

## COURSE CURRICULUM AND ASSESSMENT STANDARDS:

### SECTION F: ADVANCED LEVEL

The following pages define the curriculum and assessment standards for the advanced level of Fabrication Studies.

Advanced level courses demand a higher level of expertise and help prepare students for entry into the workplace or a related post-secondary program.

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**COURSE FAB3010: MATERIALS TESTING****Level:** Advanced**Theme:** Materials and Structures**Prerequisite:** FAB1010 Fabrication Tools & Materials**Description:** Students are introduced to the principles of materials testing, and to the development and evaluation of a mechanical materials test.**Parameters:** Access to common hand and power assisted tools, and to instruction from an individual with specialized training in material testing.**Supporting Courses:** FAB1100 Fabrication Principles  
DES1020 The Design Process [Design Studies Strand]**Curriculum and Assessment Standards**

General Outcomes	Assessment Criteria and Conditions	Suggested Emphasis
<p><i>The student will:</i></p> <ul style="list-style-type: none"> <li>describe the purpose and nature of materials testing</li> <li>apply testing principles to construct or use a piece of materials testing apparatus</li> <li>test and compare the properties of common materials used in construction and fabrication</li> <li>demonstrate basic competencies.</li> </ul>	<p><i>Assessment of student achievement should be based on:</i></p> <ul style="list-style-type: none"> <li>the description of two or more different types of materials tests and testing procedures</li> <li>identification and development of a piece of test apparatus</li> <li>results of a test on three different materials.</li> </ul> <p><i>Assessment Tool</i> <i>Lab Investigations: Testing Materials, FAB3010–1</i></p> <p><i>Standard</i> <i>The apparatus is to be safe, easily used and calibrated: results should be consistent with other forms of testing equipment. Results should be effectively communicated and be consistent with current findings</i> <i>Performance rating of 3 for each applicable task</i></p> <ul style="list-style-type: none"> <li>observations of individual effort and interpersonal interaction during the learning process.</li> </ul> <p><i>Assessment Tool</i> <i>Basic Competencies Reference Guide and any assessment tools noted above</i></p>	<p>20</p> <p>50</p> <p>30</p> <p>Integrated throughout</p>

**COURSE FAB3010: MATERIALS TESTING (continued)**

Concept	Specific Outcomes	Notes
<p>Orientation</p> <ul style="list-style-type: none"> <li>• Types of Tests</li> <li>• Testing Results</li> <li>• Health and Safety</li> </ul>	<p><i>The student should:</i></p> <ul style="list-style-type: none"> <li>• identify and describe common methods of testing materials; e.g.:               <ul style="list-style-type: none"> <li>– non-destructive</li> <li>– destructive</li> </ul> </li> <li>• explain how test results are recorded and communicate a plan showing how to anticipate the results of a test</li> <li>• identify common hazards associated with the use of a specific tool, material and/or process</li> <li>• identify and correct potential hazards within the working environment</li> <li>• describe a safety plan in case of an accident.</li> </ul>	<p>Discuss the use of non-destructive tests, such as:</p> <ul style="list-style-type: none"> <li>– magnetic particles</li> <li>– liquid dye</li> <li>– X-ray</li> <li>– ultrasonic.</li> </ul> <p>Describe methods of testing for:</p> <ul style="list-style-type: none"> <li>– hardness</li> <li>– tensile strength</li> <li>– ductility</li> <li>– metal fatigue.</li> </ul> <p>Explain why material testing is important.</p>
<p>Planning and Management</p> <ul style="list-style-type: none"> <li>• Test Equipment</li> <li>• Complete Tests</li> </ul>	<ul style="list-style-type: none"> <li>• design a piece of testing apparatus or test procedure</li> <li>• create safety controls</li> <li>• construct testing devices</li> <li style="text-align: center;"><i>or</i></li> <li>• analyze an existing piece of test equipment and describe its:               <ul style="list-style-type: none"> <li>– purpose</li> <li>– operation</li> <li>– method of calibration and data recovery</li> </ul> </li> <li>• identify type of test, calibration and data recovery</li> <li>• prepare the materials as required.</li> </ul>	<p>Have students design and build a piece of test apparatus that can be used to test a particular material property, such as shear strength, torsion, hardness and impact.</p>

**COURSE FAB3010: MATERIALS TESTING (continued)**

Concept	Specific Outcomes	Notes
<p>Implementation</p> <ul style="list-style-type: none"> <li>• Testing</li> </ul>	<p><i>The student should:</i></p> <ul style="list-style-type: none"> <li>• conduct a given test on a variety of materials and record the test results.</li> </ul>	
<p>Assessment</p> <ul style="list-style-type: none"> <li>• Quality Control/ Reliability</li> <li>• Career Information</li> <li>• Career Preparation</li> </ul>	<ul style="list-style-type: none"> <li>• compare the data obtained from the materials tested to anticipated results</li> <li>• explain the reliability of the testing procedure</li> <li>• identify the advantages/disadvantages of test being carried out</li> <li>• identify further training and career opportunities related to material testing</li> <li>• prepare a record of completed activities within a portfolio.</li> </ul>	<p>Students should be encouraged to visit a test lab either in industry or in a post-secondary institution.</p>



**COURSE FAB3020: METALLURGY FUNDAMENTALS****Level:** Advanced**Theme:** Materials and Structures**Prerequisite:** FAB1010 Fabrication Tools & Materials**Description:** Students develop fundamental understandings and skills related to metallurgy, and apply these skills to fabrication processes.**Parameters:** Access to a fabrication work centre complete with heat treating equipment, and to instruction from an individual with specialized training in heat treating practices.**Supporting Course:** FAB3010 Materials Testing**Curriculum and Assessment Standards**

General Outcomes	Assessment Criteria and Conditions	Suggested Emphasis
<i>The student will:</i> <ul style="list-style-type: none"> <li>identify and describe the fundamental principles of metallurgy and their industrial applications</li> <li>identify the basic alloy components and properties of common alloys</li> <li>apply metallurgical principles, skills and processes to heat treat a component or product</li> </ul>	<i>Assessment of student achievement should be based on:</i> <ul style="list-style-type: none"> <li>presentation of a written report that identifies and describes how the principles of metallurgy are applied to improve the quality of a given product</li> </ul>	20
	<ul style="list-style-type: none"> <li>a description of the major alloy elements and properties of four common alloys.</li> </ul> <p><i>Assessment Tool</i> <i>Presentations/Reports, CTSPRE</i></p> <p><i>Standard</i> <i>Performance rating of 3 for each applicable task</i></p>	20
	<ul style="list-style-type: none"> <li>successful production or repair of a product that requires one or more heat treating process.</li> </ul> <p><i>Assessment Tool</i> <i>Assessment Framework: Activity Assessment, FABACT</i></p> <p><i>Standard</i> <i>An acceptable repair or product that has the characteristics of hardness and toughness as specified in the design specifications</i> <i>Performance rating of 3 for each applicable task</i></p>	60

**COURSE FAB3020: METALLURGY FUNDAMENTALS (continued)**

General Outcomes	Assessment Criteria and Conditions	Suggested Emphasis
<p><i>The student will:</i></p> <ul style="list-style-type: none"> <li>demonstrate basic competencies.</li> </ul>	<p><i>Assessment of student achievement should be based on:</i></p> <ul style="list-style-type: none"> <li>observations of individual effort and interpersonal interaction during the learning process.</li> </ul> <p><i>Assessment Tool</i>  <i>Basic Competencies Reference Guide and any assessment tools noted above</i></p>	<p>Integrated throughout</p>

Concept	Specific Outcomes	Notes
<p>Orientation</p> <ul style="list-style-type: none"> <li>Metallurgy</li> <li>Metallic Structures</li> <li>Metallurgy Application</li> </ul>	<p><i>The student should:</i></p> <ul style="list-style-type: none"> <li>list and describe the three major fields of metallurgy; i.e.,                             <ul style="list-style-type: none"> <li>extractive</li> <li>mechanical</li> <li>physical metallurgy</li> </ul> </li> <li>use the following terms to describe the internal structure of metals; e.g.:                             <ul style="list-style-type: none"> <li>atomic structure</li> <li>compound</li> <li>solution</li> <li>crystal</li> </ul> </li> <li>explain how the principles of metallurgy are used in:                             <ul style="list-style-type: none"> <li>welding</li> <li>foundry</li> <li>mechanically forming and finishing metals</li> </ul> </li> <li>explain the relationship between the properties of a metal and its structure</li> </ul>	<p>Having a good understanding of the basic principles of metallurgy is important for every serious metals student.</p> <p>Student should understand that temperature, time and stress affect the properties of metals.</p> <p>The structure of a metal can be modified by altering its chemical composition alloying and heat treating.</p>





**COURSE FAB3020: METALLURGY FUNDAMENTALS (continued)**

Concept	Specific Outcomes	Notes
Assessment <ul style="list-style-type: none"><li data-bbox="207 449 444 485">• Quality Control</li><li data-bbox="207 554 391 621">• Career Preparation</li></ul>	<i>The student should:</i> <ul style="list-style-type: none"><li data-bbox="487 449 1101 516">• research ways to test a product for hardness and toughness</li><li data-bbox="487 554 1105 621">• prepare a record of completed activities within a portfolio.</li></ul>	A visit to a foundry or a manufacturing plant that produces springs and other machine parts would be helpful.



**COURSE FAB3030: GAS TUNGSTEN ARC WELDING****Level:** Advanced**Theme:** Fabrication Processes**Prerequisite:** FAB2030 Oxyfuel Welding**Description:** Students develop basic knowledge and skills related to the use of gas tungsten arc welding (GTAW) equipment and supplies to weld mild steel in the flat and horizontal positions.**Parameters:** Access to a welding facility complete with gas tungsten arc welding equipment and supplies and to instruction from an individual with welding trade qualifications.**Supporting Courses:** FAB2060 Arc Welding 2  
FAB2070 Gas Metal Arc Welding 1**Curriculum and Assessment Standards**

General Outcomes	Assessment Criteria and Conditions	Suggested Emphasis
<p><i>The student will:</i></p> <ul style="list-style-type: none"> <li>• identify health and safety hazards associated with GTAW, and take preventive measures to avoid accidents and personal injury to self and others</li> <li>• outline the advantages of GTAW over other forms of welding</li> <li>• demonstrate basic GTAW competencies in the flat and horizontal positions</li> </ul>	<p><i>Assessment of student achievement should be based on:</i></p> <ul style="list-style-type: none"> <li>• observed performance related to: <ul style="list-style-type: none"> <li>– appropriate selection and use of personal protective equipment</li> <li>– safe use of equipment and supplies</li> <li>– measures taken to ensure the safety of others</li> </ul> </li> <li>• written or oral presentation that outlines four advantages of gas tungsten arc welding</li> <li>• completion of mild steel fillet and groove welds in the flat, horizontal and vertical positions.</li> </ul> <p><i>Assessment Tool</i> <i>Fabrication Process: Tungsten Arc Welding, FAB3030-1</i></p> <p><i>Standard</i> <i>Welds should be clean and bright, with ripples that are uniformly formed and free of craters; penetration should be even throughout the weld.</i> <i>Competency level of 3</i></p>	<p>15</p> <p>15</p> <p>70</p>

