

**STATE UNIVERSITY OF NEW YORK  
COLLEGE OF TECHNOLOGY  
CANTON, NEW YORK**



**MASTER SYLLABUS  
WELD 112 – METALLURGY AND TESTING**

**Created by:** Cullen Haskins – 10/22/2020

**Updated by:**

**CANINO SCHOOL OF ENGINEERING TECHNOLOGY  
MECHANICAL ENGINEERING TECHNOLOGY  
FALL 2020**

A. **TITLE:** Metallurgy and Testing

B. **COURSE NUMBER:** WELD 112

C. **CREDIT HOURS (Hours of Lecture, Laboratory, Recitation, Tutorial, Activity):**

**# Credit Hours: 3**

**# Lecture Hours per Week: 0**

**# Lab Hours per Week: 4 hours per week**

**Other per Week: 0**

**Course Length (# of Weeks): 15**

D. **WRITING INTENSIVE COURSE:** No

E. **GER CATEGORY:** N/A

F. **SEMESTER(S) OFFERED:** Spring

G. **COURSE DESCRIPTION:**

In this course, students learn the basic metallurgy knowledge needed for welding including heat treating. Metal and weld testing processes are also covered.

H. **PRE-REQUISITES/CO-REQUISITES:**

a. Pre-requisite(s): None

b. Co-requisite(s): None

c. Pre- or co-requisite(s): None

**I. STUDENT LEARNING OUTCOMES:**

<u>Course Student Learning Outcome [SLO]</u>	<u>PSLO</u>	<u>GER</u>	<u>ISLO</u>
a. Demonstrate a practical understanding of welding based on atomic bonding, diffusion, and phase diagrams.	2		2CA
b. Describe the basic principles of phase change and solidification of metals as well as strengthening mechanisms in metals.	2		2CA
c. Describe how weld variables such as pool shape, travel speed, and cooling rate affect weld microstructure and subsequent properties.	2		2CA

<b>KEY</b>	<b><u>Institutional Student Learning Outcomes</u></b> <b>[ISLO 1 – 5]</b>
<b>ISLO #</b>	<b>ISLO &amp; Subsets</b>
<b>1</b>	<b>Communication Skills</b> Oral [O], Written [W]
<b>2</b>	<b>Critical Thinking</b> <i>Critical Analysis [CA], Inquiry &amp; Analysis [IA], Problem Solving [PS]</i>
<b>3</b>	<b>Foundational Skills</b>

	<i>Information Management [IM], Quantitative Lit./Reasoning [QTR]</i>
<b>4</b>	<b>Social Responsibility</b> <i>Ethical Reasoning [ER], Global Learning [GL], Intercultural Knowledge [IK], Teamwork [T]</i>
<b>5</b>	<b>Industry, Professional, Discipline Specific Knowledge and Skills</b>

J. **APPLIED LEARNING COMPONENT:**                      Yes\_\_\_\_\_      No   X  

If Yes, select one or more of the following categories:

Classroom/Lab\_\_\_\_\_

Civic Engagement\_\_\_\_\_

Internship\_\_\_\_\_

Creative Works/Senior Project\_\_\_\_\_

Clinical Practicum\_\_\_\_\_

Research\_\_\_\_\_

Practicum\_\_\_\_\_

Entrepreneurship\_\_\_\_\_

Service Learning\_\_\_\_\_

(program, class, project)

Community Service\_\_\_\_\_

K. **TEXTS:** N/A

L. **REFERENCES:** Welding Metallurgy, 2<sup>nd</sup> Edition, Sindo Kou, ISBN 9780471434917  
<https://www.wiley.com/en-us/Welding+Metallurgy%2C+2nd+Edition-p-9780471434917>

M. **EQUIPMENT:** N/A

N. **GRADING METHOD:** A-F

O. **SUGGESTED MEASUREMENT CRITERIA/METHODS:**

- Homework
- Quizzes
- Tests

P. **DETAILED COURSE OUTLINE:**

Content is divided into 14 weeks. Introduction to GMAW/FCAW, & Welding Safety

1. Basic Principles
  - a. Types of Atomic Bonds
  - b. Metallic Bonding
  - c. Elastic Modulus
2. Crystal Structure and Defects
  - a. Defects in Metals
  - b. Solid Solutions
  - c. Line and Planar Defects
3. Phase Diagrams
  - a. Types of Phase Diagrams
  - b. Microstructural Evolution
4. Diffusion
  - a. Diffusion in Metals
  - b. Interdiffusion of 2 Metals
  - c. Diffusion in Weld Zones
5. Strengthening Mechanisms
  - a. Solid Solution Strengthening
  - b. Strain Hardening
  - c. Precipitation Hardening

6. Basics of Welding Metallurgy
  - a. Microstructure & Properties
  - b. Metallurgical Processes
  - c. The Fusion Zone
7. Dilution
  - a. Calculation of Dilution
  - b. Dilution in Aluminum Alloys
8. The Fusion Zone
  - a. Surface Tension/Fluid Flow
  - b. Types of Nucleation
  - c. Heterogeneous Nucleation
  - d. Epitaxial Nucleation at Fusion boundary
9. Welding Parameters
  - a. Effect of Travel Speed
  - b. Effect of GL, R, and Composition
  - c. Effect of Cooling Rate
  - d. Weld Metal Epitaxial Nucleation
10. Fusion Zone & Boundaries
  - a. Solidification Grain and Subgrain Boundaries
  - b. Migrate Grain Boundary
  - c. Partially Melted Zone (PMZ)
11. Microstructure/Mechanical Properties
  - a. Microstructure of 6061-T6 Aluminum Alloy
  - b. Unmixed Zone (UMZ)
  - c. Partially Melted Zone (PMZ)
12. Boundaries in Weld Zone
  - a. Grain Boundary Liquation in the PMZ
  - b. The “True” Heat Affected Zone (HAZ)
  - c. Effect of Recrystallization on Mechanical Properties
13. Residual Stresses
  - a. Factors Influencing Residual Stresses
  - b. Fundamental Types of Distortion
  - c. Microhardness Testing
14. Mechanical Testing of Welds
  - a. Tensile Testing Welds
  - b. Stress-Strain Curves
  - c. Bend Tests
  - d. Fractography

**Q. LABORATORY OUTLINE: N/A**