# GMACW Steel Fabrication Council – Academic Pathway for Fitters (recommended)

The GMACW Steel Fabrication Council has identified training for fitters as its most urgent workforce need. The following curriculum reflects recommendations made by the council as well as a review of the Fabricators and Manufacturers Association (FMA) Fundamentals of Metal Fabrication Certification, the SME code, and post-secondary programs in fabrication and materials joining. Based upon TPMA’s review of the GMACW partner schools’ welding programs, this curriculum builds upon courses at ASU Mid-South. It is our opinion that ASU Mid-South has the capacity to add this program with the least interruption to existing programs and with the most efficiency. Moore Tech also has the physical capacity (space and equipment) to offer this program although additional course analysis is required to provide a full map of existing and proposed courses. TCAT Memphis and Southwest Tennessee would need to add space and/or equipment in order to be viable hosts for fitter training, although each has individual courses that align with some of the courses below. The curriculum is mapped so that students earn stackable credentials each term. Specific AWS, API, and ASME codes have not been identified at this time; TPMA recommends that the council identify those codes that are most commonly used in the Greater Memphis region to be incorporated into the appropriate course learning outcomes.

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| **Year 1 – Fall** | **Year 1 – Spring** | **Year 2 – Fall** | **Year 2 - Spring** |
| BUSN 1201 Career Preparation | MATH 1104Applied Technical Math | ENGL 1113English Composition 1 | MACH 1063Inspection and Testing |
| TECH 1003 Intro to Blueprint Reading | WELD ### (New course)Materials Joining Fundamentals | MATH ### (New Course) Advanced Applied Math (Trigonometry) | WELD ### (New Course)Jig and Fixture Design for Fitters |
| TECH 1013Shop Essentials | WELD ###Materials Joining Lab | Weld ### | WELD ### (New Course)Advanced Fabrication Lab |
| TECH 1303 Industrial Safety | WELD ###Fitter Tools | Weld ### | WELD ### (New Course)Welding and Fabrication for the Steel Industry |
| Weld 1053Fundamentals of Welding | MACH 1023 Intro to Metallurgy  | Industry or Technical Elective | Internship |
| Weld 1113 or 1123 or 1133 or 1143 |  |  |  |
| Outcomes: * 16 Credits
* AWS D1.1 in one process
* Certificate of Proficiency in one welding process (FCAW, SMAW, GMAW, or GTAW)
 | Outcomes:* 16 Credits
* FMA Fundamentals of Metal Fabrication Certification
* Technical Certificate Steel Fabrication (Fitting) - NEW
 | Outcomes: * 16 credits
* Additional AWS Certifications (based on elective chosen)
 | Outcomes:* 15 credits
* 250 hours work experience
* AAS Fitters Concentration
* Additional API or ASME certifications (TBD)
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| Existing Course / Required for Welding Certificate | Existing Course / Required for AAS | Proposed Course – Responds to Fitter Committee recommendations and/or FMA Core Topics | Existing Course with alignment to council recommendations and/or FMA Core Topics |

# Course Descriptions

All course descriptions are from the ASU Mid-South Course Catalog unless otherwise indicated.

## Year 1 – Fall

**BUSN 1201: Career Preparation (1 credit)** This course provides information on career planning and decision-making, job search preparation, and professionalism skills for employees. Students will learn to explore and evaluate career options, write a professional resume, prepare for an interview, and communicate effectively with potential employers and co-workers.

**TECH 1003: Intro to Blueprint Reading (3 credit)** This course is designed to provide students with knowledge and skills needed to read and interpret drawings, symbols and systems schematics and to develop drawings and sketches of components, parts and pieces into usable, working prints. The student will develop drawings and sketches of repairs and alterations and learn to utilize blueprints, graphs and charts to obtain or provide needed information.

**TECH 1013: Shop Essentials (3 credits)** This course introduces the student to basic safety practices, fire safety, measurements through the use of Micrometer and tapes, conversion of metric and English measures, shop practices, common shop paper work and basic hand tools common to various industrial trades. Students must complete lab exercises where they demonstrate competency in identifying basic safety practices, fire classes, material and proper fire control methods. Students will perform and read measurements through the use of Micrometer and tapes and demonstrate a working knowledge of conversion tables of metric and English. In addition, they will be introduced to common shop practices, common shop paper work practices and identify and appropriately use basic hand tools through practical applications.