**COURSE FAB3030: GAS TUNGSTEN ARC WELDING (continued)**

General Outcomes	Assessment Criteria and Conditions	Suggested Emphasis
<p><i>The student will:</i></p> <ul style="list-style-type: none"> <li>demonstrate basic competencies.</li> </ul>	<p><i>Assessment of student achievement should be based on:</i></p> <ul style="list-style-type: none"> <li>observations of individual effort and interpersonal interaction during the learning process.</li> </ul> <p><i>Assessment Tool</i>  <i>Basic Competencies Reference Guide and any assessment tools noted above</i></p>	

Concept	Specific Outcomes	Notes
<p>Orientation</p> <ul style="list-style-type: none"> <li>Occupational Health and Safety</li> <li>Gas Tungsten Arc Welding</li> <li>Power Supply</li> </ul>	<p><i>The student should:</i></p> <ul style="list-style-type: none"> <li>identify and describe the health and safety issues associated with GTAW such as:               <ul style="list-style-type: none"> <li>electric current</li> <li>inert gases</li> <li>arc radiation</li> <li>ventilation</li> </ul> </li> <li>describe a safety plan in case of accident</li> <li>describe the basic components and operating principles of GTAW</li> <li>identify the advantages of GTAW over other forms of arc welding</li> <li>describe the major types of power supplies and current outputs; e.g.:               <ul style="list-style-type: none"> <li>high frequency current</li> <li>alternating current (AC)</li> <li>direct current straight polarity (DCSP)</li> <li>direct current reverse polarity (DCRP)</li> </ul> </li> <li>identify the appropriate type of current used for welding:               <ul style="list-style-type: none"> <li>low carbon steel</li> <li>aluminium</li> <li>stainless steel</li> </ul> </li> </ul>	<p>This course requires specialized equipment. Students who wish to get credit in this course may need to access this equipment in an off-campus environment.</p>

**COURSE FAB3030: GAS TUNGSTEN ARC WELDING (continued)**

Concept	Specific Outcomes	Notes
<ul style="list-style-type: none"> <li>• Shielding Gases</li> <li>• Electrodes</li> <li>• Filler Metal</li> </ul>	<p><i>The student should:</i></p> <ul style="list-style-type: none"> <li>• explain the purpose of a shielding gas</li> <li>• identify the appropriate type of gas to be used with:               <ul style="list-style-type: none"> <li>– low carbon steel</li> <li>– aluminium</li> <li>– stainless steel</li> </ul> </li> <li>• select, prepare and install the appropriate electrode for:               <ul style="list-style-type: none"> <li>– AC</li> <li>– DCSP or DCEN</li> <li>– DCRP or DCEP</li> </ul>               welding             </li> <li>• demonstrate proper handling techniques to prevent weld contamination</li> <li>• identify the degreasers that are commonly used to clean filler materials.</li> </ul>	
<p>Planning and Management</p> <ul style="list-style-type: none"> <li>• Start-up and Shut-down</li> <li>• Technique</li> <li>• Weld Preparation</li> <li>• Standards</li> </ul>	<ul style="list-style-type: none"> <li>• identify and demonstrate the appropriate start-up and shut-down procedures for welding mild steel</li> <li>• demonstrate typical methods used to start an arc</li> <li>• describe the correct torch angle for a lap and groove weld in the flat, horizontal and vertical positions</li> <li>• show that mill scale, rust, paint and oil has been removed from the weldments</li> <li>• list the characteristics of a weld that meets trade standards.</li> </ul>	<p>To avoid weld contamination, stress the importance of having clean surfaces.</p>
<p>Implementation</p> <ul style="list-style-type: none"> <li>• Gas Tungsten Arc Welding</li> </ul>	<ul style="list-style-type: none"> <li>• make lap and groove welds in the flat, horizontal and vertical positions.</li> </ul>	

**COURSE FAB3030: GAS TUNGSTEN ARC WELDING (continued)**

Concept	Specific Outcomes	Notes
<p>Assessment</p> <ul style="list-style-type: none"> <li>• Quality Control</li> <li>• Career Information</li> <li>• Career Preparation</li> </ul>	<p><i>The student should:</i></p> <ul style="list-style-type: none"> <li>• perform a visual inspection of a weld and describe its characteristics</li> <li>• identify career opportunities related to GTAW</li> <li>• prepare a record of completed activities within a portfolio.</li> </ul>	<p>Welds should be clean and bright, have uniform beads and even penetration.</p>

**COURSE FAB3040: SPECIALIZED WELDING****Level:** Advanced**Theme:** Fabrication Processes**Prerequisite:** FAB2030 Oxyfuel Welding**Description:** Students develop specific skills associated with advanced welding techniques to join and repair metals other than low carbon steel.**Parameters:** Access to a welding facility complete with advanced level welding equipment and supplies and to instruction from an individual with welding trade qualifications.**Supporting Courses:** FAB3030 Gas Tungsten Arc Welding  
FAB3050 Arc Welding 3  
FAB3170 Gas Metal Arc Welding 2**Curriculum and Assessment Standards**

General Outcomes	Assessment Criteria and Conditions	Suggested Emphasis
<i>The student will:</i>	<i>Assessment of student achievement should be based on:</i>	
<ul style="list-style-type: none"> <li>list health and safety specific hazards associated with welding metals other than low carbon steels, and take preventive measures to avoid accidents and personal injury to self and others</li> </ul>	<ul style="list-style-type: none"> <li>identification of the hazards associated with welding metals containing zinc, cadmium, lead, tin and chromium</li> </ul>	10
<ul style="list-style-type: none"> <li>describe the unique welding characteristics of weldable metals other than low carbon steel</li> </ul>	<ul style="list-style-type: none"> <li>a description of the characteristics and methods of welding aluminium, stainless steel and cast iron</li> </ul>	20
<ul style="list-style-type: none"> <li>select appropriate filler material and welding process to weld a metal other than low carbon steel</li> </ul>	<ul style="list-style-type: none"> <li>performing a given weld on any one or more of the following materials: <ul style="list-style-type: none"> <li>– aluminium</li> <li>– stainless steel</li> <li>– cast iron.</li> </ul> </li> </ul> <p><i>Assessment Tool</i> <i>Assessment Framework: Fabrication Process, FABPRS</i></p> <p><i>Standard</i> <i>Performance rating of 3 for each applicable task</i></p>	70

**COURSE FAB3040: SPECIALIZED WELDING** (continued)

General Outcomes	Assessment Criteria and Conditions	Suggested Emphasis
<p><i>The student will:</i></p> <ul style="list-style-type: none"> <li>demonstrate basic competencies.</li> </ul>	<p><i>Assessment of student achievement should be based on:</i></p> <ul style="list-style-type: none"> <li>observations of individual effort and interpersonal interaction during the learning process.</li> </ul> <p><i>Assessment Tool</i>  <i>Basic Competencies Reference Guide and any assessment tools noted above</i></p>	<p>Integrated throughout</p>

Concept	Specific Outcomes	Notes
<p>Orientation</p> <ul style="list-style-type: none"> <li>Health and Safety</li> <li>Welding Parameters</li> </ul>	<p><i>The student should:</i></p> <ul style="list-style-type: none"> <li>describe the health hazards connected with welding metals containing zinc, cadmium, lead, tin and chromium</li> <li>describe a safety plan in case of accident</li> <li>research and describe the unique welding characteristics of:               <ul style="list-style-type: none"> <li>stainless steel</li> <li>cast iron</li> <li>aluminium</li> <li>white metal (zinc die cast metal).</li> </ul> </li> </ul>	<p>Explain why it is often difficult to weld these materials.</p>
<p>Planning and Management</p>	<ul style="list-style-type: none"> <li>identify a suitable filler metal and flux to join or repair:               <ul style="list-style-type: none"> <li>stainless steel</li> <li>cast iron</li> <li>aluminium</li> <li>white metal</li> </ul> </li> <li>identify the appropriate joint preparation, supports and techniques for a given metal.</li> </ul>	
<p>Implementation</p> <ul style="list-style-type: none"> <li>Welding Process</li> </ul>	<ul style="list-style-type: none"> <li>perform a weld or repair on one or more metals other than a low carbon steel.</li> </ul>	

**COURSE FAB3040: SPECIALIZED WELDING** (continued)

Concept	Specific Outcomes	Notes
Assessment <ul style="list-style-type: none"><li data-bbox="207 449 443 478">• Quality Control</li><li data-bbox="207 569 391 632">• Career Preparation</li></ul>	<i>The student should:</i> <ul style="list-style-type: none"><li data-bbox="488 449 1092 548">• complete a visual inspection by considering the overall appearance, size and shape of the beads and degree of penetration</li><li data-bbox="488 569 1105 632">• prepare a record of completed activities within a portfolio.</li></ul>	



**COURSE FAB3050: ARC WELDING 3****Level:** Advanced**Theme:** Fabrication Processes**Prerequisite:** FAB2060 Arc Welding 2**Description:** Students learn the role of codes and standards in the welding trade, as well as test welds and develop vertical position welding skills.**Parameters:** Access to a welding facility complete with shielded metal arc welding equipment and supplies and to instruction from an individual with welding trade qualifications.**Curriculum and Assessment Standards**

General Outcomes	Assessment Criteria and Conditions	Suggested Emphasis
<p><i>The student will:</i></p> <ul style="list-style-type: none"> <li>• examine and maintain sheet metal arc welding (SMAW) equipment and accessories</li> <li>• read and interpret weld drawings and symbols</li> <li>• demonstrate advanced level SMAW competencies in the vertical position</li> </ul>	<p><i>Assessment of student achievement should be based on:</i></p> <ul style="list-style-type: none"> <li>• observed performance related to the examination and maintenance of personal protective equipment, welding accessories and equipment</li> <li>• accurate reading of a welding symbol that graphically represents three details such as the type of weld, its location and process</li> <li>• completion of two successive single and multiple pass fillet vee-groove and outside corner welds in the vertical position on mild steel plate.</li> </ul> <p><i>Assessment Tool</i>  <i>Fabrication Process: Vertical Lap and Tee Joints, FAB3050-1</i>  <i>Illustrative Example: Vertical Outside Corner – Multi-pass, FAB3050-2</i></p> <p><i>Standard</i>  <i>Welds are to be the correct width and height, free of voids, slag inclusions and apparent restarts, undercutting or overlapping; plate surfaces and adjacent beads have adequate penetration and fusion.</i>  <i>Performance rating of 3 for each applicable task</i></p>	<p>15</p> <p>15</p> <p>70</p>

**COURSE FAB3050: ARC WELDING 3** (continued)

General Outcomes	Assessment Criteria and Conditions	Suggested Emphasis
<p><i>The student will:</i></p> <ul style="list-style-type: none"> <li>demonstrate basic competencies.</li> </ul>	<p><i>Assessment of student achievement should be based on:</i></p> <ul style="list-style-type: none"> <li>observations of individual effort and interpersonal interaction during the learning process.</li> </ul> <p><i>Assessment Tool</i>  <i>Basic Competencies Reference Guide and any assessment tools noted above</i></p>	<p>Integrated throughout</p>

