Welding Deliverable A Outline

COURSE # 204: Metallurgy

Module 1: Welding Metallurgy

1.1 Mechanical Properties of Metal

- 1.1.1 Hardness
- 1.1.2 Brittleness
- 1.1.3 Ductility
- 1.1.4 Toughness
- 1.1.5 Strength
  - 1.1.5.1 Tensile (Yield Strength, Yield Point, Ultimate Strength)
  - 1.1.5.2 Compressive
  - 1.1.5.3 Shear
  - 1.1.5.4 Torsional
- 1.1.6 Quenching
- 1.1.7 Annealing
- 1.1.8 Normalizing
- 1.1.9 Tempering

1.2 Heat Treatment Techniques

1.3 Heat Chart / Phase Diagrams

- 1.3.1 Crystalline Structure of Metal
  - 1.3.1.1 Body Centered Cubic
  - 1.3.1.2 Face Centered Cubic

Module 2: Weld Discontinuities and Defects

2.1 Definition of Weldability/ Weld Defects, Impurities and their Causes

- 2.1.1 Weld Discontinuities and Defects
  - 2.1.1.1 Porosity
  - 2.1.1.2 Undercut
  - 2.1.1.3 Inclusion
  - 2.1.1.4 Arc Strikes
  - 2.1.1.5 Inadequate Joint Penetration (Lack of Penetration)
  - 2.1.1.6 Underfill
  - 2.1.1.7 Lamination
  - 2.1.1.8 Delamination
  - 2.1.1.9 Lamellar Tears
  - 2.1.1.10 Incomplete Fusion (Wagon Tracks)