**TECH 1303: Industrial Safety (3 credits)** This course covers the rationale for industry safety, safety regulations, and key safety movements. Hazardous materials handling, lock out-tag out, as well as OSHA regulations are introduced. Students must successfully complete lab exercises to demonstrate practical applications in the topics in the course.

**WELD 1053: Fundamentals of Welding (3 credits)** This course introduces students to safety, application, technique, process essential variables, quality control, and inspection of common welding processes used in industry. The student will experience each welding process through instructor-led demonstrations and hands-on welding applications. Students who successfully complete this course will be able to make decisions regarding process selection and control common to non-essential welding personnel in an entry-level technical capacity.

**WELD 1113, 1123, 1133, and 1143 (3 credits each)** This course provides entry-level technical training to SENSE Level I/ NCCER Level II in the FCAW, GMAW, GTAW, or SMAW process. Students will receive instruction in process safety, equipment, filler metal selection, terminology, power sources, equipment and operational mechanics pertaining to wire feed processes.

## Year 1 – Spring

**MATH 1104 Applied Technical Mathematics (4 credits)** This course is a college-level mathematics course covering mathematical topics as they relate to technical skills and knowledge designed for AAS degrees. However, the course does not apply to transfer associate degrees or baccalaureate degrees unless specifically approved by the transfer institution. Specific emphasis is given to ratio and proportion, percentages, plan geometry, exponents, scientific notation, reading and constructing graphs, and solving quadratic equations in application problems.

**WELD ####: Materials Joining Fundamentals** **with lab** **(4 credits)** Fundamentals of materials joining theory, principles and application. Includes basics of interatomic and interfacial bonding, process characteristics and classification, arc physics and metal transfer, energy and power sources, heat flow, distortion and residual stress, joint design and weld symbols, inspection and quality, safety and health, economics and process selection.[[1]](#footnote-1)

**WELD ####: Fitter Tools (3 credits)** In this course, students will become familiar with the most common tools used by fitters and be able to demonstrate the appropriate use of those tools in a controlled environment. Students will use hand tools, learn how to operate a crane, learn proper rigging, and more.

**MACH 1023: Intro to Metallurgy (3 credits)** This course will prepare students to apply the three metal identification methods and explain what characteristics they exhibit about a metal; discuss three metal properties and observable attributes; and understand the mechanical testing methods used to measure the response of metals to mechanical forces.[[2]](#footnote-2)

## Year 1 – Summer

No courses required; however, if students need developmental courses prior to completing the required English course, they should take it during this term.

## Year 2 – Fall

**ENGL 1113: English Composition 1 (3 credits)** English Comp I gives attention to critical reading and thinking skills applicable to all college courses. The course stresses writing as a process and uses the essay as the vehicle while stressing invention, drafting, revising, and rewriting. This course utilizes computers and requires keyboarding skills of 20 wpm or better.

**MATH ###: Advanced Applied Math – Trigonometry (3 credits)** This course covers common trigonometric functions as they apply to the steel fabrication industry.

**WELD ###: Advanced Fitter Tools (4 credits)** This course provides students with an opportunity to use common fitter tools in a variety of environments.

**Industrial or Technical Elective (3 or 4 credits)** Students on the fitter pathway may choose any course from the industrial trades; we recommend that instructors/advisors and/or employers provide guidance regarding which courses will most benefit the student when seeking employment.

## Year 2 - Spring

**MACH 1063: Inspection & Testing** **(3 credits)** This course introduces the fundamental methods and instruments used to effectively inspect parts in the shop. Students will use the caliper, micrometer, and CMM to perform calibration and more advanced inspection methods. Students must demonstrate competency in core course objectives through practical applications.