Concept	Specific Outcomes	Notes
<p>Orientation</p> <ul style="list-style-type: none"> <li>Welding Codes, Standards and Specifications</li> <li>Welding Symbols</li> </ul>	<p><i>The student should:</i></p> <ul style="list-style-type: none"> <li>explain the purpose of welding:               <ul style="list-style-type: none"> <li>codes</li> <li>standards</li> <li>specifications</li> </ul> </li> <li>identify agencies that establish codes and standards in Canada and the United States; e.g.:               <ul style="list-style-type: none"> <li>Canadian Standards Association (CSA)</li> <li>American Welding Society (AWS)</li> <li>Canadian Welding Bureau (CWB)</li> <li>American Society of Mechanical Engineers</li> </ul> </li> <li>explain the purpose of a weld symbol</li> <li>identify the basic data included in a welding symbol</li> <li>show how a welding symbol can be used to specify:               <ul style="list-style-type: none"> <li>location of a weld</li> <li>type of weld</li> <li>welding process</li> <li>root opening</li> <li>contour</li> <li>degree of penetration</li> <li>type of electrode</li> </ul> </li> </ul>	<p>Stress the importance of safety and weld quality and explain how codes and standards help achieve this end.</p> <p>Point out that a welding symbol can communicate a great deal of information in a small space and therefore must be fully understood.</p>

**COURSE FAB3050: ARC WELDING 3 (continued)**

Concept	Specific Outcomes	Notes
<ul style="list-style-type: none"> <li>• Testing</li> </ul>	<p><i>The student should:</i></p> <ul style="list-style-type: none"> <li>• analyze common destructive and non-destructive testing methods.</li> </ul>	
<p>Planning and Management</p> <ul style="list-style-type: none"> <li>• Care and Maintenance of Equipment</li> <li>• Print Reading</li> </ul>	<ul style="list-style-type: none"> <li>• before beginning to weld:               <ul style="list-style-type: none"> <li>– analyze the condition of cables and lugs</li> <li>– insure adequate air flow for proper cooling</li> <li>– check the condition of all personal protective equipment</li> </ul> </li> <li>• use a welding symbol to determine:               <ul style="list-style-type: none"> <li>– location of a weld</li> <li>– type of weld</li> <li>– root opening</li> <li>– type of electrode.</li> </ul> </li> </ul>	<p>This course has a strong link to FAB2020: Print Reading.</p>
<p>Implementation</p> <ul style="list-style-type: none"> <li>• Shielded Metal Arc Welding</li> </ul>	<ul style="list-style-type: none"> <li>• use the appropriate equipment and supplies to make single and multiple pass fillet and vee-groove welds in the vertical position.</li> </ul>	<p>E6010, E6011 and E7018 electrodes are recommended for this activity.</p>
<p>Assessment</p> <ul style="list-style-type: none"> <li>• Quality Control</li> <li>• Career Preparation</li> </ul>	<ul style="list-style-type: none"> <li>• perform one or more destructive and non-destructive tests on a weld sample</li> <li>• prepare a record of completed activities within a portfolio.</li> </ul>	



**COURSE FAB3060: ARC WELDING 4****Level:** Advanced**Theme:** Fabrication Processes**Prerequisite:** FAB3050 Arc Welding 3**Description:** Students apply and extend positional welding skills, by using a variety of common electrodes and thickness of materials.**Parameters:** Access to a welding facility complete with shielded metal arc welding equipment and supplies and to instruction from an individual with welding trade qualifications.**Curriculum and Assessment Standards**

General Outcomes	Assessment Criteria and Conditions	Suggested Emphasis
<p><i>The student will:</i></p> <ul style="list-style-type: none"> <li>explain the effects heating and cooling have on a weld and weldment</li> <li>demonstrate advanced level sheet metal arc welding (SMAW) competencies in the flat, horizontal and vertical positions</li> <li>describe a career related to the welding field</li> </ul>	<p><i>Assessment of student achievement should be based on:</i></p> <ul style="list-style-type: none"> <li>the description of the effects heating and cooling have on the quality of a weld and the adjacent materials</li> <li>completion of a variety of welds to first period trade standards using different electrodes and thicknesses of materials.</li> </ul> <p><i>Assessment Tool</i>  <i>Fabrication Process, Butt Joint Welds,</i>  <i>FAB3060-1</i>  <i>Illustrative Example: Flat Vee-groove Butt Joint,</i>  <i>FAB3060-2</i></p> <p><i>Standard</i>  <i>Performance rating of 3 for each applicable task</i></p>	<p>10</p> <p>70</p>
	<ul style="list-style-type: none"> <li>presentation of one occupational profile that outlines: <ul style="list-style-type: none"> <li>description of the occupation/trade working conditions</li> <li>employment opportunities</li> <li>training requirements.</li> </ul> </li> </ul> <p><i>Assessment Tool</i>  <i>Assessment Framework: Presentations/Reports,</i>  <i>CTSPRE</i></p> <p><i>Standard</i>  <i>Performance rating of 3 for each applicable task</i></p>	<p>20</p>

**COURSE FAB3060: ARC WELDING 4** (continued)

General Outcomes	Assessment Criteria and Conditions	Suggested Emphasis
<p><i>The student will:</i></p> <ul style="list-style-type: none"> <li>• demonstrate basic competencies.</li> </ul>	<p><i>Assessment of student achievement should be based on:</i></p> <ul style="list-style-type: none"> <li>• observations of individual effort and interpersonal interaction during the learning process.</li> </ul> <p><i>Assessment Tool</i>  <i>Basic Competencies Reference Guide and any assessment tools noted above</i></p>	<p>Integrated throughout</p>

Concept	Specific Outcomes	Notes
<p>Orientation</p> <ul style="list-style-type: none"> <li>• Heating and Cooling</li> <li>• Electrode Selection</li> </ul>	<p><i>The student should:</i></p> <ul style="list-style-type: none"> <li>• describe the effect of single and multiple pass welds on the base metal and previously deposited filler metal</li> <li>• explain the effect cold working conditions might have on weld quality</li> <li>• explain the need to preheat or postheat</li> <li>• describe the factors to be considered when choosing an electrode; e.g.:               <ul style="list-style-type: none"> <li>– static and dynamic loading</li> <li>– weld position</li> <li>– materials to be welded</li> <li>– current supply</li> <li>– ease of use</li> <li>– joint design and alignment</li> <li>– rate of deposit</li> <li>– depth of penetration</li> <li>– weld finish.</li> </ul> </li> </ul>	

**COURSE FAB3060: ARC WELDING 4** (continued)

Concept	Specific Outcomes	Notes
<p>Planning and Management</p> <ul style="list-style-type: none"> <li>• Preparation</li> <li>• Equipment Set-up</li> </ul>	<p><i>The student should:</i></p> <ul style="list-style-type: none"> <li>• describe the properties and uses of the following electrodes:               <ul style="list-style-type: none"> <li>– E6010 and 11</li> <li>– E7014, 18 and 24</li> </ul> </li> <li>• select the appropriate electrode for a given application</li> <li>• prepare the surfaces for welding</li> <li>• correctly position the weld</li> <li>• adjust the equipment to coincide with the type of electrode, weld and metal thickness.</li> </ul>	
<p>Implementation</p> <ul style="list-style-type: none"> <li>• Shielded Metal Arc Welding</li> </ul>	<ul style="list-style-type: none"> <li>• demonstrate first period arc welding skills in the flat, horizontal and vertical positions using a variety of weld types, joints, electrodes and thickness of mild steel</li> <li>• prepare welds for testing.</li> </ul>	<p>Welds completed here should be similar to those found in the first period of the apprenticeship program.</p>
<p>Assessment</p> <ul style="list-style-type: none"> <li>• Quality Control</li> <li>• Career Preparation</li> </ul>	<ul style="list-style-type: none"> <li>• perform a non-destructive and destructive test where appropriate</li> <li>• describe employment opportunities and further training requirements for the welding trade or related occupation</li> <li>• evaluate personal interests and abilities related to making realistic career choices</li> <li>• prepare a record of completed activities within a portfolio.</li> </ul>	<p>At this level, most faults can be detected through visual inspection.</p>



**COURSE FAB3070: PIPE & TUBULAR WELDING****Level:** Advanced**Theme:** Fabrication Processes**Prerequisite:** FAB3170 Gas Metal Arc Welding 2**Description:** Students develop specific skills related to pipe layout, preparation of pipe/tube joints and welding techniques.**Parameters:** Access to a welding facility complete with welding equipment and supplies and to instruction from an individual with welding trade qualifications.**Supporting Courses:** FAB2040 Thermal Cutting  
FAB2060 Arc Welding 2  
FAB3050 Arc Welding 3**Curriculum and Assessment Standards**

General Outcomes	Assessment Criteria and Conditions	Suggested Emphasis
<p><i>The student will:</i></p> <ul style="list-style-type: none"> <li>identify health and safety hazards associated with pipe and enclosed vessel welding, and take preventive measures to avoid accident and personal injury to self and others</li> <li>describe the advances made in pipe welding, and identify common types of joints and welding procedures</li> <li>demonstrate basic pipe/tube preparation and welding competencies</li> </ul>	<p><i>Assessment of student achievement should be based on:</i></p> <ul style="list-style-type: none"> <li>observed performance related to:               <ul style="list-style-type: none"> <li>appropriate selection and use of personal protective equipment</li> <li>preparation and selection of equipment and supplies</li> <li>measures taken to ensure the safety of others</li> </ul> </li> </ul>	10
	<ul style="list-style-type: none"> <li>identification and description of common pipe joints, welding procedures and advantages of welded joints over other forms of joining pipe together</li> </ul>	20
	<ul style="list-style-type: none"> <li>accurate lay out, preparation and completion of a butt, tee and lateral pipe/tubular weld joint using roll and/or positional welding techniques.</li> </ul> <p><i>Assessment Tool</i> <i>Fabrication Process: Joint Preparation and Welding, FAB3070-1</i></p> <p><i>Standard</i> <i>Performance rating of 3 for each applicable task.</i></p>	70

**COURSE FAB3070: PIPE & TUBULAR WELDING (continued)**

General Outcomes	Assessment Criteria and Conditions	Suggested Emphasis
<p><i>The student will:</i></p> <ul style="list-style-type: none"> <li>demonstrate basic competencies.</li> </ul>	<p><i>Assessment of student achievement should be based on:</i></p> <ul style="list-style-type: none"> <li>observations of individual effort and interpersonal interaction during the learning process.</li> </ul> <p><i>Assessment Tool</i>  <i>Basic Competencies Reference Guide and any assessment tools noted above</i></p>	<p>Integrated throughout</p>

Concept	Specific Outcomes	Notes
<p>Orientation</p> <ul style="list-style-type: none"> <li>Pipe and Tube Welding</li> </ul>	<p><i>The student should:</i></p> <ul style="list-style-type: none"> <li>list the advantages of welding over other forms of joining pipe related to:               <ul style="list-style-type: none"> <li>strength</li> <li>required maintenance</li> <li>flow of liquids and gases</li> <li>weight of joint</li> </ul> </li> <li>identify the standards of certification required for welding:               <ul style="list-style-type: none"> <li>low pressure water lines or light structural application</li> <li>medium pressure residential gas lines</li> <li>high pressure gas lines, motor cycle and aircraft frames.</li> </ul> </li> </ul>	
<p>Planning and Management</p> <ul style="list-style-type: none"> <li>Health and Safety</li> </ul>	<ul style="list-style-type: none"> <li>identify the precautions that must be taken prior to cutting or welding pipe or other enclosed vessel               <ul style="list-style-type: none"> <li>review a safety plan in case of accident</li> </ul> </li> </ul>	<p>Stress the importance of knowing what a pipe/vessel has been used for prior to welding.</p>

