

TRADE AND INDUSTRIAL EDUCATION
Content Outline for 7662 WELDING TECHNOLOGY II
 [Recommended hours of instruction: 270 - 360]

Content Outline	T&I Leadership Teacher Guide		
A. LEADERSHIP			
W201. Demonstrate communication, problem solving, and team building skills.			
W201.01 Identify communication, problem solving, and team building techniques.			
A. Terms and definitions	30		
1. Communication terms			
a. Outline			
b. Gesture			
c. Demonstration			
d. Introduction to presentation			
e. Body of presentation			
f. Conclusion of presentation			
2. Problem solving and team building terms	37-38		
a. Bench marking			
b. Customer			
c. Customer requirements			
d. Supplier			
e. Brainstorming			
f. Check sheets			
g. Surveying			
h. Interviewing			
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j. Flowcharts			
B. Purposes for using presentations	30		
C. Guidelines for preparing successful presentations	30		
D. Step-by-step method for preparing a presentation	30		
E. Steps in problem-solving process	38-39		
1. Identify problem			
2. Describe the causes			
3. Search of possible solutions			
4. Choose a solution			
5. Carry out the solution			
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F. Steps in the quality improvement process	39		

1. Identify the end product			
2. Identify the customer			
3. Identify the customer's requirements			
4. Use customer requirements to identify your specifications			
5. Outline steps to follow in product production			
6. Identify and choose evaluation techniques to make sure you are on track.			
7. Determine if current process is adaptable enough to work when necessary changes are made.			
8. Evaluate process and results			
9. Go back to step one			
W201.02 Demonstrate communication, problem solving, and team building skills.			
Content Outline	Contren Learning Series	Modern Welding	Welding Prin & Apps
REFERENCES AND ABBREVIATIONS FOR THEM			
Reference 1: Contren Learning Series by the National Center for Construction Education and Research (NCCER) Published by Prentice Hall			
Reference 2: Modern Welding (2004) by Althouse, Turnquist, Bowditch, Bowditch, and Bowditch Published by The Goodheart-Willcox Company, Inc.			
Reference 3: Welding Principles and Applications (2004) by Jeffus and Johnson Published by Delmar Publishers, Inc.			
B. SAFETY PROCEDURES			
W202. Demonstrate safety procedures.			
W202.01 Review welding related safety procedures.	Module 00101-04 & 29101-03		
A. Introduction	Module 00101-04 Sec 1.0.0		
B. Accidents	Mod 00101-04 Sec 2.0.0 thru 2.1.9 and Mod 29101-03 Sec 2.1.0		
C. Housekeeping	Mod 00101-04 Sec 2.2.0		
D. OSHA regulations	Mod 00101-04 Sec 2.3.0 thru 2.3.3		
E. Construction site job hazards	Mod 00101-04 Sec 3.0.0		
1. Welding	Mod 00101-04 Sec 3.1.0		
2. Flame cutting	Mod 00101-04 Sec 3.2.0		
a. Hoses	Mod 00101-04 Sec 3.2.1		
b. Regulators	Mod 00101-04 Sec 3.2.1		
3. Proximity work	Mod 00101-04 Sec 3.4.0		
4. Motorized vehicles	Mod 00101-04 Sec 3.6.0		
F. Working safely with job hazards	Mod 00101-04 Sec 4.0.0		
1. Lockout/Tagout	Mod 00101-04 Sec 4.1.0		

2. Barriers and barricades	Mod 00101-04 Sec 4.2.0		
G. Personal Protective Equipment (PPE)	Mod 00101-04 Sec 5.1.0 and 5.2.0	Chapter 1, P 15	Chapter 2, P 34
1. Hard hat	Mod 00101-04 Sec 5.2.1		
2. Safety glasses, goggles and face shields	Mod 00101-04 Sec 5.2.2		
a. Infrared rays	Mod 29101-03 Sec 1.0.0	Chapter 1, P 19	Chapter 2, P 24
b. Ultraviolet rays (UV)	Mod 29101-03 Sec 1.0.0 and 3.5.0	Chapter 1, P 19	Chapter 2, P 24
3. Safety harness	Mod 00101-04 Sec 5.2.3		
4. Gloves	Mod 00101-04 Sec 5.2.4		
5. Safety shoes	Mod 00101-04 Sec 5.2.5		
6. Hearing protection	Mod 00101-04 Sec 5.2.6		
7. Respiratory protection	Mod 00101-04 Sec 5.2.7		
8. Body protection	Mod 29101-03 Sec 3.1.0		
H. Lifting	Mod 00101-04 Sec 6.0.0		
I. Ladders	Mod 00101-04 Sec 7.1.0		
1. Portable straight ladders	Mod 00101-04 Sec 7.1.1 thru 7.1.3		
2. Extension ladders	Mod 00101-04 Sec 7.1.4 thru 7.1.6		
3. Step ladders	Mod 00101-04 Sec 7.1.7 thru 7.1.9		
J. Hazard communications standard	Mod 00101-04 Sec 8.0.0	Chapter 13, P 367	Chapter 2, P 30
1. Material Safety Data Sheets (MSDS)	Mod 00101-04 Sec 8.1.0		
2. Responsibilities under HazCom	Mod 00101-04 Sec 8.2.0		
K. Fire safety	Mod 00101-04 Sec 9.0.0	Chapter 1, P 14-15	
1. Fire triangle	Mod 00101-04 Sec 9.1.0		
2. Firefighting	Mod 00101-04 Sec 9.3.0		
a. Classes of fires	Mod 00101-04 Sec 9.3.1		
b. How to use a fire extinguisher	Mod 00101-04 Sec 9.3.1 On-Site		
L. Electrical safety and safety guidelines	Mod 00101-04 Sec 10.0.0 & 10.1.0 and Mod 29101-03 Sec 12.0.0		
M. Cylinder storage and handling	Mod 29101-03 Sec 10.0.0		
1. Securing	Mod 29101-03 Sec 10.1.0		
2. Storage	Mod 29101-03 Sec 10.2.0		
3. Valve protection caps	Mod 29101-03 Sec 10.3.0		
4. General precautions	Mod 29101-03 Sec 10.4.0		
W202.02 Abide by site-specific safety rules and procedures. (Supplemental)			
C. THERMAL CUTTING			
W203. Demonstrate plasma arc cutting (PAC).			
W203.01 Identify the parts and functions of PAC equipment.			
	Module 29205-03		
	Mod 29205-03 Sec 3.3.0 thru 3.4.2	Chapter 10, P 267-269	Chap 8, P 180-181