2.1.1.10.1 Interpass Cold Lap

2.1.1.10.2 Lack of Sidewall Fusion

2.1.1.11 Cracking Defects

2.1.1.11.1 Crater Cracking

2.1.1.11.2 Hot Cracking

2.1.1.11.3 Cold Cracking

2.1.1.11.4 Carbide Precipitation

2.2 Types of Gases

2.2.1 Hydrogen

2.2.2 Nitrogen

2.2.3 Oxygen

2.2.4 Carbon Dioxide

Module 3: Processes

3.1 Cutting Process and Uses

3.1.1 Oxy-fuel cutting

3.1.1.1 Equipment

3.1.1.2 Set Up

3.1.1.3 Options

3.1.2 Plasma Arc

3.1.2.1 Equipment

3.1.2.2 Set Up

3.1.2.3 Options

3.1.3 Air Carbon Arc

3.1.3.1 Equipment

3.1.3.2 Set Up

3.1.3.3 Options

3.2 Welding Processes

3.2.1 Heat Distribution

3.2.2 Shielded Metal Arc Welding (SMAW)

3.2.1.2.1 Equipment

3.2.1.2.2 Set Up

3.2.1.2.3 Options

3.2.3 Gas Metal Arc Welding (GMAW-S)

3.2.3.1 Equipment

3.2.3.2 Set Up

3.2.3.3 Options

3.2.4 Gas Tungsten Arc Welding (GTAW)

3.2.4.1 Equipment

3.2.4.2 Set Up

3.2.4.3 Options

3.2.5 Flux Cored Arc Welding (FCAW)

3.2.5.1 Equipment

3.2.5.2 Set Up

3.2.5.3 Options

3.2.6 Spray Arc Welding (GMAW)

3.2.6.1 Equipment

3.2.6.2 Set Up

3.2.6.3 Options

3.2.7 Robotic

3.2.7.1 Equipment

3.2.7.2 Set Up

3.2.7.3 Options

3.2.8 Orbital

3.2.8.1 Equipment

3.2.8.2 Set Up

3.2.8.3 Options

Module 4: Steel and Filler Classification

4.1 Carbon and Alloy Steel

4.1.1 Iron

4.1.2 Low Carbon

4.1.3 Medium Carbon

4.1.4 High Carbon

4.1.5 Tool Steel

4.1.6 Cast Iron

4.2 Society of Automotive Engineers (SAE) and American Iron and Steel Institute (AISI) System

4.3 Identification of Filler Metal/Alloys

4.3.1 Filler Metal Selection and Identification

4.3.1.1 Arc Welding Electrode Classification

4.3.1.2 Filler Wire Classification

4.3.1.3 Spooled Wire Classification

Module 5: Testing

5.1 Destructive Testing

5.1.1 Tensile

5.1.2 Fatigue

5.1.3 Shearing Strength

5.1.4 Nick Break

5.1.5 Guided Bend Test

5.1.6 Free Bend

5.1.7 Alternate Bend

5.1.8 Fillet Break Test

5.1.9 Etching

5.1.10 Impact

5.2 Nondestructive

5.2.1 Visual

5.2.2 Penetrant

5.2.3 Magnetic Particle

5.2.4 Radiographic

5.2.5 Ultrasonic

5.2.6 Leak

5.2.7 Eddy Current

5.2.8 Hardness

5.3 Testing Procedures and Codes

5.3.1 Review codes, and Professional Society

5.3.2 Importance of Code

5.3.3 Requirements of Code

5.3.4 Quality Standards

5.3.5 Welding Procedure Specifications (WPS)

5.3.6 Welding Qualification Record (WQR)

5.3.7 Procedure Qualification Record (PQR)

Module 6: Aluminum and Aluminum Welding

6.1 Nine different alloys

6.1.1 1XXX-Pure Aluminum

6.1.2 5XXX-Magnesium

6.1.1 3XXX-Maganese

6.1.1 4XXX-Silicone (non-heat treatable)

6.1.1 4XXX-Silicone (heat treatable)

6.1.1.6 2XXX-Copper

6.1.1.7 6XXX-Magensium Silicide

6.1.1.8 7XXX-Zinc

- 6.1.1.9 8XXX-Catch All
- 6.1.1.10 9XXX-Held in reserve

6.2 Division of Alloys

- 6.2.1 Heat Treatable
  - 6.2.1.1 Heat Treatable Classification
- 6.2.2 Non Heat Treatable
- 6.2.3 Temper Designators
- 6.2.4 Dilution rates

6.4 Discontinuities and Defects

- 6.4.1 Porosity
- 6.4.2 Weld Cracking
- 6.4.3 Incomplete fusion
- 6.4.4 Incomplete penetration
- 6.4.5 Crack sensitivity

6.5 Alloy Selection

- 6.5.1 Review of Application
- 6.5.2 Selection by desired characteristics

6.6 Equipment

- 6.6.1 Weld Process
  - 6.6.1.1 MIG (Metal Inert Gas)
    - 6.6.1.1.1 Equipment
    - 6.6.1.1.2 Special Setup
  - 6.6.1.2 TIG (Tungsten Inert Gas)
    - 6.6.1.2.1 Equipment
    - 6.6.1.2.2 Special Setup

Contact Information:

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Module Outline

Module 1 Name: Welding Metallurgy

Course ID: WLD 204 **Module ID: 1** **Total time required: 3 hrs**

Prerequisites: WLD 111

Tools and Materials: Textbook: Welding Principles and Applications, Larry Jeffus, 7th Edition.

Paper and Pen

Goal

The goal of this module is to provide students with the ability to explain the mechanical properties of metal, as well as analyze and interpret phase diagrams.

Topics Covered

1.1. Mechanical Properties of Metal

1.2 Heat Treatment Techniques

1.3 Heat Chart / Phase Diagram

Assessment

- Quiz
- In module activities
- Discussion of real world scenarios

Objectives

Learner will be able to:

- Explain the mechanical properties of metal.
- List the five different strength measurements.
- Analyze and interpret phase diagrams.
- Discuss the heat treatments used in welding.
- Identify how grain size affects metal's strength.

Labs

- None

Module 2 Name: Weld Discontinuities and Defects

Course ID: WLD 204 **Module ID: 2** **Total time required: 4 hrs**

Prerequisites: WLD 111

Tools and Materials: Textbook: Welding Principles and Applications, Larry Jeffus, 7th Edition. Paper and Pen

Goal

The goal of this module is provide the student with the ability to define weldability, distinguish between weld discontinuities and weld defects, as well as analyze how gases affect weldability.

Topics Covered

2.1 Definition of Weldability / Weld Defects, Impurities and their Causes

2.2 Types of Gases

Assessment

- Quiz / Tests
- In module activities
- Discussion of real world scenarios

Objectives

Learner will be able to:

- Distinguish between weld discontinuities and weld defects.
- Explain the four major types of porosity.
- Give examples of the most common discontinuities.
- Define weldability and understand all the factors that affect weldability.
- Discuss the problems hydrogen causes during steel welding.

Labs

- None

Module Outline

Module 3 Name: Processes

Course ID: WLD 204 **Module ID: 3** **Total time required: 8 hrs**

Prerequisites: WLD 111

Tools and Materials: Textbook: Welding Principles and Applications, Larry Jeffus, 7th Edition. Paper and Pen

Goal

The goal of this module is to provide the student the ability to define various welding and cutting processes, review different options and equipment for proper setup. Also, safety concerns will be identified and discussed with students.

Topics Covered

3.1 Cutting Processes
3.2 Welding Processes

Assessment

- Quiz / Tests
- In module activities
- Discussion of real world scenarios

Commented [WU1]: Reminder per phone conversation… The assessments will be adjusted on this deliverable throughout the development of Deliverable B

Objectives

Learner will be able to:

- Compare/contrast multiple welding cutting processes specific to processes and equipment.
- List and explain the various terms specific to processes and equipment.
- Describe the oxyfuel gas cutting processes and name the commonly used fuel gases.
- Explain how a plasma cutting torch works.
- Assess the advantages and disadvantages of using a plasma cutting torch.
- Identify the safety considerations of each of the different cutting processes.