**COURSE FAB3070: PIPE & TUBULAR WELDING (continued)**

Concept	Specific Outcomes	Notes
<ul style="list-style-type: none"> <li>• Pipe/Tube Preparation</li> </ul>	<p><i>The student should:</i></p> <ul style="list-style-type: none"> <li>• calculate the cut angle for a butt joint in relation to the wall thickness and intended application</li> <li>• prepare a template for one or more of the following joints:               <ul style="list-style-type: none"> <li>– 90° two-piece turn</li> <li>– full T-joint</li> <li>– full lateral joint</li> <li>– butt joint.</li> </ul> </li> </ul>	<p>Explain the need for multiple passes when wall thickness exceeds 5 mm (3/16").</p> <p>Discuss methods used to fabricate T, K and Y tubular joints.</p>
<p>Implementation</p> <ul style="list-style-type: none"> <li>• Welding Process</li> </ul>	<ul style="list-style-type: none"> <li>• perform a vee groove weld using roll and position pipe welding techniques</li> <li>• prepare and perform:               <ul style="list-style-type: none"> <li>– full T-joint</li> <li>– full lateral joint tube and pipe weld.</li> </ul> </li> </ul>	<p>Explain the advantage of roll over positioned welding techniques.</p> <p>Discuss procedures to restart and end a weld.</p>
<p>Assessment</p> <ul style="list-style-type: none"> <li>• Quality Control</li> <li>• Career Preparation</li> </ul>	<ul style="list-style-type: none"> <li>• apply suitable destructive and non-destructive tests to ensure weld quality</li> <li>• prepare a record of completed activities within a portfolio.</li> </ul>	



**COURSE FAB3080: AUTOMATED WELDING****Level:** Advanced**Theme:** Fabrication Processes**Prerequisite:** FAB3170 Gas Metal Arc Welding 2**Description:** Students investigate and describe the operation of various manual, semi-automated and automated welding processes and systems used in fabrication industries.**Parameters:** Access to welding facility complete with welding equipment and supplies and to instruction from an individual with welding trade qualifications.**Supporting Courses:** FAB2030 Oxyfuel Welding  
FAB2040 Thermal Cutting  
FAB2060 Arc Welding 2**Curriculum and Assessment Standards**

General Outcomes	Assessment Criteria and Conditions	Suggested Emphasis
<p><i>The student will:</i></p> <ul style="list-style-type: none"> <li>explain how manual, semi-automated and automated welding processes differ from one another</li> <li>identify employment and further training opportunities related to production welding</li> </ul>	<p><i>Assessment of student achievement should be based on:</i></p> <ul style="list-style-type: none"> <li>the presentation of a written report that outlines the essential differences and similarities between manual, semi-automated and automated welding processes</li> </ul>	20
	<ul style="list-style-type: none"> <li>presentation of an occupational profile that outlines the: <ul style="list-style-type: none"> <li>description of the trade/occupation and working conditions</li> <li>employment opportunities</li> <li>training requirements and opportunities.</li> </ul> </li> </ul> <p><i>Assessment Tool</i> <i>Assessment Framework: Presentations/Reports, CTSPRE</i></p> <p><i>Standard</i> <i>Performance rating of 3 for each applicable task</i></p>	20
	<ul style="list-style-type: none"> <li>demonstration of a working or simulated automated welding system.</li> </ul> <p><i>Assessment Tool</i> <i>Assessment Framework: Activity Assessment, FABACT</i></p> <p><i>Standard</i> <i>Performance rating of 3 for each applicable task</i></p>	60

**COURSE FAB3080: AUTOMATED WELDING (continued)**

General Outcomes	Assessment Criteria and Conditions	Suggested Emphasis
<p><i>The student will:</i></p> <ul style="list-style-type: none"> <li>demonstrate basic competencies.</li> </ul>	<p><i>Assessment of student achievement should be based on:</i></p> <ul style="list-style-type: none"> <li>observations of individual effort and interpersonal interaction during the learning process.</li> </ul> <p><i>Assessment Tool</i>  <i>Basic Competencies Reference Guide and any assessment tools noted above</i></p>	<p>Integrated throughout</p>

Concept	Specific Outcomes	Notes
<p>Orientation</p> <ul style="list-style-type: none"> <li>Health and Safety</li> <li>Production Processes</li> <li>Automated Welding and Cutting</li> </ul>	<p><i>The student should:</i></p> <ul style="list-style-type: none"> <li>identify the hazards associated with specific machine and automated processes</li> <li>describe methods that are commonly used to protect an individual from injury by an automated system such as a robot</li> <li>describe a safety plan in case of accident</li> <li>explain the difference between:               <ul style="list-style-type: none"> <li>manual</li> <li>semi-automated</li> <li>automated cutting and welding processes</li> </ul> </li> <li>describe the specialized welding techniques that are suitable for semi-automated processes; e.g.:               <ul style="list-style-type: none"> <li>resistance welding</li> <li>GMAW</li> <li>GTAW</li> <li>plasma arc cutting</li> <li>laser beam welding and cutting</li> </ul> </li> <li>research the use of robots in welding to determine their advantages and disadvantages</li> <li>identify the main types of robots and describe their work envelope</li> <li>identify the main parts of a robot and the components of a robotic welding system</li> </ul>	<p>Students will likely need to go off-campus to observe automated cutting and welding processes.</p>

**COURSE FAB3080: AUTOMATED WELDING (continued)**

Concept	Specific Outcomes	Notes
<ul style="list-style-type: none"> <li>• Automated Welding and Cutting (continued)</li> </ul>	<p><i>The student should:</i></p> <ul style="list-style-type: none"> <li>• describe the use of a teach pendant in programming a robot to perform the designated task.</li> </ul>	
<p>Implementation</p> <ul style="list-style-type: none"> <li>• Application</li> </ul>	<ul style="list-style-type: none"> <li>• demonstrate or simulate a viable production system using semi- and/or fully automated processes.</li> </ul>	
<p>Assessment</p> <ul style="list-style-type: none"> <li>• Career Preparation</li> </ul>	<ul style="list-style-type: none"> <li>• identify career opportunities related to the use of automated welding processes in industry</li> <li>• prepare a record of completed activities within a portfolio.</li> </ul>	



**COURSE FAB3090: SHEET FABRICATION 4 (RADIAL LINE)****Level:** Advanced**Theme:** Fabrication Processes**Prerequisite:** FAB2100 Sheet Fabrication 3 (Parallel Line)**Description:** Students develop specialized skills in cylindrical and conical pattern development and seam construction of ferrous and nonferrous sheet metals.**Parameters:** Access to a fabrication facility complete with sheet metal shearing, forming, fastening and layout tools and to instruction from an individual with specialized training in sheet metal practices.**Curriculum and Assessment Standards**

General Outcomes	Assessment Criteria and Conditions	Suggested Emphasis
<p><i>The student will:</i></p> <ul style="list-style-type: none"> <li>describe the procedures that are used to lay out a typical cylindrical and conical shape</li> <li>demonstrate parallel and radial line pattern making skills</li> <li>perform advanced cylindrical and conical sheet stock fabrication skills and processes</li> </ul>	<p><i>Assessment of student achievement should be based on:</i></p> <ul style="list-style-type: none"> <li>accurate identification and description of parallel and radial line layout procedures</li> </ul>	10
	<ul style="list-style-type: none"> <li>application parallel and radial line development processes to produce a cylindrical and conical pattern</li> </ul>	25
	<ul style="list-style-type: none"> <li>successful completion of sheet metal products that incorporate cylindrical and conical shapes.</li> </ul> <p><i>Assessment Tool</i> <i>Assessment Framework: Product Assessment, FABPRD</i></p> <p><i>Standard</i> <i>The products are to be structurally sound, free of surface blemishes and hazards; and conform to stated overall sizes, shapes and tolerances</i> <i>Performance rating of 3 for each applicable task</i></p>	65
	<ul style="list-style-type: none"> <li>demonstrate basic competencies.</li> </ul> <p><i>Assessment Tool</i> <i>Basic Competencies Reference Guide and any assessment tools noted above</i></p>	Integrated throughout

**COURSE FAB3090: SHEET FABRICATION 4 (RADIAL LINE) (continued)**

Concept	Specific Outcomes	Notes
<p>Orientation</p> <ul style="list-style-type: none"> <li>• Ferrous and Nonferrous Stock</li> <li>• Fabrication Processes and Tools</li> </ul>	<p><i>The student should:</i></p> <ul style="list-style-type: none"> <li>• research the properties of and applications of the following sheet materials:               <ul style="list-style-type: none"> <li>– aluminum</li> <li>– copper</li> <li>– brass</li> <li>– galvanized steel</li> <li>– mild steel</li> <li>– stainless steel</li> <li>– tin plate</li> </ul> </li> <li>• describe which materials are most malleable</li> <li>• describe the techniques that are used to form sheet stock</li> <li>• describe the type of pattern development that is used to lay out a:               <ul style="list-style-type: none"> <li>– cylinder</li> <li>– cone</li> <li>– rectangle to round</li> </ul> </li> <li>• explain when single, double, grooved and wired seams are used in conjunction with cylindrical and conical fabrication</li> <li>• identify and describe the use of the following solder coppers:               <ul style="list-style-type: none"> <li>– square point</li> <li>– bottoming</li> <li>– roofing.</li> </ul> </li> </ul>	
<p>Planning and Management</p> <ul style="list-style-type: none"> <li>• Measurement</li> </ul>	<ul style="list-style-type: none"> <li>• use a micrometer caliper or sheet gauge to measure the thickness of a piece of sheet stock</li> <li>• calculate the inside, outside and mean diameter of a cylindrical component</li> <li>• identify the correct formula to calculate the allowances for seam and edges</li> </ul>	

**COURSE FAB3090: SHEET FABRICATION 4 (RADIAL LINE) (continued)**

Concept	Specific Outcomes	Notes
<ul style="list-style-type: none"> <li>• Product Design</li> </ul>	<p><i>The student should:</i></p> <ul style="list-style-type: none"> <li>• select a product that incorporates:                             <ul style="list-style-type: none"> <li>– cylindrical and conical shapes</li> <li>– grooved and double seams</li> <li>– solder joints and finished edges</li> </ul> </li> <li>• select the appropriate material for a given product and finish</li> <li>• create the necessary pattern development, using a computer or conventional means.</li> </ul>	<p>Students may require additional assistance and time to create a conical pattern.</p> <p>Consider projects such as a:</p> <ul style="list-style-type: none"> <li>– funnel</li> <li>– watering can</li> <li>– vase.</li> </ul>
<p>Implementation</p> <ul style="list-style-type: none"> <li>• Material Processing</li> <li>• Personal and Tool Safety</li> </ul>	<ul style="list-style-type: none"> <li>• use the appropriate tools, materials and processes to:                             <ul style="list-style-type: none"> <li>– cut and bend sheet stock</li> <li>– raise and finish a surface</li> <li>– locate and make joints watertight</li> </ul> </li> <li>• wear personal protective clothing and equipment</li> <li>• show that tools are kept in working order</li> <li>• handle, store and discard metal off-cuts in a correct manner.</li> </ul>	
<p>Assessment</p> <ul style="list-style-type: none"> <li>• Career Preparation</li> </ul>	<ul style="list-style-type: none"> <li>• prepare a record of completed activities within a portfolio.</li> </ul>	