A. Plasma arc cutting equipment	Mod 29205-03 Sec 3.3.0		
B. Power source-control units	Mod 29205-03 Sec 3.1.0		
C. Torches	Mod 29205-03 Sec 3.2.0		
1. Parts	Mod 29205-03 Sec 3.2.0 & Fig 8		
2. Electrodes	Mod 29205-03 Sec 3.2.0		
D. Workpiece clamp (ground clamp)	Mod 29205-03 Sec 3.3.0 thru 3.3.1		
E. Gas controls	Mod 29205-03 Sec 3.4.2		
W203.02 Explain the setup and shutdown of PAC equipment.			
A. Plasma arc cutting equipment	Mod 29205-03 Sec 3.3.0		
1. Power source-control units	Mod 29205-03 Sec 3.1.0		
a. Polarity – DCEN			
b. Size units			
c. Gas supply			
2. Torches	Mod 29205-03 Sec 3.2.0		
3. Locating the workpiece clamp (ground clamp)	Mod 29205-03 Sec 3.3.1		
4. Gas controls	Mod 29205-03 Sec 3.4.2		
a. Cylinders			
b. Regulators			
B. Setting up PAC Equipment	Mod 29205-03 Sec 5.0.0		
1. Setting cutting amperage	Mod 29205-03 Sec 5.1.0		
2. Installing gas cylinders and setting gas parameters	Mod 29205-03 Sec 5.2.0 thru 5.2.1		
C. Explain the operation of PAC Equipment	Module 29205 Sec 5.0.0 – 6.0.0	Chapter 10, P 271	
1. Square-cutting metal			
2. Bevel-cutting metal			
3. Piercing and slot-cutting metal			
D. Storage	Module 29205-03 Sec 7.0.0	Chapter 10, P 277	
E. Operating concerns	Mod 29205-03 Sec 8.1.0 thru 8.3.0		
W203.03 Demonstrate the setup and shutdown of PAC equipment.			
A. Perform PAC setup	Mod 29205-03 Sec 5.0.0 thru 6.3.0	Chapter 10, P 271	
B. Perform PAC shutdown	Module 29205-03 Sec 7.0.0	Chapter 10, P 277	
W203.04 Describe plasma arc cutting principles, procedures, and safety.			
A. PAC principles	Module 29205-03 Sec 1.0.0		
1. Plasma (fourth state of matter)	Module 29205-03 Glossary	Chapter 10, P 267	
2. Temperature			
3. Advantages			
4. Dross	Module 29205-03 Summary		Chapter 8, P 190
5. Light radiation			Chapter 8, P 193
a. Visible light			
b. Ultraviolet light			

c. Infrared light			
B. Safety	Module 29205-03 Sec 1.1.0	Chapter 10, P 271	Chapter 8, P 191
1. Protective clothing and equipment	Module 29205-03 Sec 1.1.1	Chapter 10, P 271	Chapter 8, P 191
2. Fire/explosion prevention	Module 29205-03 Sec 1.1.2	Chapter 10, P 271	Chapter 8, P 191
3. Ventilation	Module 29205-03 Sec 1.1.3		
C. Process	Module 29205-03 Sec 2.0.0		
1. Transferred arc	Module 29205-03 Sec 2.1.0		
2. Nontransferred arc	Module 29205-03 Sec 2.2.0		
D. Equipment	Module 29205-03 Sec 3.0.0		
1. Power source-control units	Module 29205-03 Sec 3.1.0		
a. Polarity - DCEN			
b. Sizes			
c. Duty cycles			
2. Cooling of torches	Module 29205-03 Sec 3.2.0		
a. Gas			
b. Water			
3. Location of workpiece clamp (ground clamp)	Module 29205-03 Sec 3.3.1		
4. Gas combinations	Mod 29205-03 Sec 3.4.1 & Table 1		
5. Installing gas cylinders	Module 29205-03 Sec 5.2.1		
E. Explain cutting procedures			
1. Square-cutting metal	Module 29205-03 Sec 6.1.0	Chapter 10, P 273	Chapter 8, P 193
2. Bevel-cutting metal	Module 29205-03 Sec 6.2.0		Chapter 8, P 195
3. Pierce and slot cutting in metal	Module 29205-03 Sec 6.3.0		Chapter 8, P 194
W203.05 Perform plasma arc cutting.			
A. Square-cutting metal	Module 29205-03 Sec 6.1.0	Chapter 10, P 273	Chapter 8, P 193
B. Bevel-cutting metal	Module 29205-03 Sec 6.2.0		Chapter 8, P 195
C. Pierce and slot cutting metal	Module 29205-03 Sec 6.3.0		Chapter 8, P 194
W204. Use the air carbon arc cutting and gouging process. (Supplemental)	Module 29204-03		
W204.01 Explain the setup and shutdown of air carbon arc cutting and gouging equipment.			
W204.02 Demonstrate the setup and shutdown of air carbon arc cutting and gouging equipment.			