**WELD ###: Jig and Fixture Design for Fitters (3 credits)** Focuses on the design and application of work-holding devices and clamping methods used in steel fabrication. Cutting theory, economic processes and continuous quality improvement principles are applied in the analysis of problems.[[3]](#footnote-3)

**WELD ###: Advanced Fabrication Lab (3 credits)** This course provides students on the fitter track ample opportunity to combine discreet skills (such as jig and fixture design, job planning, and basic welding processes) in a controlled environment. Students will practice manipulating and assembling structural steel, steel plates and pipes, etc. Students will gain practical experience with proper fitup techniques, precision measurement and tolerancing. [[4]](#footnote-4)

**WELD ###: Welding and Fabrication for the Steel Industry (3 credits)** This course provides instruction in metal working such as bending and shaping steel, including rolling, forming, etc. Students will learn to read and apply Weld Procedure Standards (WPS). Safety, Personal Protective Equipment (PPE), hand tools, and welding inspection will be included. Students will become familiar with the function(s), usage, and application(s) of the following equipment: Shears, Press Brakes, Water Jets, Punches, Lasers.[[5]](#footnote-5)

**Internship (3 credits)** Students will work with a local steel fabricator as a fitter helper for a total of 250 hours over 10-15 weeks. Interns will observe and assist in a variety of fabrication situations.[[6]](#footnote-6)

# Short-term Training

Developing a two-year associate’s degree program is a time- and labor-intensive process which requires curriculum approval at many levels (department, college, state, and accrediting body). This process can take up to two years from start to finish before any students can enroll.

In order to fill the gap and begin addressing the Steel Fabricators Council’s needs in the short-term, we also recommend developing a non-credit certificate program designed for incumbent workers. This type of program may be eligible for funding through the Workforce Innovation and Opportunity Act as Customized Job Training or similar program.

For participants to be successful in the short-term certificate program, they must come with the following core competencies (see fitter competency list below):

* Basic blueprint reading
* Basic welding
* Safety and quality practices
* Applied math

We recommend that the fitter committee work with the GMACW Education Partners to develop learning outcomes and activities in the following areas:

* Use of common fitter tools[[7]](#footnote-7)
* Crane operation and rigging
* Advanced blueprint reading
* Proper fitup, layout, and measurement techniques

The duration of this training will depend on the complexity and depth of the learning outcomes associated with the competencies above. However, best practices indicate that short-term training provide measurable skill gains in the shortest amount of time possible. For that reason, we recommend modularizing curriculum so that participants can complete portions of the training in 10 to 15 week chunks. As this training will most likely be offered to incumbent workers, a flexible schedule that allows for full-time workers to succeed is essential. One way to accommodate this is through a flipped classroom, in which students are required to complete their “book work” outside of class so that the instructor can focus on hands-on practice and instruction during class time. Another option is to provide open lab hours so that participants can take as much (or as little) time as they need to master certain skills.

Ideally, the modules developed for the short term training will also become the core courses required for the associate’s degree program or a fitter concentration in an existing degree program. This way, curriculum developed in the immediate future can be repurposed rather than reinvented.

In order to begin moving forward, the council has requested a one-day curriculum planning workshop be scheduled for January or February of 2017. At this time, instructors and subject matter experts will work together to review these recommendations, develop learning outcomes, and assign contact hours to each major topic.

# Fitter Competency List

The following competency list is based upon the Advanced Manufacturing Competency Model (<http://www.careeronestop.org/competencymodel/competency-models/advanced-manufacturing.aspx>) and the recommendations of the Steel Fabrication Council Fitter’s Committee. When a definition is not included below, please refer to the original competency model for definitions. (Note: Color Coding corresponds to Advanced Manufacturing Competency Model categories.)

