TN Department of Education | College, Career and Technical Education

Welding I

Primary Career Cluster:	Advanced Manufacturing
Consultant:	John Mummert, (615) 532-2835, John.Mummert@tn.gov
Course Code:	6078
Pre-requisite(s):	*Principles of Manufacturing* (5922) Recommended: *Algebra* (0842, 3102), *Geometry* (0843, 3108), and *Physical Science* (3202)
Credit:	1
Grade Level:	10
Graduation Requirement:	This course satisfies one of three credits required for an elective focus when taken in conjunction with other Advanced Manufacturing courses.
Programs of Study and Sequence:	This is the second course in the *Welding* program of study.
Aligned Student Organization(s):	Skills USA: http://www.tnskillsusa.com Tracy Whitehead, (615) 532-2804, Tracy.Whitehead@tn.gov
Coordinating Work-Based Learning:	Teachers are encouraged to use embedded WBL activities such as informational interviewing, job shadowing, and career mentoring. For information, visit https://tn.gov/education/topic/work-based-learning.
Available Student Industry Certifications:	AWS SENSE- Entry Level Welder
Dual Credit or Dual Enrollment Opportunities:	There are available known dual credit/dual enrollment opportunities for this course. If interested, reach out to a local postsecondary institution to establish an articulation agreement.
Teacher Endorsement(s):	551, 552, 553, 554, 555, 556, 557, 584, 705, OR any other Occupational License endorsement with AWS Industry Certification, BAT, or Certified Welding Educator Certification
Required Teacher Certifications/Training:	In addition, the teacher must hold one of the following current/valid industry certifications: American Welding Society (AWS), Certified Welding Inspector (CWI), Certified Welding Educator (CWE), Certified Radiographic Interpreters, Certified Welding Engineer (CWEng), Certified Robotic Arc Welder (CRAW), Certified Welding Fabricator, Certified Welder OR Bureau of Apprenticeship Training certification (BAT), or NOCTI Welding.
Teacher Resources:	https://tn.gov/education/article/cte-cluster-advanced-manufacturing

Approved January 30, 2015; Amended January 25, 2018

Course Description

Welding I is designed to provide students with the skills and knowledge to effectively perform cutting and welding applications used in the advanced manufacturing industry. Proficient students will develop proficiency in fundamental safety practices in welding, interpreting drawings, creating computer aided drawings, identifying and using joint designs, efficiently laying out parts for fabrication, basic shielded metal arc welding (SMAW), mechanical and thermal properties of metals, and quality control. Upon completion of this course, proficient students will be able to sit for the AWS SENSE Entry Level Welder certification and will be prepared to undertake more advanced welding coursework.

Program of Study Application

This is the second course in the *Welding* program of study. For more information on the benefits and requirements of implementing this program in full, please visit the Advanced Manufacturing website at https://tn.gov/education/article/cte-cluster-advanced-manufacturing.

Course Standards

Safety

1) Accurately read, interpret, and demonstrate adherence to safety rules, including rules published by the (1) National Science Teachers Association (NSTA), (2) rules pertaining to electrical safety, (3) Occupational Safety and Health Administration (OSHA) guidelines, (4) American Society for Testing Materials; ANSI Z49.1: Safety and Welding, Cutting, and Allied Processes, and (5) state and national code requirements. Be able to distinguish between rules and explain why certain rules apply. Complete safety test with 100 percent accuracy.

2) Identify and explain the intended use of safety equipment available in the classroom. For example, demonstrate how to properly inspect, use, store, and maintain safe operating procedures with tools and equipment.

Career Exploration

3) Locate and assess the American Welding Society website and analyze its structure, policies, and requirements for the AWS Entry Welder qualification and certification. Explain a welder certification document, what steps are required to obtain the certification, and how to prepare for the examination.

Interpreting and Creating Drawings

4) Compare and contrast the architectural scale versus the engineering scale used in mechanical drawings. Describe their distinguishing characteristics. Define a scale and perform conversion calculations of various distances.

5) Building on the knowledge of a two-dimensional drawing, create simple isometric (3-D pictorial) drawings, properly using lines (e.g., object, hidden, center), labels, and dimensioning techniques.

Welding Design and Layout

6) Identify, sketch, and explain the five basic weld joint designs (e.g., butt, lap, tee, outside corner, and edge). Find examples of various joint designs applied to structures on or around campus and take pictures to present to classmates.