W204.03 Explain air carbon arc cutting, gouging, and washing procedures.			
W204.04 Demonstrate air carbon arc cutting, gouging, and washing.			
D. WELD FIT-UP AND QUALITY			
W205. Fit-up plate joints.	Module 29104-03 and 29109-03		
W205.01 Describe job code specifications and weld fit up.	Module 29104-03 and 29109-03		
A. Governing codes & standards	Mod 29104-03 Sec 2.0.0 and 29109-03 Sec 2.1.0	Chapter 31, P 691-707	Chapter 19, P 476
1. Agencies and societies that establish codes: abbreviations, codes they produce, and revisions			
a. American Society of Mechanical Engineers (ASME)	Mod 29104-03 Sec 2.1.0 and 29109-03 Sec 2.1.0		
b. American Welding Society (AWS)	Mod 29104-03 Sec 2.2.0 and 29109-03 Sec 2.1.0		
c. American Petroleum Institute (API)	Mod 29104-03 Sec 2.3.0 and 29109-03 Sec 2.1.0		
d. American National Standards Institute (ANSI)	Mod 29104-03 Sec 2.4.0 and 29109-03 Sec 2.1.0		
2. Code changes	Module 29109-03 Sec 2.2.0		
3. Welding Procedure Specifications (WPS)	Module 29109-03 Sec 2.3.0	Chapter 31, P 692	Chap 19 P476-488
4. Procedure Qualification report (PQR)	Module 29109-03 Sec 2.3.0		
5. Performance qualification test	Module 29104-03 Sec 3.2.0		
B. Fit-up gauges and measuring devices	Module 29109-03 Sec 3.0.0		
1. Straightedges	Module 29109-03 Sec 3.1.0		
2. Squares	Module 29109-03 Sec 3.2.0		
3. Levels	Module 29109-03 Sec 3.3.0		
C. Fit-up tools and positioning parts of a weldment	Mod 29109-03 Sec 4.0.0 and 4.1.0		
1. Hydraulic jacks	Module 29109-03 Sec 4.1.1		
2. Chain hoists (chain falls)	Module 29109-03 Sec 4.1.2		
W205.02 Explain distortion and how it is controlled.			
A. Plate fit-up tools	Module 29109-03 Sec 4.2.0		
1. Strongbacks	Module 29109-03 Sec 4.2.1		
2. Clips, yokes, and wedges	Module 29109-03 Sec 4.2.2		
3. Strongbacks with yokes and wedges or bolts	Module 29109-03 Sec 4.2.3		
B. Distortion	Module 29109-03 Sec 5.0.0		Chapter 7, P 170
C. Distortion Causes	Module 29109-03 Sec 5.1.0		Chapter 7, P 170
1. Nonuniform expansion and contraction	Module 29109-03 Sec 5.1.0		
2. Coefficient of thermal expansion	Module 29109-03 Sec 5.2.0		
3. Specific heat per unit volume	Module 29109-03 Sec 5.2.0		

D. Controlling distortion	Module 29109-03 Sec 5.3.0		Chapter 7, P 170
1. Clamping and bracing	Module 29109-03 Sec 5.3.1		
2. Tack welding	Module 29109-03 Sec 5.3.2		
3. Amount of weld metal	Module 29109-03 Sec 5.3.3		
4. Intermittent welding	Module 29109-03 Sec 5.3.9		
5. Backstep welding	Module 29109-03 Sec 5.3.10		
6. Welding sequence	Module 29109-03 Sec 5.3.11		
W205.03 Use devices and tools to fit-up plate joints.			
A. Plate fit-up tools	Module 29109-03 Sec 4.2.0		Chap 18 P465-467
B. Strongbacks	Module 29109-03 Sec 4.2.1		Chap 18 P465-467
C. Clips, yokes, and wedges	Module 29109-03 Sec 4.2.2		Chap 18 P465-467
D. Strongback with yokes, wedges and bolts	Module 29109-03 Sec 4.2.3		Chap 18 P465-467
E. Plate alignment tools	Module 29109-03 Sec 4.2.4		Chap 18 P465-467
W206. Demonstrate weld testing.			
W206.01 Describe weld discontinuities and their causes.			
A. Define discontinuities.	Module 29104 Sec 4.0.0	Chapter 30, P 671	Chap 20 P510-516
1. Porosity	Module 29104 Sec 4.1.0	Chapter 30, P 671	Chap 20 P510-516
2. Inclusions	Module 29104 Sec 4.2.0	Chapter 30, P 671	Chap 20 P510-516
3. Cracks	Module 29104 Sec 4.3.0	Chapter 30, P 671	Chap 20 P510-516
a. Weld metal cracks			
b. Base metal cracks			
4. Incomplete penetration	Module 29104 Sec 4.4.0	Chapter 30, P 671	Chap 20 P510-516
5. Incomplete fusion	Module 29104 Sec 4.5.0	Chapter 30, P 671	Chap 20 P510-516
6. Undercut	Module 29104 Sec 4.6.0	Chapter 30, P 671	Chap 20 P510-516
7. Arc strikes	Module 29104 Sec 4.7.0	Chapter 30, P 671	Chap 20 P510-516
8. Spatter	Module 29104 Sec 4.8.0		
9. Unacceptable weld profiles	Module 29104 Sec 4.9.0	Chapter 30, P 671	Chap 20 P510-516

B. Explain discontinuity causes and how to correct them.	Module 29104 Sec 4.0.0 – 4.9.0	Chapter 30, P 671	Chap 20 P510-516
W206.02 Explain destructive and non-destructive examination practices.			
A. Non-destructive examination (NDE) practices	Module 29104 Sec 5.0.0	Chapter 20, P 672	Chap 20 P516-525
1. Visual inspection	Module 29104 Sec 5.1.0		
a. Undercut gauge	Module 29104 Sec 5.1.1		
b. Butt weld reinforcement gauge	Module 29104 Sec 5.1.2		
c. Fillet weld blade gauge	Module 29104 Sec 5.1.3		
2. Liquid penetrant inspection	Module 29104 Sec 5.2		
3. Magnetic particle inspection	Module 29104 Sec 5.3		
4. Radiographic inspection	Module 29104 Sec 5.4		
5. Ultrasonic inspection	Module 29104 Sec 5.5		
6. Electromagnetic (Eddy Current) inspection	Module 29104 Sec 5.6		
B. Destructive testing examination practices.			
1. Tensile test			
2. Hardness test			
3. Impact test	Module 29104 Sec 5.0.0	Chapter 20, P 671	Chap 20 P525-533
4. Soundness test			
a. Bend testing			
1) Root bends			
2) Face bends			
3) Side bends			
b. Nick-break testing			
c. Fillet weld break testing			
C. Welder performance qualification tests	Module 29104-03 Sec 7.0.0	Chapter 20, P 691	Chap 20 P476-488
1. Welding positions	Module 29104-03 Sec 7.1.0		
a. Groove			
1) Flat groove – 1G			
2) Horizontal – 2G			
3) Vertical – 3G			
4) Overhead – 4G			
b. Fillet			
1) Flat– 1F			
2) Horizontal – 2F			
3) Vertical – 3F			
4) Overhead – 4F			
2. AWS structural steel code	Module 29104-03 Sec 7.2.0		
3. ASME code	Module 29104-03 Sec 7.3.0		
4. Welder Qualification Tests	Module 29104-03 Sec 7.4.0		
a. Making the test weld	Module 29104-03 Sec 7.4.1		

