

THE UNIVERSITY OF ADELAIDE
DEPARTMENT OF MECHANICAL ENGINEERING

EXAMINATION FOR THE DEGREE OF B.E.

2552: Topics in Welded Structures

EXAMINATION - NOVEMBER, 2001

TIME: 3 HOURS & 10 MINUTES

[Students are advised to devote 10 minutes to reading the paper and planning their approach.]

[The use of notes, textbooks and calculating devices with the exception of laptop computers is permitted in the examination room.]

Attempt **ALL FIVE** questions.

Question 1

Each of the following welding processes can be used for welding mild steel sheet. For each process:

- Illustrate the process
- Identify how heat is provided in the process
- Describe how the join between the two pieces of mild steel sheet is formed
- Name one advantage of the process for the welding of mild steel sheet

a) Gas metal arc welding **(5 marks)**

b) Electron beam welding **(5 marks)**

c) Resistance spot welding **(5 marks)**

Of all the welding and joining processes described in this course, which would you use for each of the following application and why?

(5 marks – any appropriate choice will be awarded marks)

- a) a steel bridge
- b) a wine vat
- c) a sheet steel on the outside of a fridge
- d) railway lines
- e) joints in plumbing

Question 2

A piece of carbon steel is arc welded. The parent steel has a microstructure composed of ferrite and pearlite. The coarse grained (grain growth zone) heat affected zone (CGHAZ) has a microstructure composed of martensite.

- a) Illustrate the location of the parent material and the CGHAZ in a butt welded joint. **(4 marks)**
- b) How do you expect the properties of the parent steel and the CGHAZ to differ in terms of:
- Hardness **(2 marks)**
 - Strength **(2 marks)**
 - Toughness **(2 marks)**
- c) Is a martensitic heat affected zone microstructure generally considered to be 'good' or 'bad' when formed in the heat affected zone of a ferrite/pearlite steel? Give reasons. **(5 marks)**
- d) How might you improve the final mechanical properties of the CGHAZ either during or after welding if there is potential for the CGHAZ to have a martensitic microstructure? **(5 marks)**

Question 3

- a) What filler material would you recommend for gas metal arc welding of 304 grade austenitic stainless steel? **(4 marks)**
- b) Using the Schaeffler diagram on the next page, illustrate why your choice of filler metal would give a weld metal deposit with a satisfactory chemical composition and mechanical properties.

Assume:

Composition of 304 parent material is 0.06%*C*, 19%*Cr*, 9%*Ni*, 2%*Mn*

Composition of 316 GMAW filler wire is 0.08%*C*, 19%*Cr*, 12%*Ni*, 2.5%*Mo*, 0.4%*Si*, 1.8%*Mn*

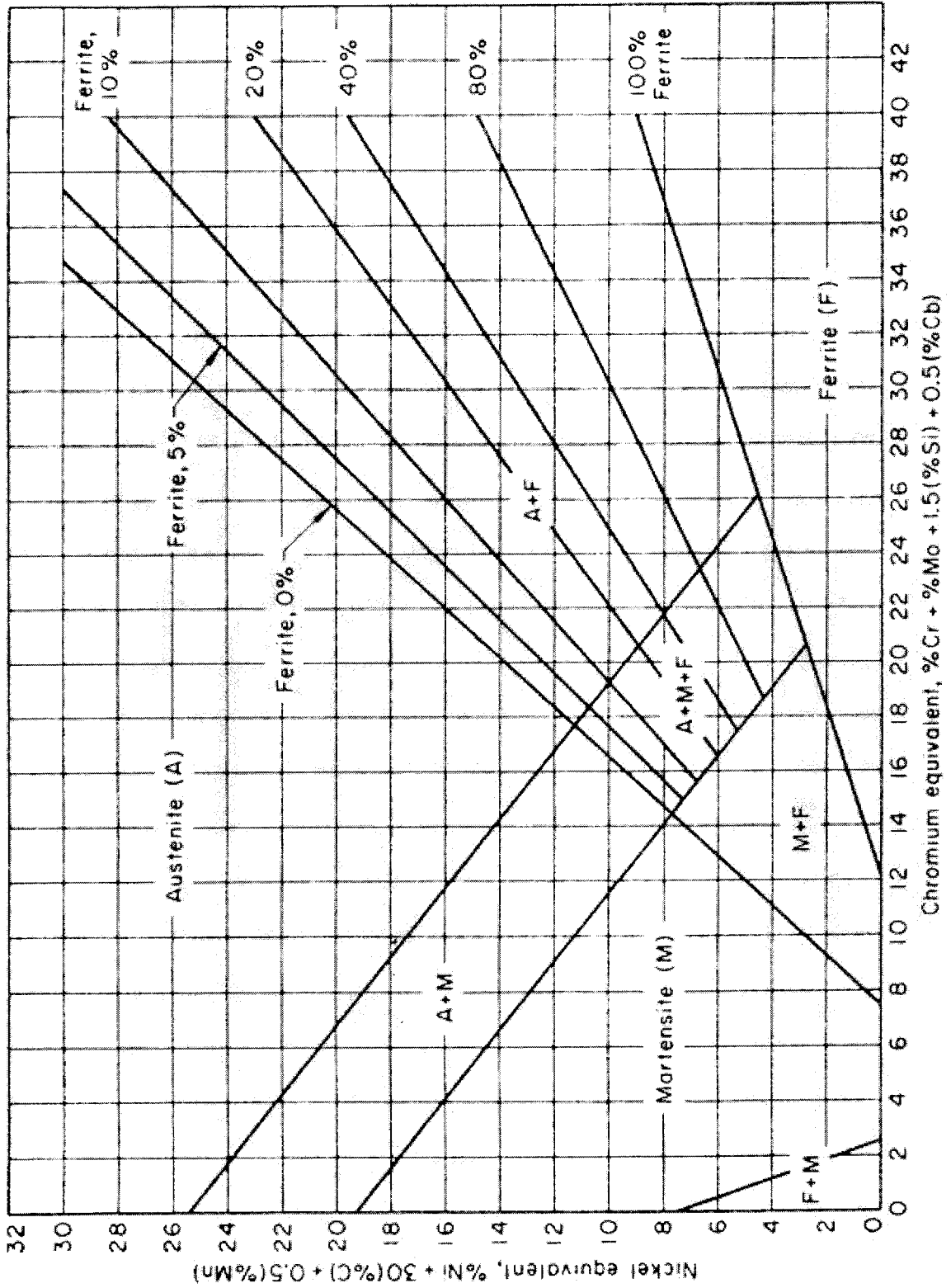
Composition of 308L GMAW filler wire is 0.03%*C*, 21%*Cr*, 10%*Ni*, 0.4%*Si*, 1.8%*Mn*