Shielded Metal Arc Welding (SMAW)

7) Safely set up equipment for shielded metal arc welding (SMAW). Identify and explain the equipment, equipment setup, and the electrical current used in the welding process. Drawing on multiple resources, compare and contrast SMAW with other welding and cutting processes such as oxyfuel gas welding (OFW), gas metal arc welding (GMAW), flux-cored arc welding (FCAW), and gas tungsten arc welding (GTAW). Write a brief informative paper discussing the distinguishing characteristics and primary advantages of each.

8) Demonstrate how to make single- and multiple-pass fillet welds and groove welds with backing on plain carbon steel in the following positions. Prior to welding, sketch a cross section, including the dimensions of each weld demonstration.
    a. Flat
    b. Horizontal
    c. Vertical
    d. Overhead

9) Research the American Welding Society (AWS) filler metal classification system and write a paper explaining the system, briefly discussing the multiple factors that affect electrode selection for shielded metal arc welding (SMAW). Using various electrodes, demonstrate how to make pad beads on plain carbon steel in the following positions.
    a. Flat
    b. Horizontal
    c. Vertical
    d. Overhead

    Summarize the demonstration results of using various electrodes and explain the findings using supporting evidence from the AWS metal classification system.

Properties of Metals

10) Research the following mechanical properties of metals and their importance in the welding process.
    a. Tensile
    b. Strength
    c. Hardness
    d. Elasticity
    e. Ductility

f. Toughness
g. Brittleness

Create a chart or table that compares and contrasts the meaning of these properties. Explain the changes in the mechanical properties of weldments that occur during the welding process.

11) Investigate the thermal properties of metals and their effects on welding processes. Describe and demonstrate techniques to mitigate the effects of thermal expansion and contraction that occur during the welding process. During the demonstrations, observe and record the changes that occur in the mechanical properties of weld and parent metals caused by heating and cooling. Write a report summarizing and explaining the findings. Justify all explanations with supporting evidence gathered from observations and welding principles.

12) Design an experiment to test and compare the effect that thermal conductivity and specific heat have on various metals such as steel and aluminum. Record all observations and write a report to present the test results in an electronic format, integrating quantitative and visual information. The report should include, but should not be limited to, explaining the effect of thermal conductivity on the heating and cooling rates observed during the welding process, as well as the effect of specific heat on heat rates required for welding.

Quality Control

13) Drawing upon multiple resources, research and write a text explaining the relationship between discontinuities and defects. Describe various examples of defects found in welded products. Also identify and explain both destructive and nondestructive tests used as quality control techniques to prevent manufacturing defects in welding. Compare and contrast these techniques and provide specific examples when they are most appropriately used. Cite evidence to justify the examples.

14) Measure and visually inspect welded products for acceptability to American Welding Society QC-10 standards. Record discontinuities and defects, and compare data to given project specifications using class-defined analysis methods. Interpret and communicate results both written and verbally. If necessary, recommend changes that will reduce the number of product defects during the manufacturing process.

Welding Procedure Specification Development

15) Research the American Welding Society (AWS) Specification for Welding Procedure and Performance Qualification (AWS B2.1/B2.1M) to learn more about Welding Procedure Specifications and the use of the document. Explain the significance of this document and define the following elements:
    a. Joint Design
    b. Base Metal
    c. Filler Metal
    d. Position
    e. Preheat and Interpass
    f. Heat Treatment

g. Shielding Gas
h. Electrical

16) Investigate procedure qualification variables associated with the above elements and their effects on welding processes. Describe techniques to mitigate the effects of these variables that can occur during the welding process. Write a report summarizing and explaining the findings. Justify all explanations with supporting evidence gathered from observations and welding principles.

17) Read and interpret an example of a welding procedure specification and observe demonstrations of qualified welders to understand the proper procedures involved in conducting a welding procedure test. Create a training document to instruct a new welders on how to properly use the welding procedure specification to help successfully conduct a welding procedure test. Include the following:
    a. Code Requirements
    b. Materials
    c. Documentation
    d. Destructive Testing
    e. Inspection and evaluation

18) Apply knowledge previously learned to properly demonstrate the ability to review a welding procedure specification and conduct a welding procedure test. Steps must include:
    a. Properly setting up welding equipment for the process being tested
    b. Properly select base material and filler metal (gas shielding if required)
    c. Gathering equipment needed to capture welding variables
    d. Properly set up test coupon (per code, or as performed in production)
    e. Properly document data as coupon is being welded
    f. Performing visual inspection
    g. Performing destructive testing
    h. Completing the Welding Procedure Specification document

Standards Alignment Notes

*References to other standards include:

- P21: Partnership for 21st Century Skills Framework for 21st Century Learning
    - Note: While not all standards are specifically aligned, teachers will find the framework helpful for setting expectations for student behavior in their classroom and practicing specific career readiness skills.