b. Removing test specimens	Module 29104-03 Sec 7.4.2		
c. Preparing the specimens for testing	Module 29104-03 Sec 7.4.3		
1) Steps to prepare the specimens			
2) Criteria for acceptance			
W206.03 Demonstrate destructive and non-destructive examination practices and welder qualification tests.			
A. Perform guided bend test	Module 29104-03 Sec 6.0.0	Chapter 30, P 678	Chapter 20, P 519
B. Perform visual test	Module 29104-03 Sec 5.1.0	Chapter 30, P 672	Chapter 20, P 525
C. Perform liquid penetrant test	Module 29104-03 Sec 5.2.0	Chapter 30, P 674	Chapter 20, P 525
D. Perform free bend test (fillet weld break test)	Module 29104-03 Sec 6.0.0 Fig 21		Chapter 20, P 523
E. PHYSICAL CHARACTERISTICS AND MECHANICAL PROPERTIES OF METALS			
W207. Demonstrate methods of identifying metals and using various heating procedures.			
W207.01 Identify the physical and mechanical properties of metals.	Module 29302-03		
A. Metal composition and classifications	Module 29302-03 Sec 2.0.0		
1. Ferrous metals	Module 29302-03 Sec 2.1.0		
2. Low alloy steel	Module 29302-03 Sec 2.2.0		
3. Stainless steel	Module 29302-03 Sec 2.3.0		
a. Austenitic	Module 29302-03 Sec 2.3.1		
b. Ferritic	Module 29302-03 Sec 2.3.2		
c. Martensitic	Module 29302-03 Sec 2.3.3		
4. Nonferrous metals	Module 29302-03 Sec 2.5.0		
a. Aluminum	Module 29302-03 Sec 2.5.1		
b. Magnesium	Module 29302-03 Sec 2.5.2		
c. Titanium	Module 29302-03 Sec 2.5.3		
d. Copper	Module 29302-03 Sec 2.5.5		
B. Field identification of base metals	Module 29302-03 Sec 3.0.0		
1. Metal labeling	Module 29302-03 Sec 3.1.0		
2. Identification by magnet	Module 29302-03 Sec 3.2.0		
3. Identification by appearance	Module 29302-03 Sec 3.3.0		
4. Spark test	Module 29302-03 P-2.24 Hot Tip	Chapter 28, P 643-647	Chap 24 P643-644
C. Physical characteristics of metals	Module 29302-03 Sec 4.0.0		
1. Density	Module 29302-03 Sec 4.1.0		
2. Electrical conductivity	Module 29302-03 Sec 4.2.0		
3. Thermal conductivity	Module 29302-03 Sec 4.3.0		
4. Thermal expansion	Module 29302-03 Sec 4.4.0		

5. Melting point	Module 29302-03 Sec 4.5.0		
6. Corrosion resistance	Module 29302-03 Sec 4.6.0		
D. Mechanical properties of metals	Module 29302-03 Sec 5.0.0	Chapter 28, P 638	
1. Stress-strain relationship	Module 29302-03 Sec 5.1.0		Chap 23 P609-610
a. Compression			
b. Shear			
c. Tension (tensile strength)			
d. Torsion			
2. Elasticity and elastic limit	Module 29302-03 Sec 5.2.0		
3. Modulus of elasticity	Module 29302-03 Sec 5.3.0		
4. Tensile strength	Module 29302-03 Sec 5.4.0		Chapter 23, P 609
5. Ductility	Module 29302-03 Sec 5.5.0		
6. Hardness	Module 29302-03 Sec 5.6.0		
W207.02 Demonstrate methods of identifying ferrous and non-ferrous metals.			
A. Magnetic test	Module 29302 Sec 3.2.0	Chapter 28, P 646	
B. Visual identification test	Module 29302 Sec 3.3.0		Chapter 20, P 525
C. Spark test	Module 29302-03 P-2.24 Hot Tip	Chapter 28, P 643-647	Chapter 24, P 643
W207.03 Explain preheat, interpass temperature, and postheat procedures.			
A. Preheat procedures	Module 29301-03 Sec 2.0.0	Chapter 21, P 515-528	Chapter 6, P 135
1. Temperature and metal structure	Module 29301-03 Sec 2.1.0		
a. Reducing shrinkage	Module 29301-03 Sec 2.1.1		
b. Preventing excessive hardening and reduced ductility	Module 29301-03 Sec 2.1.2		
c. Reducing hydrogen gas in the weld zone	Module 29301-03 Sec 2.1.3		
2. Preheating temperatures	Module 29301-03 Sec 2.2.2		
3. Preheating methods	Module 29301-03 Sec 2.3.0		
B. Measuring temperatures	Module 29301-03 Sec 3.0.0		
1. Pyrometers	Module 29301-03 Sec 3.1.0		
2. Thermocouple devices	Module 29301-03 Sec 3.2.0		
3. Temperature sensitive indicators	Module 29301-03 Sec 3.3.0		
a. Crayon sticks			
b. Liquids			
c. Chalks			
d. Powders			
e. Pellets			
f. Labels			
C. Interpass heating procedures	Module 29301-03 Sec 4.0.0	Chapter 21, P 515-528	Chapter 6, P 143

