



**I. COURSE DESCRIPTION:**

This course deals mainly with how metals are affected by welding. To be a competent welder, a good understanding of the materials being welded is needed as well as the processes and procedures required to produce sound, reliable welds. A thorough study of the mechanical and physical properties of metals is then followed by presentations that explain how metals are affected by forming and the application of welding heat. Safety precautions will be discussed, along with welding codes and standards. Topics range from Welding Metallurgy and Weldability of Metals to Testing and Inspection of Welds and Welder Certification.

**II. LEARNING OUTCOMES AND ELEMENTS OF THE PERFORMANCE:**

Upon successful completion of this course, the student will demonstrate the ability to:

**1. *Define metals, their properties, and how they are made.*****Potential Elements of the Performance:**

- Define the properties of metals and how they affect weldability:
  - Tensile strength
  - Impact strength
  - Hardness
  - Ductility
  - Chemical properties
  - Corrosion resistance
  - Alloys
  
- Review the iron-making and steel-making processes:
  - Blast furnace: pig iron and cast iron
  - Steel refining furnaces: basic oxygen furnace and electric arc furnace
  - Material forming methods: wrought and cast metals
  - Casting and continuous casting methods
  - Structural shapes: HSS, plate, hot rolled and cold rolled

Potential Elements of the Performance (continued):

- Discuss the significance of mechanical and physical properties of common metals:
  - Understand the crystalline structures of carbon steels
  - Carbon steel microstructures:
    - Ferrite
    - Pearlite
    - Martensite
    - Austenite
  - Stainless steels:
    - Austenitic
    - Martensitic
    - Ferritic
  - Aluminum (alloys):
    - Designation system
  
- Explain the purpose and effects of heat-treatments on steel:
  - Annealing
  - Normalizing
  - Quenching
  - Hardening
  - Tempering
  - Stress relieving
  
- Describe properties of metals and their effect on material selection, fabrication and welding considerations:
  - Physical properties:
    - Mass
    - Melting point
    - Thermal conductivity
    - Coefficient of expansion
    - Electrical conductivity
  - Mechanical properties:
    - Tensile strength
    - Yield strength
    - Ductility
    - Impact strength

Potential Elements of the Performance (continued):

- Identify steel types and classification systems:
  - Characteristics of:
    - Low carbon steel
    - Medium carbon steel
    - High carbon steel
    - Stainless steel
  - Classification numbering systems of plain carbon steels
    - SAE
    - AISI
    - ASTM
    - CSA
  - Metal (steel) identification methods:
    - Appearance
    - Hardness test
    - Magnetic test
    - Chisel test
    - Fracture test
    - Flame test
    - Spark test
    - Weight test
  
- Identify factors affecting the formability and weldability of the following metals:
  - Carbon and low alloy steels
  - Stainless steels
  - Aluminum and aluminum alloys
  - Cast iron and non-ferrous metals

**2. Describe methods of distortion control.**

Potential Elements of the Performance:

- Selection of preventative method
- Preheating
- Pre-setting joints
- Jigs and fixtures
- Effects of joint configuration, weld size, travel speed and multiple pass verses single pass
- Perform correction of weld distortion

**3. Explain the function and application of destructive and non-destructive testing methods for welds.**

Potential Elements of the Performance:

- Explain the function and application of mechanical test methods:
  - Tensile testing
  - Impact testing
  - Bend testing
- Explain the function and application of non-destructive test methods:
  - Visual inspection
  - Penetrant testing
  - Magnetic particle testing
  - Radiography
  - Ultrasonic testing
- Describe inspection and testing methods:
  - Non-destructive testing
  - Destructive testing
  - Hydrostatic testing
  - Leak testing
  - Vacuum testing

**4. Describe the requirements of welding codes and standards.**

Potential Elements of the Performance:

