Silicon Valley
Career Technical Education

Metals Technology

Course Outline

Course Description

This 519-hour course provides students with intermediate skills in metal design and fabrication to prepare them for industry certifications in welding and employment in metals technology occupations. Instruction is provided in Gas Metal Arc Welding (GMAW, **aka** M.I.G.), Shielded Metal Arc Welding (SMAW) Gas Tungsten Arc Welding (GTAW **aka** T.I.G.) and advanced OxyAcetylene Welding. Students are required to develop skills in welding in flat, vertical and overhead applications, along with refining skills in operating the Air Carbon Arc, Plasma Arc, and Oxy-Acetylene cutting units. Students receive instruction in safety, hand and power tool usage, planning, and material selection and usage as related to the construction of items used around the shop and home. Students experiment with their own ideas and methods in the design and fabrication of individual projects.

The course also integrates academic learning in math, science and english and art, connecting students' CTE learning with Common Core and Next Generation Science standards. This is achieved during lecture based lessons encompassing the use of CAD software, CNC machining and tooling, as well as materials selection and application. Students will design, plan and carry out their own projects using raw materials and set up routines which will allow students to experience the real life feel of operating in a manufacturing shop in today's highly technology-reliant and fast-paced marketplace.

Course Details

Length of Program and Academic Credits Earned:
Year-long 3 hour course = 519 hours total (~261/semester)
30 total credits (15/semester):

- 20 non-a–g elective credits (10/semester)
- 10 UC a-g "g" or "c" credits (5/semester)

Pre-Requisites:

- High School Junior or Senior, or 16 years or older

CTE Classification:

- **Industry Sector:** Manufacturing and Product Development
- **Industry Pathway:** Welding and Materials Joining
- **CA Basic Education Data System (CBEDS) Code:** 5619

Work-Based Learning:	Certifications & State Tests:
● Field trips ● Guest speakers	● Shielded Metal Arc 3G and 4G Heavy Plate- D1.1 Certification ● Gas Metal Arc 3G and 4G Heavy Plate- D1.1 Certification ● Flux Core Arc 3G and 4G Heavy Plate- D1.1 Certification ● Gas Tungsten Arc Steel-AWS 5.1 ● Gas Tungsten Arc Aluminum-AWS 5.1 ● Shielded Metal Arc 6G Pipe ● SVCTE Certificate of Completion awarded with "C" or better average for both semesters

Community College Articulations

Students completing the Metals Technology course with a grade of "B" or better are granted college credits at the following community college: Butte College – 3.0 units

More info and application form: https://www.butte.edu/

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Possible Education & Career Pathways	For more career information: www.onetonline.org	
College & Career Pathways:	**Career Opportunities**	**O*NET Codes**
Post-Secondary: Students with a high school diploma and having successfully completed this course have a number of entry-level career opportunities, as well as continuing their education.	• Fine Artists, Including Painters, Sculptors, and Illustrators • Model Makers, Metal and Plastic • Welders, Cutters, and Welder Fitters • Helpers – Production Workers • Structural Metal Fabricators and Fitters • Welding, Soldering, and Brazing; Machine Setters, Operators, and Tenders • Pipefitters and Steamfitters • Helpers – Pipelayers, Plumbers, Pipefitters, and Steamfitters • Sheet Metal Workers • Structural Iron and Steel Workers	27-1013.00 51-4061.00 51-4121.06 51-9198.00 51-2041.00 51-4122.00 47-2152.01 47-3015.00 47-2211.00 47-2221.00
Continuing Education: Including Community College, Training Programs, Certifications, etc: • Apprenticeship Program • AA or AS in Fine Arts, Welding Technology	• Fine Artists, Including Painters, Sculptors, and Illustrators • Model Makers, Metal and Plastic • Welders, Cutters, and Welder Fitters • Helpers – Production Workers • Structural Metal Fabricators and Fitters • Welding, Soldering, and Brazing; Machine Setters, Operators, and Tenders • Pipefitters and Steamfitters • Helpers – Pipelayers, Plumbers, Pipefitters, and Steamfitters • Sheet Metal Workers • Structural Iron and Steel Workers • Career/Technical Education Teachers, Secondary School	27-1013.00 51-4061.00 51-4121.06 51-9198.00 51-2041.00 51-4122.00 47-2152.01 47-3015.00 47-2211.00 47-2221.00 25-2032.00
University Majors & Degrees: • BA or BS in Welding Engineering Technology, Fine Arts	• Fine Artists, Including Painters, Sculptors, and Illustrators • Model Makers, Metal and Plastic • Welders, Cutters, and Welder Fitters • Helpers – Production Workers • Structural Metal Fabricators and Fitters • Welding, Soldering, and Brazing; Machine Setters, Operators, and Tenders • Pipefitters and Steamfitters	27-1013.00 51-4061.00 51-4121.06 51-9198.00 51-2041.00 51-4122.00 47-2152.01

	• Helpers – Pipelayers, Plumbers, Pipefitters, and Steamfitters	47-3015.00
	• Sheet Metal Workers	47-2211.00
	• Structural Iron and Steel Workers	47-2221.00
	• Career/Technical Education Teachers, Secondary School	25-2032.00
	• Vocational Education Teachers, Postsecondary	25-1194.00
<u>Post-Baccalaureate Degrees:</u> • Masters or Doctorate in Fine Arts	• Fine Artists, Including Painters, Sculptors, and Illustrators	27-1013.00
	• Model Makers, Metal and Plastic	51-4061.00
	• Welders, Cutters, and Welder Fitters	51-4121.06
	• Helpers – Production Workers	51-9198.00
	• Structural Metal Fabricators and Fitters	51-2041.00
	• Welding, Soldering, and Brazing; Machine Setters, Operators, and Tenders	51-4122.00
	• Pipefitters and Steamfitters	47-2152.01
	• Helpers – Pipelayers, Plumbers, Pipefitters, and Steamfitters	47-3015.00
	• Sheet Metal Workers	47-2211.00
	• Structural Iron and Steel Workers	47-2221.00
	• Career/Technical Education Teachers, Secondary School	25-2032.00
	• Vocational Education Teachers, Postsecondary	25-1194.00

Ongoing Unit: Career Readiness & Professionalism — 47 hours

Students will develop personal and professional skills in the classroom that will transfer to the workplace.