D. Postheat procedures	Module 29301-03 Sec 5.0.0	Chapter 21, P 515-528	Chapter 6, P 135
1. Stress relieving	Module 29301-03 Sec 5.1.0		
2. Annealing	Module 29301-03 Sec 5.2.0		
3. Normalizing	Module 29301-03 Sec 5.3.0		
4. Tempering	Module 29301-03 Sec 5.4.0		
F. SHIELDED METAL ARC WELDING (SMAW)			
W208. Weld V-groove joints.	Module 29108-03		
W208.01 Describe procedures for welding V-groove joints with backing in all positions.			
A. Basic SMAW procedures	Module 29107-03		
1. Preparing the welding machine	Module 29107-03 Sec 3.4.0		
2. Striking an arc	Module 29107-03 Sec 4.0.0		
a. Scratch method	Module 29107-03 Sec 4.1.0		
b. Tapping method	Module 29107-03 Sec 4.2.0		
c. Striking an arc with an E-7018	Module 29107-03 Sec 4.3.0		
3. Arc blow	Module 29107-03 Sec 5.0.0		
4. Stringer and weave beads	Module 29107-03 Sec 6.0.0		
5. Stringer beads with E-7018	Module 29107-03 Sec 6.2.0		
6. Restarting a weld	Module 29107-03 Sec 6.3.0		
7. Terminating a weld	Module 29107-03 Sec 6.4.0		
8. Weave beads with E-7018	Module 29107-03 Sec 6.6.0		
9. Vertical weave bead with E-7018	Module 29107-03 Sec 8.5.0		
B. Procedures for V-groove welds with backing	Module 29108-03		
1. Preparing weld coupons	Module 29108-03 Sec 3.3.0		
2. Electrodes	Module 29108-03 Sec 3.4.0		
3. Preparing the welding machine	Module 29108-03 Sec 3.5.0		
4. V-groove welds with backing	Module 29108-03 Sec 4.0.0		
a. Groove weld positions	Module 29108-03 Sec 4.1.0	Chapter 6, P 148-161	Chap 6, P 121-136
b. Acceptable and unacceptable groove weld profiles	Module 29108-03 Sec 4.2.0		
5. SMAW of V-groove welds with backing	Module 29108-03 Sec 5.0.0		
a. Flat V-groove (1G)	Module 29108-03 Sec 5.1.0		
b. Horizontal V-groove (2G)	Mod 29108-03 Sec 5.2.0 thru 5.2.2		
c. Vertical V-groove (3G)	Mod 29108-03 Sec 5.3.0 thru 5.3.2	Chapter 6, P 159	
d. Overhead V-groove (4G)	Mod 29108-03 Sec 5.4.0 thru 5.4.2		
6. Terms		Chapter 6, P 153	
a. Slag inclusions			
b. Tack weld			

W208.02 Weld V-groove joints with backing in all positions using E-7018 electrodes.	Module 29108-03 Sec 5.0.0	Chapter 6, P 148-161	Chapter 4, P 69-96 Chap 6, P 121-136
A. 1G	Module 29108-03 Sec 5.1.0 Performance Task - Page 8.22		
B. 2G	Module 29108-03 Sec 5.2.0 – 5.2.2 Performance Task - Page 8.23		
C. 3G	Module 29108-03 Sec 5.3.0 – 5.3.2 Performance Task - Page 8.24		
D. 4G	Module 29108-03 Sec 5.4.0 – 5.4.2 Performance Task - Page 8.25		
W208.03 Describe procedures for welding open root V-groove joints in all positions.	Module 29104-03, 29105-03, 29106-03, 29107-03, and 29110-03		
A. Weld quality	Module 29104-03		
1. AWS D.1.1 Structural Welding Code	Module 29104-03 Sec 2.2.0		
2. Discontinuities (defects)	Module 29104-03 Sec 4.0.0		
a. Porosity	Module 29104-03 Sec 4.1.0		
b. Inclusions	Module 29104-03 Sec 4.2.0		
c. Cracks	Module 29104-03 Sec 4.3.0		
d. Undercut (typical maximum allowed 0.010")	Mod 29104-03 Sec 4.4.0 & 5.1.1		
B. Equipment	Module 29105-03	Chapter 6, P 131	Chapter 4, P 68
1. Basic SMAW process	Module 29105-03 Sec 1.0.0		
2. Voltage	Module 29105-03 Sec 4.1.0		
a. Open circuit voltage			
b. Closed circuit voltage			
3. Duty cycle	Module 29105-03 Sec 7.0.0		
C. Electrodes	Module 29106-03		
1. Classification system	Module 29106-03 Sec 3.1.0		Chapter 25, P 661
2. Electrode groups	Module 29106-03 Sec 4.1.0		
a. Fast-freeze	Module 29106-03 Sec 4.1.1		
b. Fast-fill	Module 29106-03 Sec 4.1.2		
c. Fill-freeze	Module 29106-03 Sec 4.1.3		
d. Low-hydrogen	Module 29106-03 Sec 4.1.4		
3. Trade terms	Module 29106-03 Glossary		
a. Alloy			