**COURSE FAB3110: SHEET FABRICATION 5 (DUCT COMPONENTS)****Level:** Advanced**Theme:** Fabrication Processes**Prerequisite:** FAB2100 Sheet Fabrication 3 (Parallel Line)**Description:** Students apply and develop specialized skills in duct component pattern making and fabrication techniques.**Parameters:** Access to a fabrication facility complete with sheet metal shearing, forming, fastening and layout tools and to instruction from an individual with specialized training in sheet metal practices.**Supporting Course:** FAB3090 Sheet Fabrication 4 (Radial Line)**Curriculum and Assessment Standards**

General Outcomes	Assessment Criteria and Conditions	Suggested Emphasis
<i>The student will:</i> <ul style="list-style-type: none"> <li>identify common duct components and applications</li> <li>demonstrate the principle of triangulation to create a transition pattern</li> <li>apply pattern making and sheet metal fabrication skills to create a duct component</li> </ul>	<i>Assessment of student achievement should be based on:</i> <ul style="list-style-type: none"> <li>accurate identification and description of:               <ul style="list-style-type: none"> <li>radius elbow</li> <li>riser</li> <li>offset</li> <li>branch tee</li> <li>take-off components</li> </ul> </li> <li>application of triangulation principles to produce a transition pattern</li> <li>successful completion of one or more interconnecting duct components.</li> </ul>	10
	<i>Assessment Tool</i> <i>Assessment Framework: Activity Assessment, FABACT</i>	25
	<i>Standard</i> <i>The components are to be structurally sound and air tight; surfaces are to be free of blemishes and hazards. Components should be constructed to meet stated sizes and tolerances</i> <i>Performance rating of 3 for each applicable task</i>	65

**COURSE FAB3110: SHEET FABRICATION 5 (DUCT COMPONENTS) (continued)**

General Outcomes	Assessment Criteria and Conditions	Suggested Emphasis
<p><i>The student will:</i></p> <ul style="list-style-type: none"> <li>demonstrate basic competencies.</li> </ul>	<p><i>Assessment of student achievement should be based on:</i></p> <ul style="list-style-type: none"> <li>observations of individual effort and interpersonal interaction during the learning process.</li> </ul> <p><i>Assessment Tool</i>  <i>Basic Competencies Reference Guide and any assessment tools noted above</i></p>	<p>Integrated throughout</p>

Concept	Specific Outcomes	Notes
<p>Orientation</p> <ul style="list-style-type: none"> <li>Ducting</li> </ul> <ul style="list-style-type: none"> <li>Fabrication Processes</li> </ul>	<p><i>The student should:</i></p> <ul style="list-style-type: none"> <li>prepare a list of duct system applications</li> <li>list and state the purpose of the following components used in a duct system: <ul style="list-style-type: none"> <li>radius elbow</li> <li>riser</li> <li>offset</li> <li>branch tee</li> <li>take off</li> </ul> </li> <li>describe how air volume and pressures are measured</li> <li>analyze the effect of component resistance on static and velocity air pressures in a ducting system</li> <li>list and describe the use and construction of the following joints: <ul style="list-style-type: none"> <li>S and drive</li> <li>T-lock</li> <li>hammerlock</li> <li>government locks</li> </ul> </li> <li>state the advantages and disadvantages of using each of the above systems</li> <li>differentiate among the use of parallel line, radial line and triangulation in pattern development.</li> </ul>	<p>Explain why it is important for duct components to be sized accurately.</p>

**COURSE FAB3110: SHEET FABRICATION 5 (DUCT COMPONENTS) (continued)**

Concept	Specific Outcomes	Notes
<p>Planning and Management</p> <ul style="list-style-type: none"> <li>• Pattern Development</li> </ul>	<p><i>The student should:</i></p> <ul style="list-style-type: none"> <li>• calculate the material allowance for:                             <ul style="list-style-type: none"> <li>– S and drive</li> <li>– T-lock</li> <li>– hammerlock</li> </ul> </li> <li>• use triangulation to develop a pattern for an object whose sides are not parallel.</li> </ul>	<p>Students may require additional assistance and time to develop a pattern.</p>
<p>Implementation</p> <ul style="list-style-type: none"> <li>• Material Processing</li> </ul>	<ul style="list-style-type: none"> <li>• use the appropriate tools, materials and processes to fabricate specific components in a ducting system.</li> </ul>	<p>Consider one of the following components:</p> <ul style="list-style-type: none"> <li>– reducing elbow</li> <li>– square elbow</li> <li>– reducing offset</li> <li>– rectangular to round offset.</li> </ul>
<p>Assessment</p> <ul style="list-style-type: none"> <li>• Career Assessment</li> <li>• Career Preparation</li> </ul>	<ul style="list-style-type: none"> <li>• describe the trade qualifications and work opportunities related to sheet metal fabrication</li> <li>• prepare a record of completed activities within a portfolio.</li> </ul>	



**COURSE FAB3120: FOUNDRY 3 (CORE MOLDING)****Level:** Advanced**Theme:** Production Systems and Processes**Prerequisite:** FAB1120 Foundry 1 (One-piece Pattern)**Description:** Students investigate and apply advanced foundry processes to produce a hollow casting, using a sand and core mold.**Parameters:** Access to a fabrication facility complete with foundry equipment and supplies and to instruction from an individual with specialized training in foundry practices.**Supporting Course:** FAB2120 Foundry 2 (Split Pattern)**Curriculum and Assessment Standards**

General Outcomes	Assessment Criteria and Conditions	Suggested Emphasis
<p><i>The student will:</i></p> <ul style="list-style-type: none"> <li>• list and describe common core materials and production processes</li> </ul>	<p><i>Assessment of student achievement should be based on:</i></p> <ul style="list-style-type: none"> <li>• written or oral report that:               <ul style="list-style-type: none"> <li>– describes how cores are designed and fabricated</li> <li>– lists four different core binders and setting techniques</li> <li>– explains how cores are placed and reinforced in a mold.</li> </ul> </li> </ul> <p><i>Assessment Tool</i> <i>Assessment Framework: Presentations/Reports, CTSPRE</i></p> <p><i>Standard</i> <i>Performance rating of 3 for each applicable task</i></p>	10
<ul style="list-style-type: none"> <li>• demonstrate advanced sand casting and coring skills and techniques</li> </ul>	<ul style="list-style-type: none"> <li>• completion of a hollow casting using an appropriate coring technique.</li> </ul> <p><i>Assessment Tool</i> <i>Assessment Framework: Product Assessment, FABPRD</i></p> <p><i>Standard</i> <i>The core should break down at the end of the casting process and be easily removed. The casting should be clean and free of voids and meet size, shape and finish expectations.</i> <i>Performance rating of 3 for each applicable task</i></p>	70

**COURSE FAB3120: FOUNDRY 3 (CORE MOLDING)** (continued)

General Outcomes	Assessment Criteria and Conditions	Suggested Emphasis
<p><i>The student will:</i></p> <ul style="list-style-type: none"> <li>• create a profile of a trade or occupation within the foundry field</li>   <li>• demonstrate basic competencies.</li> </ul>	<p><i>Assessment of student achievement should be based on:</i></p> <ul style="list-style-type: none"> <li>• presentation of an occupational profile that outlines:               <ul style="list-style-type: none"> <li>– description of the trade/occupation and conditions of work</li> <li>– employment opportunities</li> <li>– training requirements and opportunities.</li> </ul> </li> </ul> <p><i>Assessment Tool</i>  <i>Assessment Framework: Research Process, CTSRES</i></p> <p><i>Standard</i>  <i>Performance rating of 3 for each applicable task</i></p> <ul style="list-style-type: none"> <li>• observations of individual effort and interpersonal interaction during the learning process.</li> </ul> <p><i>Assessment Tool</i>  <i>Basic Competencies Reference Guide and any assessment tools noted above</i></p>	<p>20</p>

Concept	Specific Outcomes	Notes
<p>Orientation</p> <ul style="list-style-type: none"> <li>• Cores</li>   <li>• Binders</li>   <li>• Core Construction</li>   <li>• Core Placement</li> </ul>	<p><i>The student should:</i></p> <ul style="list-style-type: none"> <li>• explain the purpose of a core and provide examples of products that require their use in casting</li> <li>• describe the variables and characteristics of good core mix</li> <li>• identify common binders that can be used with core sand; e.g.: sodium silicate and CO<sub>2</sub>, linseed oil, wheat flour and molasses and other commercially prepared products</li> <li>• identify common shapes and methods of producing and drying a core</li> <li>• research and describe common methods of supporting core in mold cavity.</li> </ul>	<p>An engine block is a good example of a part that requires cores.</p>

**COURSE FAB3120: FOUNDRY 3 (CORE MOLDING) (continued)**

Concept	Specific Outcomes	Notes
<p>Planning and Management</p> <ul style="list-style-type: none"> <li>• Core Design</li> <li>• Health and Safety</li> </ul>	<p><i>The student should:</i></p> <ul style="list-style-type: none"> <li>• for a given casting, identify the appropriate core shape placement technique, core mix and reinforcement techniques</li> <li>• prepare a sketch showing the location of:               <ul style="list-style-type: none"> <li>– parting line and type of mold</li> <li>– core and core prints</li> <li>– venting, gating and pouring system for a given casting</li> </ul> </li> <li>• describe safety concerns related to:               <ul style="list-style-type: none"> <li>– personal protective equipment</li> <li>– mold construction</li> <li>– foundry furnace start-up and shut-down procedures</li> <li>– heating and pouring procedures</li> <li>– cleaning and finishing castings</li> </ul> </li> <li>• describe a safety plan in case of accident</li> </ul>	
<p>Implementation</p> <ul style="list-style-type: none"> <li>• Material Processing</li> </ul>	<ul style="list-style-type: none"> <li>• create a casting using common pattern making, coring and pouring techniques</li> <li>• clean and finish the casting according to specification.</li> </ul>	<p>Begin with a simple part such as a hollow cylinder that could later be machined into a collar or bushing.</p>
<p>Assessment</p> <ul style="list-style-type: none"> <li>• Quality Control</li> <li>• Career Information</li> <li>• Career Preparation</li> </ul>	<ul style="list-style-type: none"> <li>• analyze the overall size, shape and structural soundness of the product</li> <li>• identify ways to gain experience and further training in foundry work</li> <li>• research and describe career and further training opportunities related to foundry work</li> <li>• evaluate personal interests and abilities related to making realistic career choices</li> <li>• prepare a record of completed activities within a portfolio.</li> </ul>	