- Time management and organization
- Interpersonal skills
- Work with a variety of technology
- Creative thinking and problem solving
- Job search skills including: resume, job applications and effective interview skills

Standards Alignments:

CCSS: WS 11-12.6,7,8,9; **RLST** 11-12.3, 4, 10; **LS** 11-12.1,6; **WHSST** 11-12.7,8

Key Assignments	CTE Anchor Standards	CTE Pathway Standards
✓ **Key Assignment:** Student will participate in mock interviews with industry professionals, peers and instructors to increase their communication, interpersonal and employability skill-set. **Assessment:** rubric, observation of role playing, peer and self- assessment	1.0, 2.4, 3.0, 4.1, 4.3, 5.1, 10.1, 11.2, 11.5	
✓ **Key Assignment:** Students will prepare a portfolio including a cover letter and resume through workshop, self and peer editing, teacher instruction and demonstration. **Assessment:** rubric, observation, peer and self- assessment	1.0, 2.4, 3.0, 4.1, 4.3, 5.1, 10.1, 11.2, 11.5	
✓ **Key Assignment:** Students will create and organize a classroom binder or notebook as a professional reference containing vital information necessary for optimal job performance in the welding industry. **Assessment:** rubric, grading form sheet, interactive notebook, student documentation	1.0, 2.4, 3.0, 4.1, 4.3, 5.1, 10.1, 11.2, 11.5	
✓ **Key Assignment:** Students will research a variety of careers within the field of fabrication and manufacturing including careers in art and sculpture. Using PowerPoint or a similar product, students will develop a presentation representing 3 possible career paths of their choice and the education and licensing necessary to achieve stated career goal and present to class. Students will field questions from peers and instructor. **Assessment:** rubric, observation	1.0, 2.4, 3.0, 4.1, 4.3, 5.1, 10.1, 11.2, 11.5	

✓ **Research:** The Artist's Path- Students will choose from a list of Metal Sculptural Artists and individually research the artist's career path. Each student will present the class with a slideshow of their artist's most famous sculptures and most significant contribution to the Art world. In addition, students will sketch at least 3 of their artist's most famous works and include them in their presentation discussing the design elements present in their work. **Assessment:** rubric, peer review, gallery walk	1.0, 2.4, 3.0, 4.1, 4.3, 5.1, 10.1, 11.2, 11.5	

Ongoing Unit: Safety — 40 hours

Students will review all aspects of shop safety, including the safe use of all machinery and tools in the lab. Oral presentations will be given each machine. Students will recognize shop safety issues, as well as interpret safety colors and Material Safety Data Sheets (MSDS)(CC.R.11-12.4, 7). Students will also learn basic first aid for shop applications and proper emergency response. Students will keep a log of safety notes throughout the semester as a reference guide on proper application and safe operation of various machines in lab.

- Introduction to tools
- Structural building code
- Proper waste disposal and recycling
- Materials Safety Data Sheet (MSDS)
- Personal Protective Equipment (PPE)

Standards Alignments:

CCSS: RSLT 11-12.4, 10; **WS** 11-12.6,8; **LS** 11-12.1,6; **WHSST** 11-12.7,8
NGSS: PS 1.B

Key Assignments	CTE Anchor Standards	CTE Pathway Standards
✓ **Key Assignment:** Safety is a major component that is reinforced throughout the year. After learning key components to shop safety, students will choose from a variety of safety concerns and work in teams to create a safety poster to display in class and give a five-minute presentation highlighting the safety concern or violation. Once completed, all posters will be displayed for the semester. **Assessment:** Using a gallery walk students will perform a peer review of the posters for overall quality and relevant information	1.0, 2.4, 2.5, 6.2, 6.4, 6.5, 6.6, 6.7	

✓ **Key Assignment:** Students will simulate how to perform work duties with a "work-related injury disability" from a shop accident. This can range from missing an eye, hand, leg, and an arm. Students will draw from a can to choose their "work-related injury disability" then be given a list of tasks to compete without being able to use the missing body part. This is a role play that is meant to educate students to the challenges and effects of a lifelong preventable injury. **Assessment:** Students will perform a self assessment at the end of the activity	1.0, 6.4, 6.5, 6.6, 6.7, 6.8	
✓ **Key Assignment:** Students will read and interpret an MSDS for different products that are used in the lab and demonstrate the proper PPE for each application in lab. Students will identify which chemicals can be mixed for usage and which can create possible uncontrolled chemical reactions. **Assessment:** Students will perform a quick write covering the assigned MSDS for overall comprehension	1.0, 4.1, 6.0, 7.7	C 2.0

Unit 1: Gas Metal Arc Welding (GMAW) - Flat — 50 hours

Students will learn how the process of GMAW works based on which components are used in the setup phase. This will include selecting the proper shielding gas, selecting the proper type of filler material to match the base metal. In a lecture setting students will demonstrate knowledge of the GMAW process on different types of base materials, using the proper shielding gas and filler needed for a given material.

- GMAW Equipment set-up including short circuit, spray and globular transfer
- Steel welding: butt weld in the flat position
- Fillet weld in the flat position
- Lapp weld in the flat position
- Welding gases and applications
- GMAW electrode classification
- Structural code D1.1 visual inspection
- Outside corner weld in the flat position

Standards Alignments:

CCSS: LS 11-12.1; **RLST** 11-12.3; **G-GMD** 5; **G-CO** 1; **G-SRT** 8
NGSS: SEP 1, 2, 3, 4, 5, 6, 7, 8; **PS** 1.A, B, 3.B; **ETS**1.A,B,C; **CC** 3,6,7;

Key Assignments	CTE Anchor Standards	CTE Pathway Standards
✓ **Key Assignment:** Using basic layout, cutting and welding skills, students will individually fabricate a small welded item (such as a truck, dinner bell, wine rack, boot rack, lamp) to specifications using a teacher provided blueprint.	1.0, 10.3	C 1.2, C 1.3, C 2.0

Assessment: rubric, observation		
✓ Scrap Metal Sculpture Building Contest: Students will engage in a lab sculpture building contest. Teams will be given certain parameters from instructor indicating goals and objectives of the project, artistic requirements, materials to choose from and time allotment. Teams will each analyze all of the requirements and work as a team to propose and build their sculpture. Teams will all present their sculptures in a gallery walk in class, then in a public display. Students, peers and public will use a rubric to evaluate each project and vote on winning sculpture. **Assessment:** gallery walk, observation, peer feedback	1.0, 2.0, 5.0, 6.3, 9.3	C 1.2, C 1.3, C 2.0, C 5.4, C 6.1
✓ Students will weld coupons constructed for evaluation by a Certified Weld Inspector (CWI). Students will prep and practice for the welding certification test. Students will have the opportunity to take the American Welding Society (AWS) test for welder's certification, a national standard in industry. **Assessment:** Use of rubrics aligned to current AWS standards for structural building code	3.4, 3.5, 3.9,	C 1.2, C 1.3, C 2.0, C 5.4, C 6.1

Unit 2: Gas Metal Arc Welding (GMAW) - Vertical — 20 hours

Students will demonstrate proficiency at all of the following: butt weld in the vertical up and down, fillet weld in the vertical up and down, lapp weld in the vertical up and down, vert fillet in the flat position, vert butt in the flat position, vert lapp weld in the flat position. All welds are to meet the American Welding Society's tolerance and quality requirements for structural code D1.1 visual inspection.

