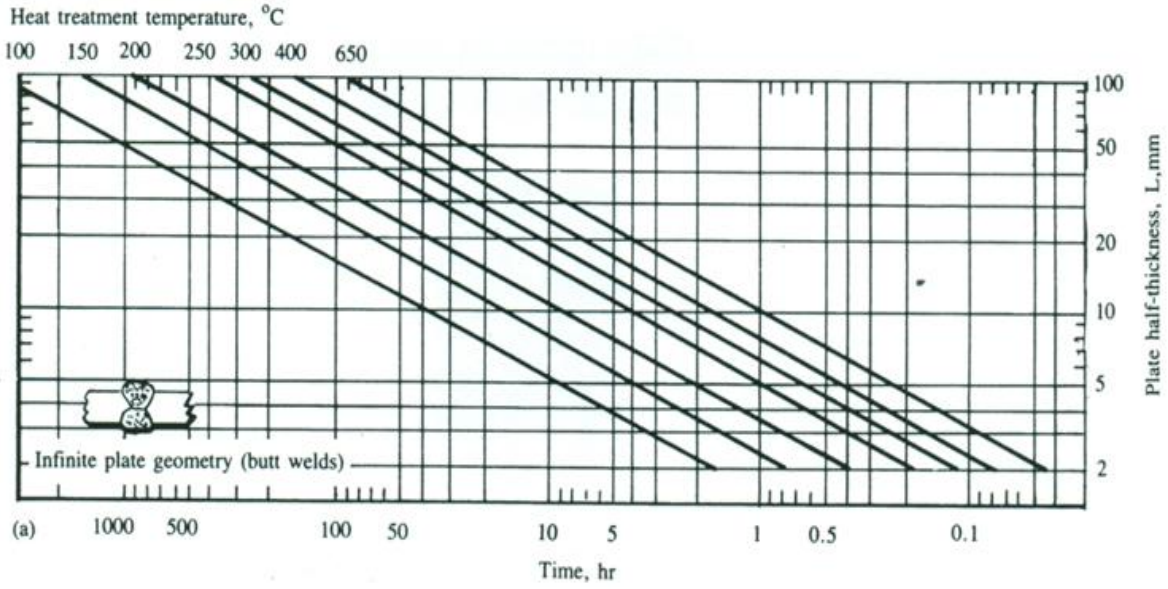

Figure 2: Approximately time for removing 75% of original hydrogen for butt weld

Question 3

One of major criterion for successful dissimilar welding is a suitable filler metal or wire have been used. Assume 30% dilution was occurred and Nitrogen pickup was 0.10% involved in dissimilar welding between two plate of A36 and SS 316L by using filler metal ER309L and ER2209.

Table 1: Base and filler metal compositions

	Base metal (%)		**Filler Metal (%)**	
	SS316L	**A36**	**ER309L**	**ER2209**
Carbon	0.02	0.15	0.03	0.02
Manganese	2.0	0.4	2.00	1.5
Chromium	17.00	-	23.5	22.5
Silicon	0.6	0.2	1.5	1.0
Nickel	12.0	-	13.5	9
Molybdenum	2.0	-	0.2	0.2
Copper	0.2	-	0.1	0.2
Nitrogen	0.02	-	0.06	0.15

(a) Calculate the Ferrite Number (FN) for joining dissimilar metal by both of filler metals.

(12 Marks)

(b) By aided of WRC 1992 diagram, determine the most suitable filler metal and explain the reason.

(4 Marks)

(c) Discuss the important of boundaries F, FA and AF in WRC 1992 diagram.

(4 Marks)

SECTION B (Total: 40 marks)

INSTRUCTION: Answer TWO (2) questions only.

Question 1

Welding austenitic stainless steel containing carbon 0.05% or more can cause severe to weld decay.

(a) Sketch the location of weld decay for single V butt joint.

(4 Marks)

(b) Discuss the effects of heat input to weld decay.

(6 Marks)

(c) State **TWO (2)** methods to prevent weld decay.

(4 Marks)

(d) Weld decay occurs due to formation of chromium carbide. Explain how chromium carbide was formed.

(6 Marks)

Question 2

(a) Generally the coefficient of thermal conductivity of aluminum is six times that of steel. Discuss the welding behavior of aluminum compare to steel influence by this physical property.

(4 Marks)

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

(6 Marks)

(c) Porosity is a common problem occurs in welding aluminum alloys. It is impossible to eliminate but able to minimize by proper control. Discuss **THREE (3)** methods to minimize the porosity.

(10 Marks)

Question 3

(a) List **THREE (3)** common problems associated with welding nickel alloy.

(6 Marks)

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

(8 Marks)

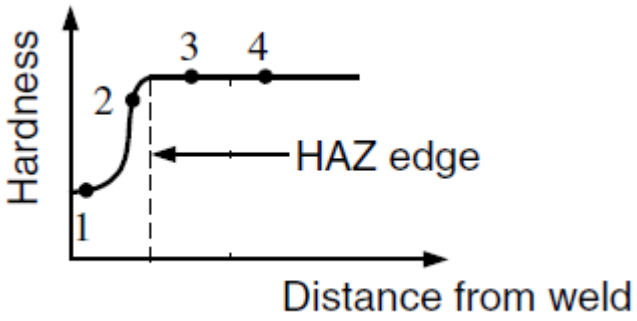

Figure 2: Hardness distribution after weld of heat treatable nickel alloy

(c) Refer to Figure 2. Sketch the microstructures for point 1 to 3.

(6 Marks)

END OF QUESTIONS

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 2: 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 1992