b. Ductile			
c. Flux			
d. Heat-affected zone			
D. SMAW techniques	Module 29107-03		
1. Correcting arc blow	Module 29107-03 Sec 5.0.0		
2. Restarting a weld	Module 29107-03 Sec 6.3.0		
3. Terminating a weld	Module 29107-03 Sec 6.4.0		
4. Weave beads	Mod 29107-03 Sec 6.5.0 & 6.6.0	Chapter 6, P 144	
5. Stringer beads (control the width with the speed of travel)	Mod 29107-03 Sec 8.6.0		
E. Open root groove weld procedures	Mod 29110-03		
1. Preparing welding coupons	Mod 29110-03 Sec 2.3.0		Chapter 4, P 69-96 Chapter 6, P 124
2. Electrodes	Mod 29110-03 Sec 2.4.0		Chapter 25, P 664
3. Preparing the welding machine	Mod 29110-03 Sec 2.5.0		
4. Root pass	Mod 29110-03 Sec 3.1.0		
5. Keyhole	Mod 29110-03 Sec 3.1.0		
6. Groove weld positions	Mod 29110-03 Sec 3.2.0	Chapter 6, P 148-161	Chap 6, P 121-136
7. Acceptable and unacceptable groove weld profiles	Mod 29110-03 Sec 3.3.0	Chapter 6, P 151	
8. Practicing beads and welds	Mod 29110-03 Sec 4.0.0 thru 4.4.2		
a. 1G	Mod 29110-03 Sec 4.1.0 thru 4.2.2		
b. 2G	Mod 29110-03 Sec 4.2.0 thru 4.2.2		
c. 3G	Mod 29110-03 Sec 4.3.0 thru 4.3.2		
d. 4G	Mod 29110-03 Sec 4.4.0 thru 4.4.2		
1) Generally most difficult position		Chapter 6, P 160-161	
2) Flip motion used to keep it cool and control the weld pool		Chapter 6, P 160-161	
W208.04 Weld open root V-groove joints in all positions using E-6010 and E-7018 electrodes.		Chapter 6, P 148-161	Chapter 4, P 69-96 Chap 6, P 121-136
A. 1G	Mod 29110-03 Sec 4.1.0 thru 4.2.2 Performance Task - Page 10.18		
B. 2G	Mod 29110-03 Sec 4.2.0 thru 4.2.2 Performance Task - Page 10.19		
C. 3G	Mod 29110-03 Sec 4.3.0 thru 4.3.2 Performance Task - Page 10.20		

D. 4G	Mod 29110-03 Sec 4.4.0 thru 4.4.2 Performance Task - Page 10.21		
G. GAS METAL ARC WELDING (GMAW)			
W209. Demonstrate GMAW.			
W209.01 Identify the parts and functions of GMAW equipment.	Module 29206-03	Chapter 7, P 179-188	Chap 11 P242-245
A. Principles of GMAW	Module 29206-03 Sec 1.0.0		
B. Transformer-rectifier power sources	Module 29206-03 Sec 4.1.1		
C. Power source ratings (duty cycle)	Module 29206-03 Sec 4.2.0		
D. GMAW system	Module 29206-03 Sec 5.0.0		
E. Welding cable	Module 29206-03 Sec 5.4.0		
F. Welding cable end connectors	Module 29206-03 Sec 5.4.1		
G. External wire feeders	Module 29206-03 Sec 5.5.0		
H. GMAW guns	Module 29206-03 Sec 5.6.0		
I. Gas regulators/flowmeters	Module 29206-03 Sec 5.8.2		
W209.02 Explain the setup and shutdown of GMAW equipment.	Module 29207-03 Sec 1.0.0 – 8.7.0	Chapter 9, P 237-254	Chap 10 P243-253
A. Principles of GMAW	Module 29206-03 Sec 1.0.0		
B. Types of power sources	Module 29206-03 Sec 4.1.0		
1. Transformer-rectifier	Module 29206-03 Sec 4.1.1		
2. Engine-driven generator and alternator sources	Module 29206-03 Sec 4.1.2		
C. Power source ratings	Module 29206-03 Sec 4.2.0		
D. GMAW metal transfer modes	Module 29206-03 Sec 5.1.0		
1. Spray transfer	Module 29206-03 Sec 5.1.1		
2. Globular transfer	Module 29206-03 Sec 5.1.2		
3. Short-circuiting transfer	Module 29206-03 Sec 5.1.3		
4. Pulsed transfer	Module 29206-03 Sec 5.1.4		
E. Power source variables	Module 29206-03 Sec 5.3.0		
1. Slope	Module 29206-03 Sec 5.3.1		
2. Pinch effect and inductance	Module 29206-03 Sec 5.3.2		
3. Arc blow	Module 29206-03 Sec 5.3.3		
F. Selecting and installing filler wire	Module 29206-03 Sec 8.6.0		
G. Placing the workpiece clamp (ground clamp)	Module 29206-03 Sec 8.7.0		
H. Trade terms	Module 29206-03 Glossary		
W209.03 Demonstrate the setup and shutdown of GMAW equipment.	Module 29206-03 Sec 8.0.0 – 8.9.4 Module 29207-03 Sec 3.0.0 – 3.9.0	Chapter 9, P 237-254	Chap 10 P243-253
W209.04 Describe GMAW principles	Modules 29206-03 and 29207-03	Chapter 9, P 233	Chapter 10, P 218