The GMAW process dilutes 15% of the parent material from each side of the weld joint into the weld metal.

Note: *Cb* is an alternative symbol for niobium (*Nb*).

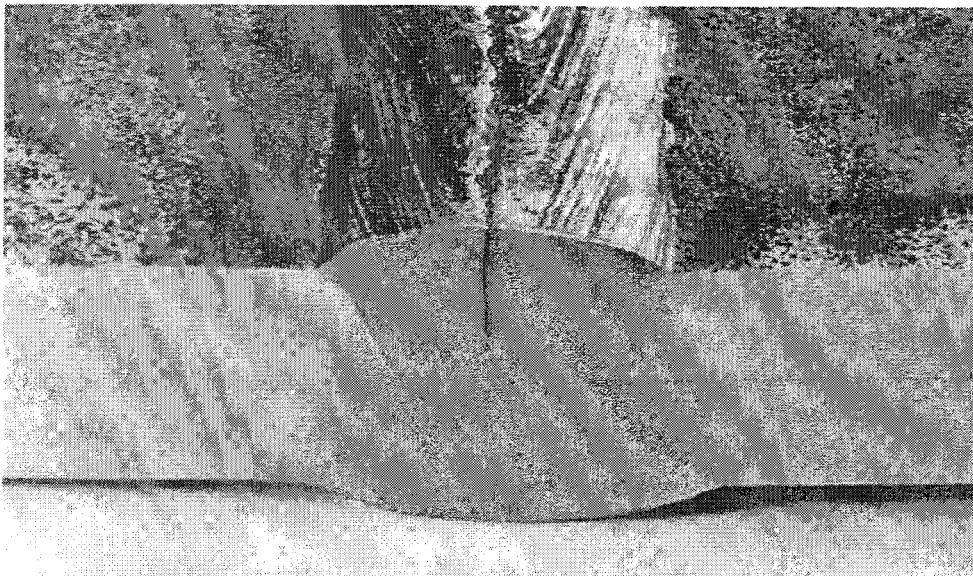
Plot the compositions of the parent material, the chosen welding consumable and the final weld metal on the Schaeffler diagram on the next page. **(10 marks)**

- c) Give reasons for your choice of consumable. **(6 marks)**



Question 4

- a) Identify the defect in the photograph below this question. **(5 marks)**
- b) Describe the mechanism by which this defect occurs. **(5 marks)**
- c) Which non destructive testing techniques could be used to detect this defect in:
- a carbon steel weld. **(3 marks)**
 - an austenitic stainless steel weld. **(3 marks)**
- d) Suggest ways in which this weld defect could be avoided for:
- a carbon steel weld. **(2 marks)**
 - an austenitic stainless steel weld. **(2 marks)**



Question 5

Refer to the diagram below this question. There are four defects in the pressure vessel illustrated. The defects are all of the same size and are through wall. The yield strength of the material is 250MPa, and the pressure in the vessel is 5MPa.

- a) If the vessel has not been stress relieved, provide formulas to describe the total stresses acting on each defect attempting to propagate the defects. List assumptions and define the parameters in the formulae. **(8 marks)**
- b) Rank the four defects in order of severity, with the defect ranked 1 being the one that will propagate first as the vessel is pressurised. **(4 marks)**
- c) Describe four ways by which the residual stress associated with a weld can be reduced. **(8 marks)**

