

SAULT COLLEGE OF APPLIED ARTS AND TECHNOLOGY

SAULT STE. MARIE, ON

COURSE OUTLINE

COURSE TITLE: MATERIAL SCIENCES - WELDING

CODE NO: WLD120 **SEMESTER:** WINTER _____

PROGRAM: WELDING and FABRICATING - Techniques
AVIATION WELDING

AUTHOR: D. SOCCHIA

DATE: **PREVIOUS OUTLINE DATED:** July 94

APPROVED: DEAN   DATE

COURSE NAME

CODE NO.

TOTAL CREDITS:

PREREQUISITE(S): Successful completion of the following semester 1 courses: Fabrication and Layout I plus Basic Shielded Metal Arc. <OR> A combination of education and previous trade experience equal to the above.

L PHILOSOPHY/GOALS:

To provide students with a reasonable understanding of the basic concepts related to the weldability of carbon steels. Secondly, to make students aware of the increasing demand placed upon them by the many welding codes and / or material specifications in use by the fabrication industry.

n. STUDENT PERFORMANCE OBJECTIVES (OUTCOMES):

Upon successful completion of this course the student will:

1. Understand mechanical properties well enough to appreciate the need for careful electrode selection.
2. Recognize the numerous variables that have the potential to affect the quality and soundness of a weld.
3. Respect the demands of CSA and / or ASME welding codes and material specifications.

m. TOPICS TO BE COVERED:

Approximate Time

- | | |
|---|------------|
| 1. Course Introduction and Orientation | |
| 2. Basic Heat Treatments and H.A.Z.
Independent Reading Assignments
—^Theory Test # 1 and Review— | @ 12 Hours |
| 3. Cold Cracking vs Hardness and Hydrogen Control
Independent Reading Assignments
Independent Study Assignments
—Theory Test # 2 and Review— | @ 12 Hours |

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IV. LEARNING ACTIVITIES / REQUIRED RESOURCES:

Topic / Unit - # 1. Course Introduction and Chientation

Learning Activities;

- 1.1 > A lecture presentation of the following major course documents:
- a) course outline
 - b) course guidelines
 - c) course marking system including attendance requirements

Resources;

- > printed handouts, overheads, chalkboard notes.

Topic / Unit - # 2. Basic Heat Treatments and H.A.Z.

Learning Activities;

- 2.1 > A lecture presentation with classroom discussion of the various crystalline structures that exist in hot rolled and normalized plain carbon steel at room temperature.
- > Student summary of main concepts and ideas.
(Met Module: 'Steel Welding MetaUurgv-', page 19, 20 and 21)
- 2.2 > A series of shop / lab demonstrations to illustrate the following basic heat treatments and their effect upon hardness, ductility and strength:
- a) anneal / normalize
 - b) water quench-harden
 - c) oil quench-harden
 - d) temper
- > Student summary of main concepts and ikieas.

- 2.3 > **Independent Reading Assignment** c/w review questions on the topic of 'Basic Heat Treatments' to include.
- a) the procedures and temperatures involved with each process.
 - b) the net effect upon crystalline structure and mechanical properties.
(Text: 'Modern Welding', page 621 to 628 incl.)
- 2.4 > A lecture presentation with classroom discussion of the individual zones in the HAZ of a completed weldment that includes the following major items:
- a) the origins, heat inputs and mechanics of the HAZ
 - b) final HAZ structures resulting from a normalized weld
 - c) final HAZ structures resulting from a quenched weld
- 2.5 > A lecture presentation with classroom discussion of the major factors affecting the extent of change in crystalline structure for a given HAZ.
- 2.6 > A slide presentation of various test welds, their resulting data plus a summary of topic areas.
- 2.7 > **Independent Reading Assignment** c/w review questions based upon learning activity #'s 2.5, 2.6, and 2.7

Resources:

- > Metallurgy Module: 'Steel Welding Metallurgy'
Text: 'Modern Welding'
Printed Handouts, Assignment Sheets, Chalkboard Notes.