- Codes and standards related to structural steel construction:
  - CSA W47.1
  - CSA W59
- Codes and standards related to boilers and pressure vessels:
  - ASME Boiler and Pressure Vessel Code
  - CSA B51 Boiler, Pressure Vessel and Pressure Piping Code
- Codes and standards related to piping systems:
  - ASME B31 Code for Pressure Piping
  - CSA Standard Z662 Oil and Gas Pipeline Systems
- Codes and standards related to storage tanks:
  - API 650
- CSA W48 Filler Metal Requirements
- Explain the requirements for welding performance qualification testing
- Explain the requirements for welding procedure qualification testing

**5. Describe the features of weld quality, welding discontinuity and welding procedures.**

Potential Elements of the Performance:

- Define welding discontinuities and their effect on weld quality
- Describe the need for other functions to assure weld quality
- Define procedures for correction of defective weld quality

**III. TOPICS:**

1. Define metals, their properties and how they are made (Metallurgy).
2. Methods of distortion control.
3. Destructive and non-destructive testing methods.
4. Welding codes and standards.
5. Weld quality.

**IV. REQUIRED RESOURCES/TEXTS/MATERIALS:**

- Textbook: "Welding Skills – Fifth Edition" (from bookstore)
- High Cut (6") Safety Boots (CSA approved)
- Impact Resistant Safety Glasses (CSA approved)

**Please Note:**

Students are expected to wear safety equipment in the shop; failure to do so will result in denial to work in the shop on that occasion. While working in the shop do not wear rings, exposed jewelry or shorts.

**CELL PHONES MUST NOT BE USED IN THE SHOP OR  
CLASSROOM**

**V. EVALUATION PROCESS/GRADING SYSTEM:**

**NOTES:**

1. Late hand in penalties will be 10% per day. Assignments will not be accepted past one week late unless there are extenuating and legitimate circumstances.
2. If a student misses a test/lab he/she must have a valid reason\* (i.e. medical or family emergency – documentation may be required). In addition, the instructor **MUST** be notified **PRIOR** to the test or lab sitting. If this procedure is not followed the student will receive a mark of zero on the test/lab with no make-up option.
3. Re-writes are **NOT** allowed for any written assignment, quiz or test.
4. Repeats are **NOT** allowed for any shop test.
5. Course attendance is mandatory. One percent (1 %) per hour will be deducted from the final course grade for unexcused\* absence.

\*Valid reasons would include:

- Doctor's note
- Apprenticeship Ministry note
- Family Death or Serious Illness supported by a written note.

**The final course grade will be determined by the following:**

Three Term Tests:	70%
Quizzes:	30%
Attendance:	<u>-1%</u> (per unexcused hour) (late = 1 hour)

TOTAL = 100%

**If shop work is included, the final course grade will be determined by the following:**

Three Term Tests:	70%
Shop Project(s):	10%
Quizzes:	20%
Attendance:	<u>-1%</u> (per unexcused hour) (late = 1 hour)

TOTAL = 100%

The following semester grades will be assigned to students in other than post-secondary courses:

<u>Grade</u>	<u>Definition</u>	<u>Grade Point Equivalent</u>
A+	90 - 100%	4.00
A	80 - 89%	4.00
B	70 - 79%	3.00
C	60 - 69%	2.00
D	50 - 59%	1.00
F (fail)	49% and below	0.00
CR (Credit)	Credit for diploma requirements has been awarded.	
S	Satisfactory achievement in field /clinical placement or non-graded subject area.	
U	Unsatisfactory achievement in field/clinical placement or non-graded subject area.	
X	A temporary grade limited to situations with extenuating circumstances giving a student additional time to complete the requirements for a course.	
NR	Grade not reported to Registrar's office.	
W	Student has withdrawn from the course without academic penalty.	

## VI. SPECIAL NOTES:

### Attendance:

Sault College is committed to student success. There is a direct correlation between academic performance and class attendance; therefore, for the benefit of all its constituents, all students are encouraged to attend all of their scheduled learning and evaluation sessions. This implies arriving on time and remaining for the duration of the scheduled session.

***It is the departmental policy that once the classroom door has been closed, the learning process has begun. Late arrivers will not be granted admission to the room.***

## VII. COURSE OUTLINE ADDENDUM:

The provisions contained in the addendum located on the portal form part of this course outline.