- GMAW equipment set-up including short circuit, spray and globular transfer
- Steel welding: butt weld in the flat position
- Fillet weld in the vertical position
- Lapp weld in the vertical position
- Welding gases and applications
- GMAW electrode classification
- Structural code D1.1 visual inspection
- Outside corner weld in the vertical position

Standards Alignments:

CCSS: G-GMD.5; **G-CO**.1; **LS** 11-12.1,6: **G-SRT** 8
NGSS: SEP 1, 2, 3, 4, 5, 6, 7, 8; **PS** 1.A, B, 3.B; **ETS** 1.A, B, C; **CC** 3,6,7

Key Assignments	CTE Anchor Standards	CTE Pathway Standards

✓ **Key Assignment:** Given a blueprint with specific dimensions, students will construct a tool box out of mild steel using fractional measurement set by American Welding Society's tolerance standards and meetings all requirements stated on their blueprint. **Assessment:** All welds are evaluated, 1/16" tolerance for construction and all angular layout to 1/16", rubric, visual inspection, self-reflection	1.0, 10.3, 11.1	C 1.2, C 1.3, C 2.0, C 5.4, C 6.1

Unit 3: Measurement and Layout — 30 hours

Students will prepare technical drawings at specific scales in both metric and imperial units, compute scale factors, measurements, and size drawings appropriately and accurately, use drafting instruments for hand drawings, for input into CAD systems. Students will create accurate and real CAD drawings then implement them in lab.

- GTAW process
- GMAW process
- SMAW process
- Layout tools used for project construction
- Blueprints interpretation
- Blueprint construction

Standards Alignments:

CCSS: G-CO.12; **G-C**O.1; **G-GMD**.5
NGSS: SEP 1, 2, 3, 4, 5, 6, 7, 8; **PS** 1.A, B, 3.B; **ETS** 1.A, B, C; **CC** 3, 6, 7

Key Assignments	CTE Anchor Standards	CTE Pathway Standards
✓ **Key Assignment:** Logo Design: Using Auto-CAD and Torchmate, students will work in groups to design their own logo made from steel, utilize CAD software to create prints, program G-Code for CNC machines and cut logo out using CNC plasma tables. Students will present and display their logos for peer and instructor review and feedback. **Assessment:** CAD software will be reviewed to machine usage, gallery walk and oral defense used for evaluation student logo designs	1.0, 2.0, 5.1, 5.2, 6.1, 9.2, 10.1, 10.2, 10.3	C 1.0, C 2.0, C 6.1, C 7.4
✓ **Key Assignment:** Students will be provided with a print to evaluate and interpret. Using this print, students will build a GTAW welded dice to the exact proportions stated on print. **Assessment:** Self-assessment using the given print to see if their product matches desired product	1.0, 2.3, 5.1, 5.2, 6.1, 10.1	C 1.0, C 2.0, C 6.1, C 7.4
✓ **Lab:** Bank on It!- Using a teacher provided blueprint, students will individually build a SMAW welded bank out of ⅜" steel cut freehand using OXY-Fuel cutting to indicated specifications.	1.0, 2.3, 5.1, 5.2, 6.1, 10.1	C 1.0, C 2.0, C 6.1, C 7.4

Using soapstone to draw out the necessary parts, students will freehand cut the materials, prep all parts for welding and will weld the bank together using the shielded metal arc welding process. **Assessment:** Gallery walk will be used for a peer review and then finally compared to the blueprint for construction using a rubric		
✓ **Key Assignment:** Students will construct a box out of mild steel using fractional measurement to American Welding Society's tolerance requirements. The project is held to 1/16" fractional tolerance when being constructed by students. Students will measure their own and peer's project for tolerance levels. **Assessment:** rubric, observation, self review, peer review	1.0, 2.3, 5.1, 5.2, 6.1, 10.1	C 1.0, C 2.0, C 6.1, C 7.4

Unit 4: OXY Fuel Cutting Free Hand and On Track Cutter — 15 hours

Students will demonstrate proficiency at free hand cutting and machine cutting to specified measurements.

- Gas mixtures
- Proper gas use
- Metal cutting techniques (manual and automated)
- Cutting speeds
- Cutting bevels
- Material prep for welding operations

Standards Alignments:

CCSS: G-GMD.5; **G-CO**.1; **LS** 11-12.1,6: **G-SRT** 8
NGSS: SEP 1, 2, 3, 4, 5, 6, 7, 8; **PS** 1.A, B, 3.B; **ETS** 1.A, B, C; **CC** 3, 6, 7

Key Assignments	CTE Anchor Standards	CTE Pathway Standards
✓ **Key Assignment:** Ongoing throughout the year, students will cut and grind all slag from coupons of various sizes from a variety of metals following instructor specified measurements. Students will individually use a 4' x10' piece of metal to free hand cut using the OXY Fuel cutting process. Students will measure exact size before submitting to instructor for final inspection. **Assessment:** rubric, self-assessment, observation	1.0, 2.3, 5.1, 5.2, 6.1, 10.1	C 2.0, C 3.0, C 4.0, C 6.0, C 8.0
✓ **Key Assignment:**Using a track cutting machine, students will cut bevels for weld joints. Students will set up machine, cutting speed and gas mixtures for automated cutting. Students will operate track cutter independently while plates are cut to a required size for	1.0, 5.0, 6.0, C 7.4, 10.1,	C 2.0, C 3.0, C 4.0, C 6.0, C 8.0

the welding process that will join them together. After cutting, plates will be checked for proper layout and all slag will be ground off for the welding process. All cuts are held to 1/16" tolerance for fit up and size. This assignment will be repeated a minimum of 25 times throughout the year to various specifications. **Assessment:** rubric, observation, oral questioning		
✓ **Key Assignment:** Students will set and tear down different types of cutting equipment used in the welding and manufacturing industry. Students will set gas regulators, select proper cutting tips for material and apply the correct cutting speed. Acetylene fuel as well as propylene fuel will be used for cutting applications. Students will demonstrate their ability to follow all procedural steps to peers and instructor. **Assessment:** observation, quiz, oral questioning	6.0	C 2.0, C 3.0, C 4.0, C 6.0, C 8.0

Unit 5: Shielded Metal Arc Welding (SMAW) Welding All Positions — 50 hours

Students will demonstrate proficiency at using cut metal as well as cutting materials to coupon size using OXY Fuel, and welding out fully with good bead pattern. They will demonstrate proficiency at proper joint fit up as well as understanding proper beading and weld appearance, troubleshooting and resolving weld defects. In addition, students will use a variety of electrodes to weld heavy plate in multiple positions, and use a tape measure to fit up weld joint for proper welding.