Labs: None

Module Outline

Module 4 Name: Steel and Filler Classification

Course ID: WLD 204 **Module ID: 4** **Total time required: 4 hrs**

Prerequisites: WLD 111

Tools and Materials: Textbook: Welding Principles and Applications, Larry Jeffus, 7th Edition. Paper and Pen

Goal

The goal of this module is to provide the student the ability to understand metal classification nomenclature, as well as recognize the differences in ferrous metals.

Topics Covered

4.1 Carbon and Alloy Steel / Iron Carbon Alloys
4.2 Society of Automotive Engineers (SAE) and American Iron and Steel Institute (AISI) System
4.3 Identification of Filler Metal / Alloys

Assessment

- Quiz / Tests
- In module activities
- Discussion of real world scenarios

Objectives

Learner will be able to:

- Distinguish the differences between SAE and AISI metal classification.
- Identify the correct filler metal combination with base metal.
- Recognize the differences in ferrous metals.

Labs

- None

Module Outline

Module 5 Name: Testing

Course ID: WLD 204 **Module ID: 5** **Total time required: 8**

Prerequisites: WLD 111
Tools and Materials: Textbook: Welding Principles and Applications, Larry Jeffus, 7th Edition. Paper and Pen

Goal
The goal of this module is to provide the students with the ability to understand the importance of weld testing and to be able to distinguish between destructive and nondestructive testing. Also, the students will be able to explain how a tentative WPS becomes a certified WPS and gain skills needed to read, interpret and implement a welding procedure specification.

Topics Covered
5.1 Destructive Testing
5.2 Nondestructive Testing
5.3 Testing Procedure and Codes

Assessment
- Quiz/Test
- In module activities
- Discussion of real work scenarios

Objectives
Learner will be able to:
- Distinguish between destructive and nondestructive testing.
- Identify the correct code or standard according to application.
- Summarize the requirements of a welding procedure specification.
- Recognize the purpose of weld testing.
- Explain how a tentative WPS becomes a certified WPS.
- Relate the PQR to the WPS.
- Express the differences between the WPS and the WQR.

Labs: None

Module Outline

Module 6 Name: Aluminum and Aluminum Welding

Course ID: WLD 204 **Module ID: 6** **Total time required: 8 hrs**

Prerequisites: WLD 111
Tools and Materials: Textbook: Welding Principles and Applications, Larry Jeffus, 7th Edition. Paper and Pen

Goal

The goal of this module is to provide the students with the ability to explain the aluminum alloy tree, distinguish between heat treatable and non-heat treatable alloys, and choose proper filler metals. Also students will be able to set up weld processes specific to aluminum welding.

Topics Covered

6.1 Aluminum Alloy
6.2 Division of Alloys
6.3 Discontinuities and Defects
6.4 Alloy Selection
6.5 Equipment

Assessment

- In module activities
- Discussion of real work scenarios
- Final Exam

Objectives

Learner will be able to:

- Identify and explain the nine different alloys included in the aluminum alloy tree.
- Distinguish between heat treatable alloys and non-heat treatable alloys.
- State the causes of discontinuities and defects in welding aluminum.
- Recognize the importance and requirements of welding machine set up.
- Choose the proper filler metal alloy by desired metal characteristic.

Labs: None

Instructional Design Checklist

	Course:	**WLD 204 Welding Metallurgy**	
	Author:	**Paul Phelps**	
Standard		**Present (Y/N)**	**Comments**
Item 1. Overall Course Outline			
1.1	Course Outline divided into modules is provided	Y	
Item 2. One Page Module Outline			
2.1	Main goal/overview of module briefly stated	Y	
2.2	Topics covered are listed and are in the order they appear in the course	Y	
2.3	Assessments are listed and briefly described	Y	Quiz/Test; In-module activities; Discussion of real world scenarios
2.4	Objective(s) listed	Y	
2.5	If relevant, labs are listed and described		No Labs
2.6	Other information (course ID, module ID, total time required, prerequisites, warnings/cautions, and contact information) is provided	Y	
Item 3. Objectives			
3.1	Objectives are listed and measurable	Y	Measured by Quiz/Test; In-module activities; Discussion of real world scenarios
3.2	Cognitive outcomes direct students to accomplishments on multiple levels especially the five higher intellectual levels (Bloom's Taxonomy)	Y	Analyze, Assess, Choose, Compare, Contrast, Describe, Discuss, Distinguish, Explain, Express, Give Examples, Identify, List, Recognize, Relate, State, Summarize,
Item 4. Module Content and Materials			
4.1	A pretest and/or appropriate module opener is included	Y	
4.2	Module employs a student-centered approach.	Y	This class will use a**ctive learning**, in which students, answer questions, formulate questions of their own, discuss and brainstorm about the welding topics during class. Also, this class will use **inductive teaching and learning**, in which