Topic / Unit: - THEORY TEST # 1 and REVIEW

Resources:

- > Test Booklets, Student Response Sheets, Grade / Answer Sheets

Topic / Unit - # 3. Cold Cracking vs Hardness and Hydrogen Control

Learning Activities:

- 3.1 > A lecture presentation with classroom discussion of the following:
- a) the mechanism of hydrogen absorption and retention
 - b) elimination of hydrogen from the completed weld.

(Met Module: 'Steel Welding Metallurgy', page 69, 71, 72, 74)

- 3.2 > **Independent Reading Assignment** c/w review questions based upon
- a) materials covered by Learning Activity #3.1
 - b) typical location of weld and base metal cracks
 - c) detrimental properties of hydrogen
 - d) potential sources of hydrogen contamination

(Met Module: 'Steel Welding Metallurgy', page 58, 71, 72, 73)

- 3.3 > A lecture presentation with classroom discussion of the following items:
- a) conditions necessary for hydrogen cracking to occur
 - b) the concept, formula and application of 'carbon equivalent'

(Met Module: 'Steel Welding Metallurgy', page 75, 77)

- 3.5 > A lecture presentation with classroom discussion of the following major items:
- a) the use of preheat, weld size and postheat to control hardness
 - b) the use of preheat, weld size and postheat to control hydrogen content
 - c) the concept, formula and application of energy / heat input

(Met Module: 'Steel Welding Metallurgy', page 61 and 62)

(WIC Module # 6: 'Electrodes and Consumables for Welding', page 81 to 85 incl)

- 3.6 > A lecture presentation with classroom summary of this topic by means of hardening curves and crack prevention techniques for the following steels:
- a) conventional carbon
 - b) alloy
 - c) micro-alloy, fine grained

- 3.7** > **Independent Study Assignment** c/w written informal report based upon hypothetical situations that involve cold cracking of fabricated weldments.

Resources:

- > Metallurgy Module: 'Steel Welding Metallurgy'
WIC Module # 6: 'Electrodes and Consumables for Welding'
Printed Handouts, Assignment Sheets, Chalkboard Notes.

Topic / Unit: - THEORY TEST # 2 and REVIEW

- > Test Booklets, Student Response Sheets, Grade / Answer Sheets

COURSE NAME**CODE NO.****EVALUATION METHODS: (INCLUDES ASSIGNMENTS, ATTENDANCE REQUIREMENTS, ETC.)****General Assessment:**

A+ = 90 to 100%
 A - 80 to 89%
 B = 70 to 79%
 C = 60 to 69%
 F/R = 0 to 59%

Final Mark:

Theory Tests	75 %
Ind_Std	25 %
Attendance	**See Attached

VI. PRIOR LEARNING ASSESSMENT

Students who wish to apply for advanced credit in MATERIAL SCIENCES - WELDING should consult with their professor. Credit for prior learning will be given upon successful completion of the following:

1. The successful completion of a welding metallurgy course with student outcomes and course topics that are at least 80% compatible with this course outline... AND
2. The successful challenge of all theory tests identified by this course outline with a resulting average mark of at least 75 %.

<OR>

3. Written proof of at least three (3) years of competent trade experience involving the fabrication of structural steel and / or the maintenance of heavy equipment by means of welding ... AND
4. The successful challenge of all theory tests identified by this course outline with a resulting average mark of at least 75 %.

Vn. REQUIRED STUDENT RESOURCES:

Safety Glasses (Impact Resistant and CSA Approved)
 Safety Work Boots (8 inch High Cut and CSA Approved)
 Metallurgy Module: 'Steel Welding Metallurgy'
 WIC Module # 6: 'Electrodes and Consumables for Welding'
 The Metal Trades Handbook.

VIU. SPEOAL NOTES:

Students with special needs (eg. physical limitations, visual impalements, hearing impalements, learning disabilities etc.) are encouraged too discuss required accommodations confidentially with their professor.

Your professor reserves the right to modify the course as he/she deems necessary to meet the needs of students.

* Student evaluations concerning the Tinal Mark' are fiarther affected by conditions set forth in the printed handout, 'Welding Department Guidelines'

** Special guidelines for class attendance are included in the above paper.