**COURSE FAB3130: PRECISION TURNING 2****Level:** Advanced**Theme:** Production Systems and Processes**Prerequisite:** FAB2130 Precision Turning 1**Description:** Students develop specialized lathe skills for thread cutting and taper turning techniques.**Parameters:** Access to a fabrication facility complete with metal lathe and accessories and to instruction from an individual with specialized training in metal lathe practices.**Curriculum and Assessment Standards**

General Outcomes	Assessment Criteria and Conditions	Suggested Emphasis
<p><i>The student will:</i></p> <ul style="list-style-type: none"> <li>• demonstrate print reading and job sequencing competencies</li> <li>• perform safe taper turning and thread cutting set-up procedures</li> <li>• perform taper turning and thread cutting operations</li> <li>• demonstrate basic competencies.</li> </ul>	<p><i>Assessment of student achievement should be based on:</i></p> <ul style="list-style-type: none"> <li>• application of print reading and organizing skills to prepare a safe and efficient sequence of machining operations</li> <li>• demonstration of approved practices to set up a lathe for: <ul style="list-style-type: none"> <li>– taper turning</li> <li>– thread cutting</li> </ul> </li> <li>• completion of the following machining operations: <ul style="list-style-type: none"> <li>– outside and inside tapers</li> <li>– outside and inside right hand threading.</li> </ul> </li> </ul> <p><i>Assessment Tool</i>  <i>Assessment Framework: Fabrication Process, FABPRS</i></p> <p><i>Standard</i>  <i>Dimensions, levels of finish and fits are to be within stated tolerances and specifications</i>  <i>Performance rating of 3 for each applicable task</i></p> <ul style="list-style-type: none"> <li>• observations of individual effort and interpersonal interaction during the learning process.</li> </ul> <p><i>Assessment Tool</i>  <i>Basic Competencies Reference Guide and any assessment tools noted above</i></p>	<p>20</p> <p>10</p> <p>70</p> <p>Integrated throughout</p>

**COURSE FAB3130: PRECISION TURNING 2 (continued)**

Concept	Specific Outcomes	Notes
<p>Orientation</p> <ul style="list-style-type: none"> <li>• Health and Safety</li> <li>• Lathe Accessories</li> <li>• Taper Turning</li> <li>• Threading</li> </ul>	<p><i>The student should:</i></p> <ul style="list-style-type: none"> <li>• describe the hazards associated with metal lathes and metal cutting operations</li> <li>• describe a safety plan in case of accident</li> <li>• list and describe common lathe accessories such as drill chuck, taper attachment and thread dial</li> <li>• list and describe common types of tapers such as:               <ul style="list-style-type: none"> <li>– Morse taper</li> <li>– standard milling machine taper</li> <li>– taper pins</li> </ul> </li> <li>• observe methods of cutting a taper by using the:               <ul style="list-style-type: none"> <li>– compound rest</li> <li>– tailstock offset</li> <li>– taper attachment methods</li> </ul> </li> <li>• identify the factors that determine the most efficient method of cutting a taper such as the:               <ul style="list-style-type: none"> <li>– length and angle of taper</li> <li>– quality of finish</li> <li>– number of duplicates</li> </ul> </li> <li>• identify the parts of a thread</li> <li>• list and describe the principal features of a:               <ul style="list-style-type: none"> <li>– Unified National Coarse (UNC)</li> <li>– Unified National Fine (UNF)</li> <li>– tapered pipe thread</li> <li>– ISO metric thread</li> </ul> </li> <li>• describe the set-up procedures to cut internal and external left- and right-handed threads</li> <li>• describe the classes of fit associated with Unified Thread system</li> </ul>	<p>Demonstrate these processes on the lathe.</p> <p>Consider also a square, ACME, B.S.W. and buttress thread.</p>

**COURSE FAB3130: PRECISION TURNING 2 (continued)**

Concept	Specific Outcomes	Notes
<p>Planning and Management</p> <ul style="list-style-type: none"> <li>• Print Reading</li> <li>• Boring</li> <li>• Work Sequencing</li> </ul>	<p><i>The student should:</i></p> <ul style="list-style-type: none"> <li>• use a machine drawing to identify the:               <ul style="list-style-type: none"> <li>– overall size and shape of a machine part</li> <li>– thread type, size, tolerance and fit</li> <li>– taper type, size and fit</li> <li>– materials</li> </ul> </li> <li>• research hole-machining operations procedures</li> <li>• create a systematic sequence of operations to machine a given part</li> <li>• calculate the appropriate cutting speeds, feed rates and depth of cuts for a given operation.</li> </ul>	
<p>Implementation</p> <ul style="list-style-type: none"> <li>• Taper Turning and Thread Cutting</li> </ul> <p>Assessment</p> <ul style="list-style-type: none"> <li>• Career Information</li> <li>• Career Preparation</li> </ul>	<ul style="list-style-type: none"> <li>• demonstrate skills in:               <ul style="list-style-type: none"> <li>– hole-machining operations</li> <li>– inside and outside taper turning</li> <li>– cutting inside and outside threads.</li> </ul> </li> <li>• describe career and further training opportunities related to precision lathe work</li> <li>• prepare a record of completed activities within a portfolio.</li> </ul>	<p>If possible, have students visit a local machine or repair shop.</p>



**COURSE FAB3140: PRECISION MILLING 2****Level:** Advanced**Theme:** Production Systems and Processes**Prerequisite:** FAB2140 Precision Milling 1**Description:** Students develop specialized skills to use vertical and/or horizontal milling machines.**Parameters:** Students have access to a fabrication facility complete with horizontal mill plus accessories and to instruction from an individual with specialized training in advanced level machining practices.**Curriculum and Assessment Standards**

General Outcomes	Assessment Criteria and Conditions	Suggested Emphasis
<i>The student will:</i> <ul style="list-style-type: none"> <li>• demonstrate print reading and job sequencing competencies</li> <li>• perform safe vertical and/or horizontal mill set-up procedures</li> <li>• perform groove keyway and gear cutting operations</li> </ul>	<i>Assessment of student achievement should be based on:</i> <ul style="list-style-type: none"> <li>• application of print reading and sequencing skills to prepare a safe and efficient sequence of milling operations</li> </ul>	20
	<ul style="list-style-type: none"> <li>• demonstrate approved practices to set up a vertical or horizontal mill to cut:               <ul style="list-style-type: none"> <li>– grooves</li> <li>– keyways</li> <li>– gear teeth</li> </ul> </li> </ul>	10
	<ul style="list-style-type: none"> <li>• completion of one or more of the following milling operations:               <ul style="list-style-type: none"> <li>– groove/slot</li> <li>– keyway</li> <li>– gear.</li> </ul> </li> </ul> <p><i>Assessment Tool</i>  <i>Assessment Framework: Fabrication Process, FABPRS</i></p> <p><i>Standard</i>  <i>Dimensions and levels of fit are to be within the stated tolerances and specifications</i>  <i>Performance rating of 3 for each applicable task</i></p>	70

**COURSE FAB3140: PRECISION MILLING 2** (continued)

General Outcomes	Assessment Criteria and Conditions	Suggested Emphasis
<p><i>The student will:</i></p> <ul style="list-style-type: none"> <li>demonstrate basic competencies.</li> </ul>	<p><i>Assessment of student achievement should be based on:</i></p> <ul style="list-style-type: none"> <li>observations of individual effort and interpersonal interaction during the learning process.</li> </ul> <p><i>Assessment Tool</i>  <i>Basic Competencies Reference Guide and any assessment tools noted above</i></p>	<p>Integrated throughout</p>

Concept	Specific Outcomes	Notes
<p>Orientation</p> <ul style="list-style-type: none"> <li>Health and Safety</li> <li>Milling Operations</li> <li>Cutters</li> <li>Indexing</li> </ul>	<p><i>The student should:</i></p> <ul style="list-style-type: none"> <li>describe the hazards associated with manual milling operations</li> <li>describe a safety plan in case of accident</li> <li>describe safe set-up procedures to mill grooves, keyways and gear teeth</li> <li>identify and describe the types of cutters that are available for cutting common grooves/slots, keyways and gear teeth</li> <li>explain the difference between a high speed steel and a tungsten carbide cutter</li> <li>identify the conditions that produce cutter failure such as:               <ul style="list-style-type: none"> <li>excessive heat</li> <li>clogging</li> <li>work hardening</li> </ul> </li> <li>identify common machine parts that require indexing</li> <li>describe how an indexing head is used when cutting a spur gear.</li> </ul>	<p>Teacher should be prepared to demonstrate each of these processes.</p> <p>Consider cutting and feed rates; material harness and condition of the cutters.</p>

**COURSE FAB3140: PRECISION MILLING 2** (continued)

Concept	Specific Outcomes	Notes
<p>Planning and Management</p> <ul style="list-style-type: none"> <li>• Print Reading</li> <li>• Work Sequencing</li> </ul>	<p><i>The student should:</i></p> <ul style="list-style-type: none"> <li>• use a machine drawing to determine:               <ul style="list-style-type: none"> <li>– overall size and shape of a machine part</li> <li>– specific types and sizes of grooves/slots, keyways and gear teeth</li> </ul> </li> <li>• list and describe the machining operations for a given machine part and/or feature in a logical sequence</li> <li>• identify the appropriate type of milling machine and cutters for each operation</li> <li>• select work piece holding device</li> <li>• calculate the appropriate cutting speeds, feed rates and recommended depths of cut for a given operation</li> <li>• select appropriate cutting fluids.</li> </ul>	<p>Student calculations should be checked prior to their use.</p>
<p>Implementation</p>	<ul style="list-style-type: none"> <li>• demonstrate skills in milling:               <ul style="list-style-type: none"> <li>– grooves/slots</li> <li>– keyways</li> <li>– gear teeth.</li> </ul> </li> </ul>	
<p>Assessment</p> <ul style="list-style-type: none"> <li>• Career Information</li> <li>• Career Preparation</li> </ul>	<ul style="list-style-type: none"> <li>• identify career and further training opportunities related to precision milling</li> <li>• prepare a record of completed activities within a portfolio.</li> </ul>	<p>Remind students that conventional machining processes will remain; however, new methods such as laser, electric and electrochemical processes are emerging as alternative ways of machining.</p>



**COURSE FAB3150: CNC MILLING (COMPUTER NUMERICAL CONTROL)****Level:** Advanced**Theme:** Production Systems and Processes**Prerequisite:** FAB1130 Principles of Machining**Description:** Students develop skills in computer numerical control (CNC) programming to manufacture a three-dimensional product.**Parameters:** Access to a CNC milling centre and to instruction from an individual with specialized training in CNC mill work.**Supporting Course:** FAB2150 CNC Turning (Computer Numerical Control)**Curriculum and Assessment Standards**