			students are first presented with challenges (questions or problems) and learn the course material in the context of addressing the challenges.
4.3	Module includes relevant examples and authentic (real-world) material.		Videos will be used to demonstrate how to properly utilize their knowledge of mechanical properties of metal and phase diagrams.
4.4	Unoriginal resources and materials used in the course are cited *(author of the module must ensure that citations are correct)*.	Y	
4.5	Text color, font size, and type are consistent throughout the course with proper headings and formats. Colors used are high contrast and fonts are easy to read.	Y	
Item 5. Exercises and Closers			
5.1	Exercises support teaching of the material presented in the module.	Y	
5.2	Exercises support authentic (real-world) applications.	Y	
5.3	Appropriate module closers are included, examples may include: -summary of key points (reviewing objectives of module) -list of definitions -review questions -other appropriate closers	Y	
Item 6. Labs *(if appropriate for course)*			
6.1	Physical Labs: -Introduction -Materials and methods -Requirements for successful lab completion	N	No labs
6.2	Virtual Labs: -Instructions -Requirements for successful lab completion -Description of visualization	N	No labs
Item 7. Assessments			
7.1	The types of assessments selected measure the stated learning objectives and are consistent with course activities and resources.	Y	
7.2	The multiple assessment methods are utilized.	Y	Quizzes and tests will be given to assess student's progress.

7.3	Students have multiple opportunities to measure their own learning progress (practice quizzes, study questions, etc…)	Y	In-module activities, such as word search puzzles, cross word puzzles, practice quizzes and multiple choice activities will be given for the student to measure their own learning progress.
7.4	Assessments are clearly identified	Y	
7.5	Answers/samples for assessments are included	Y	Answer will be accessible for the student at the end of each module.
Item 8. Accessibility			
8.1	Course materials provide equivalent alternatives to auditory and visual content *(Ultra Hal Text-to-Speech Reader may also be suggested to the learner)*		
8.2	When possible, media should be accompanied by closed-captions or a transcript		Videos with closed-captions, filmed by instructors, showing demonstrations
8.3	Visual elements should be text-captioned and contain appropriate ALT attribute tags		You Tube Video with closed-captions
8.4	The course materials ensure screen readability		
8.5	Sufficient contrast is used in the front and background colors (use of special fonts or special character sets is avoided)		
Item 9. Universal Design of Learning Principles For ideas to address the UDL standards, visit https://www.box.com/shared/l7r12z0f8x0hc3i0js89			
9.1	Principle 1: Provide multiple means of representation *Examples may include:* -Module design includes strategies for all learning styles (visual, auditory, tactile) -Accessibility standards (#8 above) have been met -Pre-teach vocabulary, highlight key terms -Use multiple media		Use visual, auditory and printed text material. Use color for emphasis, along with varied text size. Use contrast between the background and the text.
9.2	Principle 2: Provide multiple means of action and expression *Examples may include:* -Provide multiple examples -3D models, CAD drawings, virtual manipulative -Interactive web tools -Guide goal setting: give prompts, models, checklists for completion, etc…		Provide multiple examples of solutions to problems. Use social media and web tools, such as “You Tube”.
9.3	Principle 3: Provide multiple means of engagement *Examples may include:* -Give learners choice in perceived challenge, tools, timing, and content used, etc… -Design authentic activities		Vary activities and sources of information so that they can be socially relevant, age and ability appropriate, as well as appropriate for different racial, cultural, ethnic, and gender groups.

	-Provide opportunities for personal response and self-reflection/evaluation -Provide charts, schedules, rubrics, norms, etc…		Vary the pace of work, length of work sessions, availability of breaks or time-outs, or timing or sequence of activities.
Item 10. Instructor Resources			
10.1	Resources for instructors (answers, teaching notes, recommendations, etc…) are included where appropriate		
Content Area Expert Check & Self-Check (CUCWD is not responsible for checking these items)			
a	The instructional materials contribute to the achievement of the stated course and module/unit learning objectives.		Yes
b	The instructional materials have sufficient breadth, depth, and currency for the student to learn the subject.		Yes
c	The instructional materials are technically accurate and have been reviewed by a content area expert.		Yes
d	Graphics are appropriate and well utilized.		Yes
e	If a mini lecture is appropriate, the PowerPoint should include: -highlights of instructional content and key points of module -individual slides do not include too many words or too much information -contains appropriate media (pictures, videos, links, etc…) -lecture outline/script included -lecture is around 20 minutes		
f	Copyright Considerations: Unoriginal content is licensed for use in curriculum and appropriately attributed (see www.creativecommons.org for more attribution information)		Yes

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