A. Basic theory	Module 29206-03 Sec 1.0.0	Chapter 9, P 233	
B. Metal transfer modes	Module 29206-03 Sec 5.1.0		
1. Spray transfer	Module 29206-03 Sec 5.1.1	Chapter 9, P 236	Chapter 10, P 220
2. Globular transfer (a special type is buried arc or submerged arc)	Module 29206-03 Sec 5.1.2	Chapter 9, P 235 - 236	Chapter 10, P 221
3. Short circuit transfer	Module 29206-03 Sec 5.1.3	Chapter 9, P 234	Chapter 10, P 223
4. Pulsed transfer	Module 29206-03 Sec 5.1.4	Chapter 9, P 236	Chapter 10, P 221
C. Pinch effect and inductance	Module 29206-03 Sec 5.3.2	Chapter 9, P 235	
D. Shielding gases	Module 29206-03 Sec 6.0.0 - 6.1.0		
1. Argon	Module 29206-03 Sec 6.0.1		
2. Helium	Module 29206-03 Sec 6.0.2		
3. Carbon dioxide	Module 29206-03 Sec 6.0.3		
4. Gas mixtures	Module 29206-03 Sec 6.0.4		
E. Welding voltage	Module 29207-03 Sec 3.4.0		
F. Electrode extension, stickout, and standoff distance	Module 29207-03 Sec 3.8.0		
W209.05 Explain GMAW safety.	Module 29207-03	Chapter 9, P 262-263	Chap 11 P246-248
A. Safety practices	Module 29207-03 Sec 2.0.0		
1. Protective clothing and equipment	Module 29207-03 Sec 2.1.0		
2. Fire/explosion prevention	Module 29207-03 Sec 2.2.0		
3. Work area ventilation	Module 29207-03 Sec 2.3.0		
4. Filter lens for eye protection		Chapter 7, P 198	
B. Cylinder safety	Module 29207-03 Sec 5.8.1		
C. Placing the workpiece clamp	Module 29207-03 Sec 8.7.0		
W209.06 Explain GMAW filler metals and gasses.	Module 29206-03		
A. Shielding gases	Module 29206-03 Sec 6.0.0	Chapter 9, P 244-249	Chapter 10, P 228
1. Shielding gas characteristics	Module 29206-03 Sec 6.1.0		
a. Argon	Module 29206-03 Sec 6.1.1		
b. Helium	Module 29206-03 Sec 6.1.2		
c. Carbon dioxide	Module 29206-03 Sec 6.1.3		
d. Gas mixtures	Module 29206-03 Sec 6.1.4		
2. Shielding gas selection	Module 29206-03 Sec 6.2.0 and Table 6 notes		
B. Filler materials	Module 29206-03 Sec 7.0.0	Chapter 7, P 189-191	Chapter 10, P 225
1. Filler characteristics and specifications	Module 29206-03 Sec 7.1.0		
2. Carbon steel filler metals	Module 29206-03 Sec 7.1.1		

W209.07 Describe procedures for welding multi-pass fillet welds on plate in all positions.	Module 29206-03 and 29207-03	Chapter 9, P 255-259	
A. Welding current characteristics	Module 29206-03 Sec 3.0.0		
1. Voltage	Module 29206-03 Sec 3.1.0		
2. Amperage	Module 29206-03 Sec 3.2.0		
B. Metal transfer modes	Module 29206-03 Sec 5.1.0		
1. Spray transfer	Module 29206-03 Sec 5.1.1	Chapter 9, P 236	Chapter 10, P 220
2. Globular transfer (a special type is buried arc or submerged arc)	Module 29206-03 Sec 5.1.2	Chapter 9, P 235 - 236	Chapter 10, P 221
3. Short circuit transfer	Module 29206-03 Sec 5.1.3	Chapter 9, P 234	Chapter 10, P 223
4. Pulsed transfer	Module 29206-03 Sec 5.1.4	Chapter 9, P 236	Chapter 10, P 221
C. GMAW process	Module 29207-03 Sec 1.1.0		
D. Welding voltage	Module 29207-03 Sec 3.4.0		
E. Welding amperage	Module 29207-03 Sec 3.5.0		
F. Travel speed	Module 29207-03 Sec 3.6.0		
G. Gun position	Module 29207-03 Sec 3.7.0		
1. Work angle	Module 29207-03 Sec 3.7.1		
2. Travel angle	Module 29207-03 Sec 3.7.2		
H. Electrode extension, stickout, and standoff distance	Module 29207-03 Sec 3.8.0		
I. Gas nozzle cleaning	Module 29207-03 Sec 3.9.0		
J. Bead types	Mod 29207-03 Sec 4.0.0 & 4.1.0		
1. Stringer	Module 29207-03 Sec 4.1.1		
2. Weave	Module 29207-03 Sec 4.2.0		
K. Weld restarts	Module 29207-03 Sec 4.3.0		
L. Weld terminations	Module 29207-03 Sec 4.4.0		
M. Fillet welds	Module 29207-03 Sec 5.0.0		
1. Flat position (1F)	Module 29207-03 Sec 5.1.0		
2. Horizontal position (2F)	Module 29207-03 Sec 5.2.0		
3. Vertical position (3F)	Module 29207-03 Sec 5.3.0		
a. Weave	Module 29207-03 Sec 5.3.1		
b. Stringer	Module 29207-03 Sec 5.3.2		
4. Overhead position (4F)	Module 29207-03 Sec 5.4.0		
W209.08 Weld GMAW multi-pass fillet welds on plate in all positions.	Module 29207-03	Chapter 9, P 255-259	
A. 1F	Module 29207-03 Sec 5.1.0 Performance Task - Page 7.36		
B. 2F	Module 29207-03 Sec 5.2.0 Performance Task - Page 7.37		
C. 3F	Module 29207-03 Sec 5.3.0 Performance Task - Page 7.38		

D. 4F	Module 29207-03 Sec 5.4.0 Performance Task - Page 7.39		
H. FLUX CORED ARC WELDING (FCAW)			
W210. Demonstrate FCAW.			
W210.01 Explain the setup and shutdown of FCAW equipment.	Module 29206-03 and 29207-03	Chapter 9, P 237-254	Chap 10 P243-253
A. Transformer rectifier power sources	Module 29206-03 Sec 4.1.1		
B. Duty cycle	Module 29206-03 Sec 4.2.0		
C. External wire feeders	Module 29206-03 Sec 5.5.0		
D. FCAW guns			
1. FCAW-G (gas shielded)	Module 29206-03 Sec 5.6.0		
2. FCAW-S (self-shielded)	Module 29206-03 Sec 5.7.0		
E. Shielding gas supply	Module 29206-03 Sec 5.8.0		
1. Cylinder safety	Module 29206-03 Sec 5.8.1		
2. Gas regulators/Flowmeters	Module 29206-03 Sec 5.8.2		
F. Selecting an FCAW power source	Module 29206-03 Sec 8.2.0		
G. Placing the workpiece (ground) clamp	Module 29206-03 Sec 8.7.0		
H. Welding voltage	Module 29207-03 Sec3.4.0		
I. Electrode extension, stickout, and standoff distance	Module 29207-03 Sec 3.8.0		
W210.02 Demonstrate the setup and shutdown of FCAW equipment.	Module 29206-03	Chapter 9, P 237-254	Chap 10 P243-253
W210.03 Explain FCAW principles.	Mod 29206-03 Sec 5.2.0 & 5.3.3	Chapter 7, P 190	Chap 12 P276-280
A. Principles	Mod 29206-03 Sec 5.2.0		
B. Arc Blow	Mod 29206-03 Sec 5.3.3		
W210.04 Explain FCAW electrodes and shielding gasses.	Module 29206-03	Chapter 7, P 194-195	Chapter 12, P 235
A. Shielding gas supply	Module 29206-03 Sec 5.8.0		
B. FCAW filler metals	Module 29206-03 Sec 7.2.0	Chapter 7, P 190-192	Chapter 12, P 285
C. Carbon steel flux cored electrodes	Module 29206-03 Sec 7.2.1		
W210.05 Describe procedures for welding fillet welds in all positions.	Module 29207-03 Sec 5.0.0 – 5.4.0	Chapter 9, P 255-259	
A. Welding voltage	Module 29207-03 Sec 3.4.0		
B. Welding amperage	Module 29207-03 Sec 3.5.0		
C. Travel speed	Module 29207-03 Sec 3.6.0		
D. Gun position	Module 29207-03 Sec 3.7.0		
1. Work angle	Module 29207-03 Sec 3.7.1		