- Flat, horizontal, vertical, overhead fillet weld
- Flat, horizontal, vertical, overhead groove weld
- Flat, horizontal, vertical, overhead butt weld
- Flat, horizontal, vertical, overhead lap weld
- All welds evaluated to D1.1 building code

Standards Alignments:

CCSS: G-GMD.5; **G-CO**.1; **LS** 11-12.1,6: **G-SRT** 8
NGSS: SEP 1, 2, 3, 4, 5, 6, 7, 8; **PS** 1.A, B, 3.B; **ETS** 1.A, B, C; **CC** 3, 6, 7

Key Assignments	CTE Anchor Standards	CTE Pathway Standards
✓ **Key Assignment:** Students will use 70' series electrodes in flat, horizontal, vertical and overhead welding positions. Student apply knowledge of amperage and voltage to adjust the machines accordingly to the proper electrode size and the desired weld position. Students will perform groove welds on 1" thick steel using a backing bar with a weave or stringer	1.0, 5.0, 6.0, 7.4, 10.0	C 1.0, C 2.0, C 6.0, C 8.0

welding technique. Students will construct weldments to simulate structural steel building and pipeline tie-ins. **Assessment:** rubric, self reflection, observation		
✓ **Key Assignment:** Students will use 60' series electrodes all positions in flat, horizontal, vertical and overhead welding positions. Student apply knowledge of amperage and voltage to adjust the machines accordingly to the proper electrode size and the desired weld position. Students will weld groove welds on ⅝" thick steel in an open root fit up using the stringer welding technique. students will construct weldments to simulate welding on pipeline systems. **Assessment:** rubric, self reflection, observation	1.0, 5.0, 6.0, 7.4, 10.0	C 1.0, C 2.0, C 6.0, C 8.0
✓ **Key Assignment:** Students will use 80' series electrodes all positions in flat, horizontal, vertical and overhead welding positions. Student apply knowledge of amperage and voltage to adjust the machines accordingly to the proper electrode size and the desired weld position. students will perform groove welds on 1"thick steel using a backing bar with a weave or stringer welding technique Students will construct weldments to simulate structural steel building and pipeline tie-ins. **Assessment:** rubric, self reflection, observation	1.0, 5.0, 6.0, 7.4, 10.0	C 1.0, C 2.0, C 6.0, C 8.0

Unit 6: GTAW Welding All Positions — 60 hours

Students will demonstrate proficiency at understanding and using the Gas Tungsten Arc Welding Process.

- Filler and shielding gas for base metal
- Electrical characteristics
- Weldments on steel
- Weldments on stainless steel
- Proper machine set up

Standards Alignments:

CCSS: LS 11-12.1,6; **A-CED** 4; **G-GMD**.5; **G-CO**.1; **G-SRT** 8
NGSS: SEP 1, 2, 3, 4, 5, 6, 7, 8; **PS** 1.A,B, 3.B, D; **ETS** 1.A,B,C, 2A, B; **CC** 3,6,7

Key Assignments	CTE Anchor Standards	CTE Pathway Standards
✓ **Lab-Aluminum Welds:** Students will perform multiple butt, fillet, lap and outside corner welds on aluminum in various welding positions including flat, horizontal, vertical and overhead. Student apply knowledge of amperage and voltage to adjust the machines	1.0, 5.0, 6.0, 7.4, 10.0	C 1.0, C 2.0, C 3.0, C 4.0, C 6.0, C 8.0

according to the proper electrode size, filler metal type and weld position. Students will present their weld to the instructor and defend choices regarding A/C balance and pulse settings. **Assessment:** self observation, rubric, peer review		
✓ **Lab-Mild Steel Welds:** Students will weld on mild steel in various welding positions including flat, horizontal, vertical and overhead. Student apply knowledge of amperage and voltage to adjust the machines accordingly to the proper electrode size, filler metal type and weld position. Students will present their weld to instructor and defend choices based on machine parameters for the desired weld. **Assessment:** self observation, rubric, peer review	1.0, 5.0, 6.0, 7.4, 10.0	C 1.0, C 2.0, C 3.0, C 4.0, C 6.0, C 8.0
✓ **Lab-Stainless Steel Welds:** Students will weld on stainless steel in various welding positions including flat, horizontal, vertical and overhead.Student apply knowledge of amperage and voltage to adjust the machines accordingly to the proper electrode size, filler metal type and weld position. Students will present their weld to instructor and defend choices based on post weld characteristics through interpreting the color of the finished weld and the heat affected zone. **Assessment:** self observation, rubric, peer review	1.0, 5.0, 6.0, 7.4, 10.0	C 1.0, C 2.0, C 3.0, C 4.0, C 6.0, C 8.0
✓ **Key Assignment:** Students will build a GTAW welded airplane out of 1/16" steel. Using a CNC plasma table, students will write the needed computer program to cut out the airplane components. Once all parts are cut out, the students will then fully weld the fabricated pieces together to create a complete airplane to exact specifications indicated on print out. **Assessment:** CNC code will be test run for operations, weld quality done by peer review along with overall project design	1.0, 5.0, 6.0, 7.4, 10.0	C 1.0, C 2.0, C 3.0, C 4.0, C 6.0, C 8.0

Unit 7: Flux Core Arc Welding (FCAW) All Positions — 40 hours

Students will learn how the FCAW process works as well as setting proper current setting, running wire out of position, controlling the temperature of the base metal to keep its carbon content stable while fusing the base metal.

- Multiple wire types on groove welds
- Machine setup for different base metals
- Heavy plate weld
- Sheet metal weld
-

Standards Alignments:
CCSS: LS 11-12.1; **RLST** 11-12.3; **G-GMD** 5; **G-CO** 1; **G-SRT** 8; **WHSST** 11-12.7, 11-12.8
NGSS: SEP 1, 2, 3, 4, 5, 6, 7, 8; **PS** 1.A,B, 3.B; **ETS** 1.A,B,C; **CC** 3,6,7

Key Assignments	CTE Anchor Standards	CTE Pathway Standards
✓ **Key Assignment:** Students will use the NR232 electrode for welding in all positions on groove welds on 1" thick steel. Students fit-up and weld-out weldments to simulate a structural steel welding environment. Upon mastery of the process, students will have the opportunity to test in the vertical and overhead welding positions to become a certified welder through the American Welding Society under D1.1 building code. **Assessment:** self reflection, test, rubric, visual inspection	1.0, 5.0, 6.0, 7.4, 10.0	C 1.0, C 2.0, C 3.0, C 4.0, C 5.0, C 8.0
✓ **Lab-**The Art of Welding: Ornamental Welding - Students will use NR211 electrode for welding fillets, lap, grooves and outside corner welds in all positions. Students will demonstrate the proper application for NR211 as a non load bearing weldment used on materials under 5/16" thick. Students will apply this electrode on weldments that simulate various field repairs and ornamental welding such as gates and fences. **Assessment:** rubric, self reflection, visual inspection	1.0, 3.0, 5.0, 6.0, 7.4, 9.2, 10.0	C 1.0, C 2.0, C 3.0, C 4.0, C 5.0, C 8.0
✓ **Lab-**Welded Art in America: Students will work in collaborative teams to investigate an American city of their choice known for its unique ornamental welding style (such as the French Quarter in New Orleans). Each student in the group will sketch a minimum of 3 examples from that city and create one design of their own emulating the same design style. Teams will present all of their sketches and a brief historical perspective to the class using a presentation software tool such as PowerPoint. **Assessment:** critique, rubric, oral defense, peer and instructor feedback	1.0, 5.0, 6.0, 7.4, 10.0	C 1.0, C 2.0, C 3.0, C 4.0, C 5.0, C 8.0
✓ **Key Assignment:** Students will role play a weld inspection scenario for all welds under the D1.1 welding code. Using weld inspection practices, students will perform a guided bend test to examine weld quality and look for weld defects in the weldment. Students will write reports on the tested weldments and document weld failure, as well as the amount and size of the weld defects. **Assessment:** written documentation, observation, self reflection	1.0, 5.0, 6.0, 7.4, 10.0	C 1.0, C 2.0, C 3.0, C 4.0, C 5.0, C 8.0

Unit 8: Introduction of Structural Welding Using FCAW, SMAW All Positions — 10 hours

In the lab, students will explore how a structural weldment has load applied to it, what are the forces that cause structural welds failure, and how to properly and safely fuse two heavy plate joints.