General Outcomes	Assessment Criteria and Conditions	Suggested Emphasis
<p><i>The student will:</i></p> <ul style="list-style-type: none"> <li>demonstrate three-dimensional CNC programming skills</li> <li>apply CNC programming and operating skills to manufacture a milled part</li> <li>identify further training and employment opportunities related to CNC machining</li> </ul>	<p><i>Assessment of student achievement should be based on:</i></p> <ul style="list-style-type: none"> <li>development of a 3-D program to produce a machineable part on a CNC mill using absolute coordinates, canned cycles and/or CAD file conversion</li> <li>performing the appropriate programming set-up, testing and running procedures to produce a milled part</li> <li>presentation of an occupational profile that outlines: <ul style="list-style-type: none"> <li>description of the occupation and conditions of work</li> <li>employment opportunities</li> <li>training requirements and locations.</li> </ul> </li> </ul> <p><i>Assessment Tool</i>  <i>Assessment Framework: Research Process, CTSRES</i></p> <p><i>Standard</i>  <i>Performance rating of 3 in each applicable task</i></p>	<p>60</p> <p>30</p> <p>10</p>
<ul style="list-style-type: none"> <li>demonstrate basic competencies.</li> </ul>	<ul style="list-style-type: none"> <li>observations of individual effort and interpersonal interaction during the learning process.</li> </ul> <p><i>Assessment Tool</i>  <i>Basic Competencies Reference Guide and any assessment tools noted above</i></p>	<p>Integrated throughout</p>

**COURSE FAB3150: CNC MILLING (COMPUTER NUMERICAL CONTROL) (continued)**

Concept	Specific Outcomes	Notes
<p>Orientation</p> <ul style="list-style-type: none"> <li>• Mill Operation</li> <li>• Programming</li> <li>• Canned Cycles</li> </ul>	<p><i>The student should:</i></p> <ul style="list-style-type: none"> <li>• after observing the operation of a CNC mill, describe how the cutting speeds, feed rates and depth of cuts are controlled; cutting tools and different sizes and shapes of workpieces are mounted</li> <li>• identify milling capabilities of a given machine, e.g.: size of cutters, size and types of materials</li> <li>• describe the safety features that are built into the CNC equipment</li> <li>• identify the relationship of the x, y and z axis on a vertical milling machine</li> <li>• determine how to program a CNC mill using absolute coordinates</li> <li>• describe the types of canned cycles used in machining operations</li> <li>• identify when to use canned cycles to improve efficiency</li> <li>• list the information required to calculate and format a canned cycle.</li> </ul>	<p>Demonstrate how to program and use a CNC mill using pre-designed/programmed part.</p>
<p>Planning and Management</p> <ul style="list-style-type: none"> <li>• Health and Safety</li> <li>• 3-D Programming</li> </ul>	<ul style="list-style-type: none"> <li>• describe the: <ul style="list-style-type: none"> <li>– appropriate use of personal protective equipment</li> <li>– importance of keeping all covers and guards in place and following the manufacturer's recommendations</li> <li>– need to keep the work area clean and free of personal hazards</li> </ul> </li> <li>• describe a safety plan in case of accident</li> <li>• prepare a program from a print using absolute coordinates and/or produce a CAD design.</li> </ul>	

**COURSE FAB3150: CNC MILLING (COMPUTER NUMERICAL CONTROL) (continued)**

Concept	Specific Outcomes	Notes
Implementation	<p><i>The student should:</i></p> <ul style="list-style-type: none"> <li>• load the program or convert a CAD file</li> <li>• mount and secure the workpiece</li> <li>• identify reference and clearance points</li> <li>• mount and set cutting tool(s)</li> <li>• carry out a test run</li> <li>• manufacture the part.</li> </ul>	
<p>Assessment</p> <ul style="list-style-type: none"> <li>• Quality Control</li> <li>• Career Information</li> </ul>	<ul style="list-style-type: none"> <li>• inspect the part to see that it meets the print dimensions, tolerances and specifications</li> <li>• research and describe further education and work opportunities related to the use of computer-controlled equipment</li> <li>• evaluate personal interests and abilities related to making realistic career choices</li> <li>• prepare a record of completed activities within a portfolio.</li> </ul>	<p>Note: This field is expanding as new technology is developed and applications are found.</p>



**COURSE FAB3160: PREFABRICATION PRINCIPLES**

<b>Level:</b>	Advanced
<b>Theme:</b>	Production Systems and Processes
<b>Prerequisite:</b>	FAB2160 Custom Fabrication
<b>Description:</b>	Students work in a cooperative learning environment to plan and construct a prefabricated product/ structure to meet the specific needs of a client.

**Parameters:** Access to fabrication facilities and equipment and to instruction from an individual with journeyman qualifications if students are involved in customer work related to welding or other trade-related activities.

**Curriculum and Assessment Standards**

General Outcomes	Assessment Criteria and Conditions	Suggested Emphasis
<p><i>The student will:</i></p> <ul style="list-style-type: none"> <li>perform basic shop drawing take-off skills</li> <li>demonstrate advanced level resource management skills</li> <li>demonstrate appropriate prefabrication skills and practices</li> </ul>	<p><i>Assessment of student achievement should be based on:</i></p> <ul style="list-style-type: none"> <li>development of an accurate cutting list and fabrication flow chart</li> </ul>	20
	<ul style="list-style-type: none"> <li>observed resource management skills used to access and deploy human and material resources</li> </ul>	20
	<ul style="list-style-type: none"> <li>successful prefabrication of a component that fulfills the design specifications, quality and quantity requirements.</li> </ul> <p><i>Assessment Tool</i>  <i>Product Assessment: Prefabricated Project, FAB3160-1</i>  <i>Illustrative Example, Gear Puller, FAB3160-2</i></p> <p><i>Standard</i>  <i>Jigs and fixtures are to be developed and appropriate tools and materials acquired and used efficiently through proper scheduling and time allocations</i></p>	60
	<ul style="list-style-type: none"> <li>demonstrate basic competencies.</li> </ul> <p><i>Assessment Tool</i>  <i>Basic Competencies Reference Guide and any assessment tools noted above</i></p>	Integrated throughout

**COURSE FAB3160: PREFABRICATION PRINCIPLES (continued)**

Concept	Specific Outcomes	Notes
<p>Orientation</p> <ul style="list-style-type: none"> <li>• Prefabrication Principles</li> </ul>	<p><i>The student should:</i></p> <ul style="list-style-type: none"> <li>• cite examples of products that are built from prefabricated parts</li> <li>• describe the advantages and disadvantages of prefabricating a component</li> <li>• identify specific design considerations that must be adhered to when using prefabricated components</li> <li>• explain procedures that are used to create a cutting list from a shop drawing</li> <li>• describe safe rigging procedures that are used to move materials and components.</li> </ul>	<p>Greater efficiency and productivity are achieved by using pre-fabrication processes. However, extra care must be taken to ensure that components have been accurately designed and fabricated in the shop prior to the assembly on site.</p>
<p>Planning and Management</p> <ul style="list-style-type: none"> <li>• Quality Customer Service</li> </ul>	<ul style="list-style-type: none"> <li>• create a cutting list from a shop drawing</li> <li>• prepare the required templates jigs and fixtures</li> <li>• locate appropriate materials and supplies</li> <li>• identify specialized equipment and processes that will be required</li> <li>• prepare production flow chart</li> <li>• show how to meet with the customer to determine the product/structure specifications</li> <li>• create a suitable prefabricated design, timeline and budget</li> <li>• show how to apprise the customer of any need to make changes.</li> </ul>	<p>Good communication between the customer, designer engineer and fabricator is a must.</p> <p>Students need to develop their interpersonal and communication skills.</p>

**COURSE FAB3160: PREFABRICATION PRINCIPLES (continued)**

Concept	Specific Outcomes	Notes
<p>Implementation</p> <ul style="list-style-type: none"> <li>• Material Processing</li> </ul>	<p><i>The student should:</i></p> <ul style="list-style-type: none"> <li>• assign responsibilities to:               <ul style="list-style-type: none"> <li>– break out materials according to a prearranged plan</li> <li>– process materials with a minimum number of set-ups</li> <li>– assemble, finish and prepare the product for delivery</li> </ul> </li> <li>• explain the need to:               <ul style="list-style-type: none"> <li>– identify group and individual responsibilities</li> <li>– identify and capitalize on individual strengths</li> </ul> </li> <li>• help install/assemble the product if contracted.</li> </ul>	
<p>Assessment</p> <ul style="list-style-type: none"> <li>• Quality Control</li> <li>• Career Preparation</li> </ul>	<ul style="list-style-type: none"> <li>• participate in group and self-evaluation processes</li> <li>• demonstrate strategies for positive criticism</li> <li>• complete a customer satisfaction follow-up survey</li> <li>• prepare a record of completed activities within a portfolio.</li> </ul>	<p>Students need to understand the importance of having good intra- and interpersonal skills.</p>



**COURSE FAB3170: GAS METAL ARC WELDING 2****Level:** Advanced**Theme:** Fabrication Processes**Prerequisite:** FAB2070 Gas Metal Arc Welding 1**Description:** Students develop skills to evaluate and improve the quality of gas metal arc weldings, and they extend their gas metal arc welding (GMAW) skills by performing horizontal and vertical groove welds.**Parameters:** Access to a fabrication work centre complete with gas metal arc welding (GMAW) equipment and supplies, and to instruction from an individual with welding trade qualifications.**Curriculum and Assessment Standards**

General Outcomes	Assessment Criteria and Conditions	Suggested Emphasis
<p><i>The student will:</i></p> <ul style="list-style-type: none"> <li>identify variables that affect the quality of gas metal arc welds, and identify strategies to evaluate and improve weld quality</li> </ul>	<p><i>Assessment of student achievement should be based on:</i></p> <ul style="list-style-type: none"> <li>assessment, based on trade standards, of a gas metal arc weld; assessment to focus attention on: <ul style="list-style-type: none"> <li>variables affecting weld quality</li> <li>possible causes of observed defects</li> <li>corrective measures to improve weld quality</li> </ul> </li> </ul> <p><i>Assessment Tools</i>  <i>Fabrication Process: Fillet and Butt Welding on Mild Steel, FAB3170-1</i>  <i>Illustrative Example:</i>  <i>Horizontal Single Vee Butt Joint Weld, FAB3170-2</i></p> <p><i>Standard</i>  <i>Performance rating of 3 for each applicable task</i></p>	10
<ul style="list-style-type: none"> <li>perform safe set-up, maintenance and troubleshooting procedures with GMAW equipment</li> </ul>	<ul style="list-style-type: none"> <li>demonstration of safe start-up, shut-down, maintenance and troubleshooting procedures, using GMAW equipment</li> </ul> <p><i>Assessment Tools</i>  <i>Equipment Checklist: GMAW Start-Up and Shut-Down Procedures, FABEQUIP-6</i></p> <p><i>Standard</i>  <i>All procedures to be performed correctly</i></p>	10