2. Travel angle	Module 29207-03 Sec 3.7.2		
E. Electrode extension, stickout, and standoff distance	Module 29207-03 Sec 3.8.0		
F. Gas nozzle cleaning	Module 29207-03 Sec 3.9.0		
G. Weld restarts	Module 29207-03 Sec 4.3.0		
H. Weld terminations	Module 29207-03 Sec 4.4.0		
I. Fillet welds	Module 29207-03 Sec 5.0.0		
1. Flat position (1F)	Module 29207-03 Sec 5.1.0		
2. Horizontal position (2F)	Module 29207-03 Sec 5.2.0		
3. Vertical position (3F)	Module 29207-03 Sec 5.3.0		
a. Weave	Module 29207-03 Sec 5.3.1		
b. Stringer	Module 29207-03 Sec 5.3.2		
4. Overhead position (4F)	Module 29207-03 Sec 5.4.0		
W210.06 Perform fillet welds in all positions. (Supplemental)	Module 29207-03		
I. GAS TUNGSTEN ARC WELDING (GTAW)			
W211. Demonstrate GTAW.			
W211.01 Explain the setup and shutdown of GTAW equipment.	Module 29208-03		
A. Types of current	Module 29208-03 Sec 2.2.0		
1. DC	Module 29208-03 Sec 2.2.1		
a. DCEN	Module 29208-03 Sec 2.2.2		
b. DCEP	Module 29208-03 Sec 2.2.2		
2. AC	Module 29208-03 Sec 2.2.3		
3. High frequency	Module 29208-03 Sec 2.2.4		
B. Power sources	Module 29208-03 Sec 3.0.0		
C. Duty cycle	Module 29208-03 Sec 3.5.0		
D. Equipment	Module 29208-03 Sec 5.0.0		
1. Torches	Module 29208-03 Sec 5.1.0		
2. Gas nozzles	Module 29208-03 Sec 5.2.0		
3. Electrodes	Module 29208-03 Sec 5.3.0		
4. Cylinders	Module 29208-03 Sec 5.4.3		
5. Gas regulators/flowmeters	Module 29208-03 Sec 5.4.4		
6. Remote current control	Module 29208-03 Sec 5.5.0		
E. Setting shielding gas flow rate	Module 29208-03 Sec 7.4.0		
F. Preparing the electrode	Module 29208-03 Sec 7.6.0		
1. Pointing the electrode tip	Module 29208-03 Sec 7.6.1		
2. Balling the electrode tip	Module 29208-03 Sec 7.6.2		
G. Installing the nozzle	Module 29208-03 Sec 7.7.0		
H. Installing the electrode	Module 29208-03 Sec 7.8.0		
W211.02 Demonstrate the setup and shutdown of GTAW equipment. (Supplemental)	Module 29208-03		

W211.03 Describe GTAW principles.	Module 29208-03 Sec 1.0.0 – 5.0.0	Chapter 8, P 204	Chap 15 P347-369
A. Principles	Module 29208-03 Sec 1.0.0		
B. Types of current	Module 29208-03 Sec 2.2.0		
1. DC	Module 29208-03 Sec 2.2.1		
a. DCEN	Module 29208-03 Sec 2.2.2		
b. DCEP	Module 29208-03 Sec 2.2.2		
2. AC	Module 29208-03 Sec 2.2.3		
3. High frequency	Module 29208-03 Sec 2.2.4		
C. Shielding gas	Module 29208-03 Sec 5.4.0		
W211.04 Explain GTAW safety.	Module 29208-03	Chapters 7 and 8	
A. Safety practices	Module 29208-03 Sec 1.1.0		
1. Protective clothing and equipment	Module 29208-03 Sec 1.1.1		
2. Fire/explosion prevention	Module 29208-03 Sec 1.1.2		
3. Work area ventilation	Module 29208-03 Sec 1.1.3		
4. Filter lens for eye protection		Chapter 7, P 198	
B. Connecting the shielding gas	Module 29208-03 Sec 7.3.0		
C. Shielding gases in confined spaces		Chapter 8, P 220	
D. Phosgene		Chapter 8, P 230	
W211.05 Explain GTAW electrodes, filler metal, and shielding gasses.	Module 29208-03		
A. Tungsten electrodes	Module 29208-03 Sec 5.3.0		
B. Shielding gas	Module 29208-03 Sec 5.4.0		
1. Argon	Module 29208-03 Sec 5.4.1		
2. Helium	Module 29208-03 Sec 5.4.2		
C. Filler metals	Module 29208-03 Sec 6.0.0		
1. Carbon steel and low-alloy steel filler metals	Module 29208-03 Sec 6.1.0		
2. Specifications and classification system	Module 29208-03 Table 2		
D. Selecting the electrode	Module 29208-03 Sec 7.5.0		
W211.06 Perform fillet and groove welds in all positions. (Supplemental)	Module 29209-03		