- Bends using a guided bend test
- Code books used in industry
- Structural building code
- Weld repair using all processes
- Welds evaluation

Standards Alignments:

CCSS: LS 11-12.1; **RLST** 11-12.3; **G-GMD** 5; **G-CO** 1; **G-SRT** 8; **WS** 11-12.2, 4
NGSS: SEP 1, 2, 3, 4, 5, 6, 7, 8; **PS** 1.A,B,3.B; **ETS** 1.A, B, C; **CC** 3,6,7;

Key Assignments	CTE Anchor Standards	CTE Pathway Standards
✓ **Key Assignment:** Students will review welding code D1.1 and D1.8 and evaluate welds with weld inspector tools and techniques. Using various stress method tests, students will perform destructive weld testing and nondestructive testing. After testing results are compiled, students will compare the fail data against the building code to see if weldments meet or pass the building code standards. **Assessment:** calculation check, notebook check, student/instructor conference, self-reflection	1.0, 5.0, 6.0, 7.4, 10.0	C 1.0, C 2.0, C 3.0, C 4.0, C 5.0, C 8.0
✓ **Key Assignment:** Students will use a guided bend test for weld evaluation and welders certification and compare results to the desired building code. Results will be formatted into a written statement and recorded in the same manner as a building inspection on a performance qualification record (PQR) **Assessment:** journaling, notebook check	1.0, 5.0, 6.0, 7.4, 10.0	C 1.0, C 2.0, C 3.0, C 4.0, C 5.0, C 8.0
✓ **Key Assignment:** Students will have the option to test to become a Certified Welder through the American Welding Society. Testing is administered throughout the year. Students can test on Shielded Metal Arc Welding, Flux Core Arc Welding, Gas Metal Arc Welding in all positions to the D1.1 building code. Testing is administered for Gas Tungsten Arc Welding on aluminum and steel to D5.1 building code. **Assessment:** student conference, industry standard exam, test, observation	1.0, 5.0, 6.0, 7.4, 10.0	C 1.0, C 2.0, C 3.0, C 4.0, C 5.0, C 8.0

Unit 9: Weld Symbols — 10 hours

Weld symbols are used in the fabrication industry to provide continuity. Students will learn:

- Weld symbols identification
- Application and use of a weld symbols
- Understand and interpret the different types of weld symbols
- Application of proper weld symbol and notations to the desired weldments

Standards Alignments:

CCSS: LS 11-12.6; **RLST** 11-12.4; **WS** 11-12.4; **G-CO** 11-12.1; **G-GMD** 5; **G-SRT** 8
NGSS: SEP 1, 2, 3, 4, 5, 6, 7, 8; **ETS** 1, A, B, 2 A ,B; **CC** 6, 7

Key Assignments	CTE Anchor Standards	CTE Pathway Standards
✓ **Key Assignment:** Students will first review a Weld Symbol Packet in a lecture setting. In lab, students will demonstrate a variety of welds for multiple process in all positions and all types of weld joints. Measurement will be used to layout welds in proper place and proper size. All welds are held to the American Welding Society's tolerance and quality requirements for structural code D1.1. **Assessment:** visual inspection	1.0, 3.6, 5.0, 6.0, 10.0, 11.0	C 1.0, C 2.0, C 3.0, C 8.0
✓ **Key Assignment:** Students will apply welding symbols to blueprints, interpret the symbols, then apply the correct type of weld as called out. Students will draw called out weld symbols as notated for a variety of blueprints which will include the sub notes. All must be constructed and notated using American Welding Society standards. **Assessment:** test, pair share, exit ticket, student/instructor conference	1.0, 5.0, 6.0, 10.0	C 1.0, C 2.0, C 3.0, C 8.0
✓ **Key Assignment:** Students will interpret weld symbols in lab then apply to weldments to be constructed. Students will construct the product in lab with the proper and notated symbols in the correct locations and using the correct called out symbols. Students are tasked with selecting the proper welding process noted by the symbol, including choosing the correct electrode and filler materials for the job. **Assessment:** rubric, quiz, self-assessment	1.0, 5.0, 6.0, 10.0	C 1.0, C 2.0, C 3.0, C 8.0

Unit 10: Print Reading and Construction — 20 hours

Students will be introduced to the necessary skills to read and construct blueprints and practice these skills in a lab setting.

- Print reading
- Print tools and materials
- Notation
- Scale
- Print symbols
- Print construction

Standards Alignments:

CCSS: LS 11-12.6; **RLST** 11-12.4; **WS** 11-12.4; **G-CO** 11-12.1; **G-GMD** 5; **G-SRT** 8
NGSS: SEP 1, 2, 3, 4, 5, 6, 7, 8; **ETSA** 1, A, B, 2 A ,B; **CC** 6, 7;

Key Assignments	CTE Anchor Standards	CTE Pathway Standards
✓ **Key Assignment:** Students will draw isometric and orthographic sketches using proper engineering notation for blueprints. Sketches will be created by students of actual machined parts including notations for sizing and scale. Students will compare their own sketches with industry standard prints for proper line type and construction. Student sketches will be presented to peers for interpretation and evaluation. Students will conference to discuss readability of plans. **Assessment:** exit ticket, notebook check, pair share, peer feedback, self-reflection	1.0, 2.1-4, 5.0, 6.0, 7.4, 7.5, 10.0, 11.2	C 1.0, C 7.0
✓ **Key Assignment:** Students will investigate how CAD systems work and how they are used in the manufacturing industry. Students will use CAD to make a print for use in the shop for their fabrication projects. Once the CAD files are complete, students have the option to construct the projects free hand or convert it into G-code for CNC cutting operations. Students will display their prints and products for critique and feedback. **Assessment:** student conference, peer/instructor feedback, critique	1.0, 2.1-4, 5.0, 6.0, 7.4, 7.5, 10.0, 11.2	C 1.0, C 7.0
✓ **Key Assignment:** Students will work as a manufacturing team by collaboratively brainstorm and propose a project to build in lab. Class will vote on which project to construct as a class. Upon project selection, students will develop a bill of materials and finish costs for the project competition to include the cost of materials, welding operating costs, finishing costs and painting costs. Once all of the costs are sourced, the project will be submitted for approval and production.	1.0, 2.1-4, 5.0, 6.0, 7.4, 7.5, 9.0, 10.0, 11.2	C 1.0, C 7.0, C 9.1

Assessment: public display and feedback, peer evaluation, observation, discussion, proposal pitches		

Unit 11: Structural Shapes and Project Design — 10 hours

Students will engage in lab activities that are designed to provide them with a basic understanding of the principles of structure and load as related to welding practices.