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| Competency Model Category | Competency | Definition |
| Occupation Specific Requirements | Steel fabrication terminology | Understand the terminology and nomenclature used in metal fabrication, including processes and materials/tools related to joining, forming, and shaping steel. |
| Jig and fixture design | Demonstrate the ability to identify the need for and specifications of jigs and fixtures in a fabrication environment; design drawings and/or molds to use in creation of jigs and fixtures. |
| Advanced fabrication | Determine process and materials required; develop fabrication methodology; create and communicate welder and inspector requirements; operate or oversee operation of welders, machines, etc. |
| Industry-Sector Technical Competencies | Blueprint reading | Identify the three basic elements of a blueprint, section views, tolerances, dimensions; Interpret the blueprint for use in manufacturing processes. |
| Measurement/tolerance | Calculate dimensions or tolerances, using instruments such as micrometers or Vernier calipers. Demonstrate knowledge of the differences and similarities of semiprecision and precision measurement. |
| Use of measurement tools | Demonstrate ability to use calipers, rules, protractors, and other precision measurement tools within prescribed tolerances |
| Machine operation | Demonstrate safe set up and operation of machines (including mills, lathes, drill presses, and other common machines used in a fabrication setting); read work orders and drawings required |
| Press brake operation | Set up and operate Press Brake; read and follow work orders, drawings as required |
| Basic welding | Be familiar with common welding practices including SMAW, GMAW, FCAW, GTAW, and thermal cutting processes; read and interpret weld symbols and simple prints; use PPE and follow safety procedures when operating welding equipment |
| Industry-Wide Technical Competencies | Manufacturing Process Design and Development |  |
| Production |  |
| Maintenance, Installation, and Repair |  |
| Supply Chain Logistics |  |
| Quality Assurance / Continuous Improvement |  |
| Sustainable & Green Manufacturing |  |
| Health, Safety, Security & Environment |  |
| Workplace Competencies | Business Fundamentals |  |
| Teamwork |  |
| Adaptability / Flexibility |  |
| Marketing and Customer Focus |  |
| Planning and Organizing |  |
| Problem Solving and Decision Making |  |
| Working with Tools and Technology |  |
| Checking, Examining, and Recording |  |
| Sustainable Practices |  |
| Academic Competencies | Science |  |
| Basic Computer Skills |  |
| Mathematics | Know and apply mathematical principles: * Number Systems and Relationships - whole numbers, decimals, fractions, alternate base systems (e.g. binary, octal, and hexadecimal numbers)
* Arithmetic – arithmetic operations on numbers, percentages, square root, exponentiation, and logarithmic functionsPlane and Solid Geometry – distance, perimeter, area, and volume, spatial coordinates, visualization, spatial reasoning, and geometric modeling
* Measurement – measurement of length, mass, time, systems of measurement, units, and conversion between systems (e.g. from English to metric)
* Estimation -- estimate sizes, distances, and quantities; or determine time, costs, resources, or materials needed to perform a work activity
* Mathematical Notation - the language of mathematics to express mathematical ideas
* Mathematical Reasoning and Problem Solving – inductive and deductive reasoning, conjectures, arguments, strategies, and interpretation of results
* Elementary Statistics and Laws of Probability – mean, median, and standard deviation
* Algebra and Functions – equations, patterns, and functions

(From Competency Model Clearinghouse) |
| Reading |  |
| Writing |  |
| Communication - Listening and Speaking |  |
| Critical & Analytic Thinking |  |
| Information Literacy |  |
| Personal Effectiveness Competencies | Interpersonal Skills |  |
| Integrity |  |
| Professionalism |  |
| Initiative |  |
| Dependability and Reliability |  |
| Lifelong Learning |  |

1. Course description from: http://catalog.letu.edu/preview\_program.php?catoid=6&poid=1193 [↑](#footnote-ref-1)
2. Course is not listed in ASU Mid-South’s current course catalog but has been offered previously. Course description based on Core Topics for FMA Certification. [↑](#footnote-ref-2)
3. Adapted from http://www.triton.edu/collegecatalog/ent-260--jig-amp-fixture-design.htm [↑](#footnote-ref-3)
4. Course description based on Fitter Committee recommendations [↑](#footnote-ref-4)
5. Course description based on Fitter Committee recommendations and Core Topics for FMA Certification. [↑](#footnote-ref-5)
6. Course description based on Fitter Committee recommendations [↑](#footnote-ref-6)
7. Fitter committee is currently developing the full list of tools to include in this module. [↑](#footnote-ref-7)