**COURSE FAB3170: GAS METAL ARC WELDING 2 (continued)**

Concept	Specific Outcomes	Notes
<p>Orientation</p> <ul style="list-style-type: none"> <li>• Health and Safety</li> <li>• GMAW Variables</li> <li>• Gas Mixtures</li> <li>• Filler Metals</li> <li>• Arc Control</li> </ul>	<p><i>The student should:</i></p> <ul style="list-style-type: none"> <li>• describe safety issues related to:               <ul style="list-style-type: none"> <li>– the use of personal protective equipment</li> <li>– handling and storage of consumables</li> <li>– keeping the welding area free of hazards</li> <li>– insuring adequate ventilation</li> </ul> </li> <li>• describe a safety plan in case of accident</li> <li>• identify the variables that can directly affect weld quality; i.e.:               <ul style="list-style-type: none"> <li>– the welding current and voltage</li> <li>– type of shielding gas/flux</li> <li>– diameter and type of filler metal</li> <li>– type and condition of equipment</li> <li>– welding technique</li> </ul> </li> <li>• select the appropriate shielding gas mixture based on:               <ul style="list-style-type: none"> <li>– mode of metal transfer</li> <li>– base metal type and thickness</li> <li>– joint design</li> <li>– filler material</li> <li>– desired weld quality</li> </ul> </li> <li>• describe how to select the type and size of filler metal</li> <li>• explain how to avoid contamination of filler materials</li> <li>• identify the relationship between:               <ul style="list-style-type: none"> <li>– wire speed and amperage</li> <li>– welding voltage and arc length</li> </ul> </li> <li>• describe the effects of:               <ul style="list-style-type: none"> <li>– backhand or pull welding</li> <li>– forehand or push welding</li> </ul> </li> <li>• describe the effects of torch angle on:               <ul style="list-style-type: none"> <li>– weld penetration</li> <li>– weld appearance</li> </ul> </li> </ul>	<p>Explain how the following affect weld quality:</p> <ul style="list-style-type: none"> <li>• voltage</li> <li>• amperage</li> <li>• polarity</li> <li>• electrode extension.</li> </ul> <p>Discuss the properties and uses of:</p> <ul style="list-style-type: none"> <li>• inert gases; e.g., argon, helium</li> <li>• reactive gases; e.g., carbon dioxide, oxygen, hydrogen, nitrogen</li> <li>• shielding gas mixes; e.g., argon-oxygen, argon-carbon dioxide, argon-helium, argon-helium-carbon dioxide, argon-carbon dioxide-hydrogen.</li> </ul> <p>Demonstrate backhand and forehand welding techniques.</p>

**COURSE FAB3170: GAS METAL ARC WELDING 2 (continued)**

Concept	Specific Outcomes	Notes
<p>Planning and Management</p> <ul style="list-style-type: none"> <li>• Equipment Set-up</li> <li>• Preparation</li> <li>• Equipment Maintenance/Repair</li> </ul>	<p><i>The student should:</i></p> <ul style="list-style-type: none"> <li>• apply safe work practices and procedures to:               <ul style="list-style-type: none"> <li>– select and use appropriate personal protective equipment</li> <li>– maintain a clean and tidy work station</li> <li>– demonstrate safe tool/material handling and storage techniques</li> </ul> </li> <li>• for a given type of weld and/or weldment, select the appropriate:               <ul style="list-style-type: none"> <li>– wire type, size and feed rate</li> <li>– current</li> <li>– shielding gas type and flow rate</li> </ul> </li> <li>• select the proper fit-up for a given weld</li> <li>• prepare and clean all surfaces to be welded</li> <li>• properly position metal for welding</li> <li>• perform maintenance required for wire drive systems and gun assemblies</li> <li>• diagnose and demonstrate corrective measures for malfunctioning GMAW equipment</li> </ul>	
<p>Implementation</p> <ul style="list-style-type: none"> <li>• Gas Metal Arc Welding</li> <li>• Troubleshooting</li> </ul>	<ul style="list-style-type: none"> <li>• demonstrate safe GMAW techniques and perform groove welds in the horizontal and vertical positions on mild steel plate</li> <li>• describe corrective actions that can be taken to avoid:               <ul style="list-style-type: none"> <li>– surface porosity</li> <li>– subsurface porosity</li> <li>– lack of fusion</li> <li>– burn through</li> <li>– lack of penetration</li> <li>– coldlapping</li> </ul> </li> <li>• identify problems common to out of position welding</li> </ul>	

**COURSE FAB3170: GAS METAL ARC WELDING 2** (continued)

Concept	Specific Outcomes	Notes
<p>Assessment</p> <ul style="list-style-type: none"> <li>• Quality Control</li>   <li>• Career Preparation</li> </ul>	<p><i>The student should:</i></p> <ul style="list-style-type: none"> <li>• complete a visual inspection (i.e., non-destructive test) by observing and assessing:               <ul style="list-style-type: none"> <li>– overall size, shape and appearance of beads</li> <li>– plate penetration</li> <li>– fusion</li> <li>– degree of undercutting and overlapping</li> </ul> </li> <li>• perform a destructive test where appropriate</li>   <li>• prepare a record of completed activities within a portfolio</li> <li>• explain employment and further training opportunities for GMAW</li> </ul>	



**COURSE FAB3048: FLUX CORE ARC WELDING 2****Level:** Advanced**Theme:** Fabrication Processes**Prerequisite:** FAB2048 Flux Core Arc Welding 1**Description:** Students develop skills to evaluate and improve the quality of flux core arc weldings, and they extend their flux core arc welding (FCAW) skills by performing horizontal and vertical groove welds.**Parameters:** Access to a fabrication work centre complete with flux core arc welding (FCAW) equipment and supplies, and to instruction from an individual with welding trade qualifications.**Curriculum and Assessment Standards**

General Outcomes	Assessment Criteria and Conditions	Suggested Emphasis
<p><i>The student will:</i></p> <ul style="list-style-type: none"> <li>identify variables that affect the quality of flux core arc welds, and identify strategies to evaluate and improve weld quality</li> </ul>	<p><i>Assessment of student achievement should be based on:</i></p> <ul style="list-style-type: none"> <li>assessment, based on trade standards, of a flux core arc weld; assessment to focus attention on: <ul style="list-style-type: none"> <li>variables affecting weld quality</li> <li>possible causes of observed defects</li> <li>corrective measures to improve weld quality</li> </ul> </li> </ul> <p><i>Assessment Tools</i>  <i>Fabrication Process: Fillet and Butt Welding on Mild Steel, FAB3048-1</i>  <i>Illustrative Examples:</i>  <i>Horizontal Single Vee Butt Joint Weld, FAB3048-3</i>  <i>Vertical Single Vee Butt Joint Weld, FAB3048-4</i></p> <p><i>Standard</i>  <i>Performance rating of 3 for each applicable task</i></p>	10
<ul style="list-style-type: none"> <li>perform safe set-up, maintenance and troubleshooting procedures with FCAW equipment</li> </ul>	<ul style="list-style-type: none"> <li>demonstration of safe start-up, shut-down, maintenance and troubleshooting procedures, using FCAW equipment</li> </ul> <p><i>Assessment Tools</i>  <i>Equipment Checklist: FCAW Set-up, Maintenance and Troubleshooting Procedures, FAB3048-2</i></p> <p><i>Standard</i>  <i>All procedures to be performed correctly</i></p>	10



**COURSE FAB3048: FLUX CORE ARC WELDING 2** (continued)

Concept	Specific Outcomes	Notes
<p>Orientation</p> <ul style="list-style-type: none"> <li>• Health and Safety</li> <li>• FCAW Variables</li> <li>• Gas Mixtures</li> <li>• Filler Metals</li> <li>• Arc Control</li> </ul>	<p><i>The student should:</i></p> <ul style="list-style-type: none"> <li>• describe safety issues related to:               <ul style="list-style-type: none"> <li>– the use of personal protective equipment</li> <li>– handling and storage of consumables</li> <li>– keeping the welding area free of hazards</li> <li>– insuring adequate ventilation</li> </ul> </li> <li>• describe a safety plan in case of accident</li> <li>• identify the variables that can directly affect weld quality; i.e.:               <ul style="list-style-type: none"> <li>– the welding current and voltage</li> <li>– type of shielding gas/flux</li> <li>– diameter and type of filler metal</li> <li>– type and condition of equipment</li> <li>– welding technique</li> </ul> </li> <li>• select the appropriate shielding gas mixture based on:               <ul style="list-style-type: none"> <li>– mode of metal transfer</li> <li>– base metal type and thickness</li> <li>– joint design</li> <li>– filler material</li> <li>– desired weld quality</li> </ul> </li> <li>• describe how to select the type and size of filler metal</li> <li>• explain how to avoid contamination of filler materials</li> <li>• identify the relationship between:               <ul style="list-style-type: none"> <li>– wire speed and amperage</li> <li>– welding voltage and arc length</li> </ul> </li> <li>• describe the effects of:               <ul style="list-style-type: none"> <li>– backhand or pull welding</li> <li>– forehand or push welding</li> </ul> </li> <li>• describe the effects of torch angle on:               <ul style="list-style-type: none"> <li>– weld penetration</li> <li>– weld appearance</li> </ul> </li> </ul>	<p>Explain how the following affect weld quality:</p> <ul style="list-style-type: none"> <li>• voltage</li> <li>• amperage</li> <li>• polarity</li> <li>• electrode extension.</li> </ul> <p>Discuss the properties and uses of:</p> <ul style="list-style-type: none"> <li>• inert gases; e.g., argon, helium</li> <li>• reactive gases; e.g., carbon dioxide, oxygen, hydrogen, nitrogen</li> <li>• shielding gas mixes; e.g., argon-oxygen, argon-carbon dioxide, argon-helium, argon-helium-carbon dioxide, argon-carbon dioxide-hydrogen.</li> </ul> <p>Describe the filler metal classification for typical flux-cored wire; e.g.:</p> <ul style="list-style-type: none"> <li>• E 480 1 T – 6 CH</li> <li>• E – XXT – XM JHZ.</li> </ul> <p>Demonstrate backhand and forehand welding techniques.</p>

**COURSE FAB3048: FLUX CORE ARC WELDING 2** (continued)

Concept	Specific Outcomes	Notes
<p>Planning and Management</p> <ul style="list-style-type: none"> <li>• Equipment Set-up</li> <li>• Preparation</li> <li>• Equipment Maintenance/Repair</li> </ul>	<p><i>The student should:</i></p> <ul style="list-style-type: none"> <li>• apply safe work practices and procedures to:               <ul style="list-style-type: none"> <li>– select and use appropriate personal protective equipment</li> <li>– maintain a clean and tidy work station</li> <li>– demonstrate safe tool/material handling and storage techniques</li> </ul> </li> <li>• for a given type of weld and/or weldment, select the appropriate:               <ul style="list-style-type: none"> <li>– wire type, size and feed rate</li> <li>– current</li> <li>– shielding gas type and flow rate</li> </ul> </li> <li>• select the proper fit-up for a given weld</li> <li>• prepare and clean all surfaces to be welded</li> <li>• properly position metal for welding</li> <li>• perform maintenance required for wire drive systems and gun assemblies</li> <li>• diagnose and demonstrate corrective measures for malfunctioning FCAW equipment</li> </ul>	
<p>Implementation</p> <ul style="list-style-type: none"> <li>• Flux Core Arc Welding</li> <li>• Troubleshooting</li> </ul>	<ul style="list-style-type: none"> <li>• demonstrate safe FCAW techniques and perform groove welds in the horizontal and vertical positions on mild steel plate</li> <li>• describe corrective actions that can be taken to avoid:               <ul style="list-style-type: none"> <li>– surface porosity</li> <li>– subsurface porosity</li> <li>– lack of fusion</li> <li>– burn through</li> <li>– lack of penetration</li> <li>– coldlapping</li> </ul> </li> <li>• identify problems common to out of position welding</li> </ul>	