- Different metal stress loads
- Material shapes and sizes
- Load transfer
- Filler grades
- Different weldment design for loaded applications
- Materials comprehension for structures
- Proper filler metal selection for loaded structures
- Stress relieving materials

Standards Alignments:

CCSS: LS 11-12.1; RLST 11-12.3; G-GMD 5; G-CO 1; G-SRT 8; **WS** 11-12.2, 11-12.4
NGSS: SEP 1, 2, 3, 4, 5, 6, 7, 8; **PS** 1.A,B, 3.B; **ETS** 1.A, B, C; **CC** 3, 6, 7

Key Assignments	CTE Anchor Standards	CTE Pathway Standards
✓ **Lab-**Metal Bridge competition: Students will research the history and background of bridges with emphasis on structural integrity and application. Working in teams and within given specs and distance span, students will design their own bridge using CAD software, create a bill of materials, determine a plan of action, and construct their bridge from steel using the Gas Tungsten Welding process for all welds and joints. Students will problems solve as a team to consider the structural integrity of the bridge as well as the aesthetic properties. Students will present their bridges to their peers and instructor for critique and feedback. **Assessment:** self-assessment, portfolio check, oral questioning, critique, peer feedback	2.0, 5.0, 8.0, 9.0, 10.0	C 1.0, C 2.0, C 3.0, C 4.0, C 7.4, C 8.0
✓ **Key Assignment:** Students will learn how to join structures for cyclic loading using welding process approved by American Welding Society D1.1 building code. Students will apply heat to a weldment and how and analyze and describe how the Heat Affected Zone (HAZ) changes the steel's structure and how stress relieving practices can be applied to a cyclical loaded structure. **Assessment:** observation, self reflection, instructor/student conference, code check	1.0, 5.0, 6.0, 10.0	C 2.0, C 3.0, C 4.0, C 8.0

✓ **Lab-**Product Design: Students will work in teams to design their own product to fit a specific need described by instructor. They will formulate a design for the product, create blueprints, produce a materials spreadsheet for cost of production including source parts and materials and fabricate their product in lab setting to completion. **Assessment:** quick write, observation, calculations check, peer and self reflection	2.0, 5.0, 8.0, 9.0, 10.0	C 3.0, C 4.0, C 7.4, C 8.0

Unit 12: Large Fabrication — 40 hours

Students will build large metal structures using all forms of welding and using layout practices in a practical application. Student will act as contractors to carry out jobs, assemble a bill of materials and cut sheet for a variety of large fabrication projects.

- Materials cost analysis (bill of materials)
- Blueprints for construction
- Project quote/bidding
- Cut sheet

Standards Alignments:

CCSS: LS 11-12.1; **RLST** 11-12.3; **G-GMD** 5; **G-CO** 1; **G-SRT** 8; **WS** 11-12.2, 11-12.4
NGSS: SEP 1, 2, 3, 4, 5, 6, 7, 8; **PS** 1.A,B, 3.B; **ETS** 1.A, B, C; **CC** 3,6,7

Key Assignments	CTE Anchor Standards	CTE Pathway Standards
✓ **Key Assignment:** Teams of students will build a tandem axle car trailer. Using selected materials made from their own blueprints, students will create cost of production spreadsheets for the trailer fabrication, present and justify their costs to peers and instructor. Students will work collaboratively to build the trailer using various welds meeting all industry standard code. **Assessment:** observation, work order documentation, tool demonstration, calculations check, peer and instructor feedback	2.0, 5.0, 8.0, 9.0, 10.0, 11.0	C 1.0, C .,0, C 3.0, C 4.0, C 5.0, C 6.0, C 7.0, C 8.0, C 9.0
✓ **Key Assignment:** Throughout the year with the guidance of the instructor, students individually and collaboratively diagnose non working tools and machines, create work orders and collaboratively research technical manuals, order parts and repair broken classroom tools restoring them to their original performance specifications. **Assessment:** work order documentation, observation, tool demonstration	1.0, 2.0, 5.0, 8.0, 9.0, 10.0, 11.0	C 1.0, C 2.0, C 3.0, C 4.0, C 5.0, C 6.0, C 7.0, C 8.0, C 9.0

Unit 13: Simulated Field Welding Environment — 27 hours

Students will work in simulated field welding environments practicing a higher level of welding to reduce weld failures while working out of a service truck environment using large equipment in a fabrication application.

- SMAW heavy plate
- Field preparing weldments for construction
- Gantry crane
- FCAW heavy plate
- Oxy-Fuel cutting and fitting
- Rigging
- All position welding
- Sourcing tools from service trucks
- Hydraulic lift

Standards Alignments:

CCSS: LS 11-12.1; **RLST** 11-12.3; **G-GMD** 5; **G-CO** 1; **G-SRT** 8; **WS** 11-12.2, 11-12.4
NGSS: SEP 1, 2, 3, 4, 5, 6, 7, 8; **PS** 1.A,B, 3.B; **ETS** 1.A,B,C; **CC** 3,6,7

Key Assignments	CTE Anchor Standards	CTE Pathway Standards
✓ **Key Assignment:** At multiple times throughout the year, students will build various large projects, such as a past year is a roll off dumpster for a local company. Projects are real-world based and students will apply all skills previously practiced to construct to the print on hand. All welds must meet or exceed American Welding Society standard for DOT code and structural code D1.1. Project vary in number, design and scope from year to year as these are customer based projects and are unique to each customer required build. Students will use customer service, teamwork and skills demonstration to complete these projects. Some examples from previous years have included: dumpsters, trailers, tool carts, scaffolding and low walls for commercial construction. **Assessment:** visual inspection, customer satisfaction, self-reflection, peer reflection, teacher/student conference	1.0, 2.0, 5.0, 8.0, 9.0, 10.0	C 1.0, C 2.0, C 3.0, C 4.0, C 7.4, C 8.0

Unit 14: Metal Shaping and Sculpture Career Exploration — 50 hours

Students will create and design sculptures from various materials using manual and CNC operations with an emphasis on the arts and current art trends. Students will create and shape various types of metals using a variety of tools. The sculptures that will be created will be done using manual and automated tools such as Oxy-Fuel cutting and CNC plasma table. Students will create a variety of sculptural projects using multiple types of materials, both individually and in groups.

- Oxy-Fuel manual processes
- GMAW, GTAW weld processes
- Computer generated art projects
- Different medias for sculptures

Standards Alignments:
CCSS: LS 11-12.1; **RLST** 11-12.3; **G-GMD** 5; **G-CO** 1; **G-SRT** 8; **WS** 11-12.2, 11-12.4
NGSS: SEP 1, 2, 3, 4, 5, 6, 7, 8; **PS** 1.A,B, 3.B; **ETS** 1.A, B, C; **CC** 3,6,7

Key Assignments	CTE Anchor Standards	CTE Pathway Standards
✓ **Lab-**Fire Art Sculpture: Students will work in teams to generate an idea for a welded Fire Art Sculpture. The sculpture must have aesthetic merit, incorporate a variety of welding techniques and include a fire element. Teams will each draw up their idea and pitch their idea to the class. The class will vote on one sculpture to create as a class. The class will collectively work to create the chosen sculpture by deciding upon materials, time commitments, job assignments and welding practices. This project will be displayed on campus for public enjoyment and feedback. **Assessment:** gallery walk, observation, peer review	1.0, 2.0, 5.0, 8.0, 9.0, 10.0, 11.0	C 1.0, C 2.0, C 3.0, C 4.0, C 7.4, C 8.0
✓ **Lab-**Scrap Metal Roses: Students will work individually to create a rose from scrap metal. They will determine a way to express the delicate nature of the flower using a variety of metals and weld techniques. They must consider artistic quality and proper fabrication to produce a well-designed piece of art. Students will display their works for peer and public critique and feedback. **Assessment:** gallery walk, peer review, observation	1.0, 2.0, 5.0, 8.0, 9.0, 10.0, 11.0	C 1.0, C 2.0, C 3.0, C 4.0, C 7.4, C 8.0
✓ **Lab-**Customer Request for Sculpture: At various times throughout the school year, students will be asked by other school faculty to create a sculpture with a specific purpose in mind. The students will work in teams to consider details of the request, generate design proposals, sketch and pitch their proposals to associated staff member and work collectively to create the chosen sculpture. The most recent project completed by the welding class was a lighted trophy sculpture to honor the class on campus with the best attendance. Different projects will be assigned each year based on customer request. **Assessment:** portfolio check, 3-2-1, self-assessment	1.0, 2.0, 5.0, 8.0, 9.0, 10.0, 11.0	C 1.0, C 2.0, C 3.0, C 4.0, C 7.4, C 8.0
✓ **Lab-**Fabricated Art: Students design a work of art to be fabricated by the CNC machine. Students will draw their design considering form and aesthetic properties, import their	1.0, 2.0, 5.0, 8.0, 9.0, 10.0, 11.0	C 1.0, C 2.0, C 3.0, C 4.0, C 7.4, C 8.0

design into the CNC machine, program as needed and assemble their work of art from the cut components. Students will use fabrication tools to properly weld all components to industry standard specifications. Students will engage in robust discussion and critique each piece of artwork created. **Assessment:** CNC checks and operations steps, observation		
✓ **Lab-**Reproducible Art Pieces for Sale: Throughout the school year, students will engage in designing and fabricating a variety of small artistic pieces for resale. In the past, these small projects have included business card holders, Halloween skulls painted in the style of Dia de los Muertos art and holiday ornaments cut in the form of snowflakes. The students will generate creative product ideas that will attract buyers and showcase excellent craftsmanship. The students will take orders from the public for these products and fabricate to specifications considering deadlines and teamwork. **Assessment:** pair share, gallery walk, observation	1.0, 2.0, 5.0, 8.0, 9.0, 10.0, 11.0	C 1.0, C 2.0, C 3.0, C 4.0, C 7.4, C 8.0

Instructional Materials

Textbooks:	**Electronic Media/Supplemental Print Materials/Online Resources:**
Blueprint Reading for Welders 9th edition A.E. Bennett, Louis J. Siy – Cengage Learning © 2015 ISBN: 978-1-133-60578-2 ***Gas Tungsten Arc Welding Handbook*** 6th edition William H. Minnick, Mark A. Prosser – Goodheart-Willcox Publisher © 2012 ISBN: 978-1-60525-793-8 ***Gas Metal Arc Welding Handbook*** 5th edition William H. Minnick – Goodheart-Willcox Publisher © 2007 ISBN: 978-1-59070-866-8	

Math for Welders 5th edition Nino Marion – Goodheart-Wilcox © 2012 ISBN: 978-1-60525-901-7	

Standards Assessed in this Course

CTE Anchor Standards:

1.0 Academics: Academics standards are aligned to pathways; see below.
2.0 Communications: Acquire and use accurately sector terminology and protocols at the career and college readiness level for communicating effectively in oral, written, and multimedia formats.
3.0 Career Planning and Management: Integrate multiple sources of career information from diverse formats to make informed career decisions, solve problems, and manage personal career plans.
4.0 Technology: Use existing and emerging technology, to investigate, research, and produce products and services, including new information, as required in the sector workplace environment.
5.0 Problem Solving and Critical Thinking: Conduct short, as well as more sustained, research to create alternative solutions to answer a question or solve a problem unique to the sector using critical and creative thinking, logical reasoning, analysis, inquiry, and problem-solving techniques.
6.0 Health and Safety: Demonstrate health and safety procedures, regulations, and personal health practices and determine the meaning of symbols, key terms, and domain-specific words and phrases as related to the sector workplace environment.
7.0 Responsibility and Flexibility: Initiate, and participate in, a range of collaborations demonstrating behaviors that reflect personal and professional responsibility, flexibility, and respect in the sector workplace environment and community settings.
8.0 Ethics and Legal Responsibilities: Practice professional, ethical, and legal behavior, responding thoughtfully to diverse perspectives and resolving contradictions when possible, consistent with applicable laws, regulations, and organizational norms.
9.0 Leadership and Teamwork: Work with peers to promote divergent and creative perspectives, effective leadership, group dynamics, team and individual decision making, benefits of workforce diversity, and conflict resolution.
10.0 Technical Knowledge and Skills: Apply essential technical knowledge and skills common to all pathways in the sector following procedures when carrying out experiments or performing technical tasks.

Industry Sector: Manufacturing and Product Development - Industry Pathway: Welding and Materials Joining

C1.0 Interpret and demonstrate the planning and layout operations used in the welding processes.

C1.1	Use current information technology ideation and design process systems in the manufacturing of welded parts and products.
C1.2	Interpret scaled welding blueprints; gather design and materials information; perform calculations; and use the detail to plan, lay out, and produce parts or finished products.
C1.3	Analyze welding symbols on drawings, specifications, and welding procedure specifications.
C1.4	Critique the design parameters across welding processes to produce a welded part or product.
C2.0	**Understand and demonstrate how materials can be processed through the use of welding tools and equipment.**
C2.1	Introduce joint preparation methods and explain how to identify joint specifications.
C2.2	Use standard and new emerging welding tools and equipment, such as oxygen fuel cutting (OFC), plasma arc cutting (PAC), and carbon arc cutting (CAC) to cut materials for the purpose of completing a finished product that meets the standards of the AWS or a similar industry standard.
C2.3	Use welding tools and equipment such as oxy fuel welding (OFW), shielded metal arc welding (SMAW), gas metal arc welding (GMAW), flux-cored arc welding (FCAW), gas tungsten arc welding (GTAW), forge, and furnace to combine or join manufactured parts and products resulting in a finished product that meets the standards of the AWS or a similar industry standard.
C2.4	Compare and contrast the physical qualities of various industrial materials and how these qualities affect the ability of the materials to be processed to produce useful welded parts and products.
C3.0	**Differentiate and apply various types of welding assembly processes.**
C3.1	Use welding tools such as OFW, SMAW, GMAW, FCAW, GTAW, forge, and furnace and the equipment and assembly processes appropriate to the design criteria of a specific product to result in a finished part or product that meets the standards of the AWS or similar industry welding standards.
C3.2	Produce bonded industrial materials by using adhesive such as flow, pressure, and fusion welding.
C3.3	Compare and contrast existing material bonding methods with future innovative bonding processes.
C4.0	**Understand finishing processes and the differences between various types of finishing materials used in the manufacture of welded parts and products.**
C4.1	Employ and explain the steps to be taken, and the choices to be made, in finishing welded materials.
C4.2	Apply the processes used for finishing welded materials.
C4.3	Assess how to select an appropriate finishing process to meet the design criteria of a specific welded product.
C5.0	**Understand and defend the purposes and processes of inspection and quality control in welding manufacturing processes.**
C5.1	Identify and explain weld imperfections and their causes.
C5.2	Identify and explain destructive and nondestructive examination practices.
C5.3	Describe the reasons for inspection and quality control in the manufacturing of welded parts.
C5.4	Analyze and identify the steps to check for distortion, joint misalignment, and poor fit-up before and after welding.
C5.5	Perform continuous online quality control inspections of welded parts.

C5.6	Evaluate and know how to troubleshoot performance problems of welding systems.
C6.0	**Explore and understand various welding systems that require standard hand and machine tools.**
C6.1	Select and use appropriate welding tools, equipment, and inspection devices to manufacture parts or products.
C6.2	Compare and contrast the various welding systems used in conventional manufacturing industries in order to select and use appropriate tools, equipment, and inspection devices.
C6.3	Research new and emerging welding systems and their effects on the standard hand and machine manufacturing industry.
C7.0	**Understand various automated welding systems, welding design for manufacturing, flexible manufacturing systems, and materials resource planning.**
C7.1	Recognize materials and processes in relation to welding systems.
C7.2	Understand the importance of maintaining documentation for welding systems.
C7.3	Distinguish between welding processes involved in the following manufacturing systems: "just in time," design for manufacturing, flexible manufacturing systems, and materials resource planning.
C7.4	Use computers to design and produce welded products, write numerical control programs, and control robots.
C7.5	Compare and contrast the ways in which emerging welding systems may be integrated into current manufacturing processes.
C8.0	**Understand various joining or combining processes, including welding processes used in manufacturing, maintenance, and repair.**
C8.1	Recognize the importance of base metal preparation and joint fit-up and alignment.
C8.2	Analyze and be able to defend various welding processes used to complete a fabrication, an assembly, or a repair.
C8.3	Produce a completed fabrication, an assembly, or a repair by using appropriate joining and mechanical fastening techniques and processes.
C9.0	**Understand how a manufacturing company is organized and the elements of welding production management.**
C9.1	Know how scheduling, quality control, accident prevention, and inventory control are used efficiently and appropriately in a welding production management system.
C9.2	Understand that a welding production management system includes planning, engineering, organizing, and controlling resources and manufacturing processes.
C9.3	Diagram corporate structures that affect welding production.

Common Core Language Standards:

Language Standards – LS – (Standard Area, Grade Level, Standard #)

LS 11-12.1.	Demonstrate command of the conventions of standard English grammar and usage when writing or speaking.
LS 11-12.6	Acquire and accurately use general academic and domain-specific words and phrases sufficient for reading, writing, speaking, and listening at the college and career readiness level; demonstrate independence in gathering vocabulary knowledge when considering a word or phrase important to comprehension or expression.

Reading Standards for Literacy in Science and Technical Subjects – RLST – (Standard Area, Grade Level, Standard #)

RLST 11-12.3.	Follow precisely a complex multistep procedure when carrying out experiments, taking measurements, or performing technical tasks; analyze the specific results based on explanations in the text.
RLST 11-12.4.	Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to grades 11-12 texts and topics.
RLST 11-12.10.	By the end of grade 12, read and comprehend science/technical texts in the grades text complexity band independently and proficiently.
Writing Standards – WS – (Standard Area, Grade Level, Standard #)	
WS 11-12.2	Write informative/explanatory texts to examine and convey complex ideas, concepts, and information clearly and accurately through the effective selection, organization, and analysis of content.
WS 11-12.4	Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.
WS 11-12.6.	Use technology, including the Internet, to produce, publish, and update individual or shared writing products in response to ongoing feedback, including new arguments or information.
WS 11-12.7.	Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation.
WS 11-12.8.	Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the strengths and limitations of each source in terms of the task, purpose, and audience; integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism and overreliance on any one source and following a standard format for citation including footnotes and endnotes.
WS 11-12.9	Draw evidence from literary or informational texts to support analysis, reflection, and research.
Writing Standards for Literacy in History/Social Studies, Science, and Technical Subjects – WHSST	
WHSST 11-12.7.	Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation.
WHSST 11-12.8.	Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the strengths and limitations of each source in terms of the specific task, purpose, and audience; integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism and overreliance on any one source and following a standard format for citation.
Algebra – A-CED – Creating Equations	
A-CED 4	Rearrange formulas to highlight a quantity of interest, using the same reasoning as in equations. For example, rearrange Ohm's law V = IR to highlight resistance R.

Geometry – G-CO – Congruence

G-CO.1	Know precise definitions of angle, circle, perpendicular line, parallel line, and line segment, based on the undefined notions of point, line, distance along a line, and distance around a circular arc.

Geometry – G-GMD – Geometric Measurement & Dimensions

G-GMD.5	Determine how changes in dimensions affect the perimeter, area and volume of common geometric figures and objects.

Math Standards – Geometry – Similarity, Right Triangles, and Trigonometry – G-SRT – (Standard Area, Grade Level, Standard #)

G-SRT 8.	Know and use angle and side relationships in problems with special right triangles, such as, 30°, 60°, and 90' triangles and 45°, 45°, and 90° triangles.

Next Generation Science Standards:

Scientific and Engineering Practices

SEP 1	Asking questions (for science) and defining problems (for engineering)
SEP 2	Developing and using models
SEP 3	Planning and carrying out investigations
SEP 4	Analyzing and interpreting data
SEP 5	Using mathematics and computational thinking
SEP 6	Constructing explanations (for science) and designing solutions (for engineering)
SEP 7	Engaging in argument from evidence
SEP 8	Obtaining, evaluating, and communicating information

Disciplinary Core Ideas

Physical Sciences – PS

PS1	Matter and Its Interactions
PS1.A	Structure and Properties of Matter
PS1.B	Chemical Reactions
PS 3.B	Conservation of Energy and Energy Transfer
PS 3.D	Energy: Energy in Chemical Processes and Everyday Life

Engineering, Technology, and the Applications of Science – ETS

ETS 1.A	Defining and Delimiting Engineering Problems
ETS 1.B	Developing Possible Solutions
ETS 1.C	Optimizing the Design Solution

Crosscutting Concepts

CC 3.	Scale, proportion, and quantity
CC 6.	Structure and function. The way in which an object or living thing is shaped and its substructure determine many of its properties and functions.
CC 7.	Stability and change. For natural and built systems alike, conditions of stability and determinants of rates of change or evolution of a system are critical elements of study.