

Title 7: Education K-12

Part 62: Metal Fabrication



2015 Metal Fabrication

Mississippi Department of Education

Program CIP: 48.0511 Metal Fabricator

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The Research and Curriculum Unit (RCU), located in Starkville, MS, as part of Mississippi State University, was established to foster educational enhancements and innovations. In keeping with the land grant mission of Mississippi State University, the RCU is dedicated to improving the quality of life for Mississippians. The RCU enhances intellectual and professional development of Mississippi students and educators while applying knowledge and educational research to the

lives of the people of the state. The RCU works within the contexts of curriculum development and revision, research, assessment, professional development, and industrial training.

Table of Contents

Acknowledgments	5
Standards	Error! Bookmark not defined.
Preface	7
Mississippi Teacher Professional Resources	Error! Bookmark not defined.
Executive Summary	8
Course Outlines	9
Research Synopsis	Error! Bookmark not defined.
Professional Organizations	Error! Bookmark not defined.
Using This Document	Error! Bookmark not defined.
Unit 1: Introduction and Orientation	Error! Bookmark not defined.
Unit 2: Basic Safety	Error! Bookmark not defined.
Unit 3: Introduction to Construction Math	Error! Bookmark not defined.
Unit 4: Hand and Power Tools	Error! Bookmark not defined.
Unit 5: Introduction to Construction Drawings	Error! Bookmark not defined.
Unit 6: Introduction to Materials Handling	Error! Bookmark not defined.
Unit 7: Lathe Theory and Operation	Error! Bookmark not defined.
Unit 8: Milling Machine Theory and Operation	Error! Bookmark not defined.
Unit 9: Drill Press and Band Saw Theory and Operation	Error! Bookmark not defined.
Unit 10: Introduction to Welding	Error! Bookmark not defined.
Unit 11: Orientation, Advanced Leadership, and Employability Skills	Error! Bookmark not defined.
defined.	
Unit 12: Basic Safety (Review and Reinforcement)	Error! Bookmark not defined.
Unit 13: Advanced Lathe Operation	Error! Bookmark not defined.
Unit 14: Advanced Milling Operation	Error! Bookmark not defined.
Unit 15: Introduction to Shielded Metal Arc Welding (SMAW) ..	Error! Bookmark not defined.
Unit 16: Shielded Metal Arc Welding (SMAW)	Error! Bookmark not defined.
Unit 17: Gas Metal Arc Welding (GMAW) and Flux Core Arc Welding (FCAW)	Error!
Bookmark not defined.	
Unit 18: Introduction to Gas Tungsten Arc Welding (GTAW)	Error! Bookmark not defined.
Unit 19: Basic Oxy-fuel and Plasma Arc Cutting (PAC)	Error! Bookmark not defined.
Unit 20: Grinding Theory and Operation	Error! Bookmark not defined.
Unit 21: Computerized Numerical Control	Error! Bookmark not defined.
Student Competency Profile	Error! Bookmark not defined.
Appendix A: Unit References	Error! Bookmark not defined.
Appendix B: Industry Standards	Error! Bookmark not defined.
Appendix C: 21st Century Skills	Error! Bookmark not defined.
Appendix D: Common Core Standards	Error! Bookmark not defined.

[Appendix E: International Society for Technology in Education Standards \(ISTE\)](#)..... **Error!**
Bookmark not defined.

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Dr. John R. Kelly, Chair
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Mrs. Kami Bumgarner
Mr. William Harold Jones
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Mr. Danny J. Spreitler
Mr. Johnny Franklin

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Jo Ann Watts, Instructional Design Specialist for the Research and Curriculum Unit at Mississippi State University researched and authored this framework. jo.watts@rcu.msstate.edu

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Betsey Smith, Associate Director for the Research and Curriculum Unit at Mississippi State University

Scott Kolle, Project Manager for the Research and Curriculum Unit at Mississippi State University

Jolanda Young, Educational Technologist for the Research and Curriculum Unit at Mississippi State University

Preface

Secondary career and technical education programs in Mississippi face many challenges resulting from sweeping educational reforms at the national and state levels. Schools and teachers are increasingly being held accountable for providing true learning activities to every student in the classroom. This accountability is measured through increased requirements for mastery and attainment of competency as documented through both formative and summative assessments.

The courses in this document reflect the statutory requirements as found in Section 37-3-49, *Mississippi Code of 1972*, as amended (Section 37-3-46). In addition, this curriculum reflects guidelines imposed by federal and state mandates (Laws, 1988, Ch. 487, §14; Laws, 1991, Ch. 423, §1; Laws, 1992, Ch. 519, §4 eff. from and after July 1, 1992; Carl D. Perkins Vocational Education Act IV, 2007; and No Child Left Behind Act of 2001).

Executive Summary

Pathway Description

The Metal Fabrication pathway is designed as a secondary program for preparation to enter the field of metalworking. The Metal Fabrication program includes an introduction to the basic machining metalworking processes as well as an introduction to the basic welding profession. The purpose of the course is to prepare students to continue study in a postsecondary metals program (Welding or Machine Tool Operation) or to begin work at the entry level in a metal occupation. The machining units in this curriculum are written to the National Institute for Metalworking Skills (NIMS) credentialing standards, and the welding units are written to the National Center for Construction Education and Research (NCCER) certification standards.

Industry Certification

NIMS – Level I

NCCER Learning Series – Welding Standards Level 1

Assessment

The latest assessment blueprint for the curriculum can be found at <http://www.rcu.msstate.edu/Curriculum/CurriculumDownload.aspx>

Student Prerequisites

In order for students to experience success in the program, the following student prerequisites are suggested:

1. C or higher in English (the previous year)
2. C or higher in Math (last course taken or the instructor can specify the math)
3. Instructor Approval and TABE Reading Score (eighth grade or higher)

or

1. TABE Reading Score (eighth grade or higher)
2. Instructor Approval

or

1. Instructor Approval

Teacher Licensure

The latest teacher licensure information can be found at <http://www.mde.k12.ms.us/educator-licensure>

Professional Learning

If you have specific questions about the content of any of training sessions provided, please contact the Research and Curriculum Unit at 662.325.2510

Option 1—Four One-Carnegie-Unit Courses

This curriculum consists of four one-credit courses, which should be completed in the following sequence:

- 1. Fundamentals of Metal Fabrication - Course Code: 993208**
- 2. Application of Metal Fabrication - Course Code: 993209**
- 3. Theory of Metal Fabrication - Course Code: 993210**
- 4. Advanced Skills of Metal Fabrication - Course Code: 993211**

Course Description: Fundamentals of Metal Fabrication

Fundamentals of Metal Fabrication includes an introduction to the field as well as fundamentals of safety, tools, math, blueprint reading, and milling machinery. This is a one-Carnegie-unit course.

Course Description: Application of Metal Fabrication

Application of Metal Fabrication emphasizes an overview of safety and leadership, the lathe theory, and grinding operations. This course gives students real-world, hands-on practice in these areas. This one-Carnegie-unit course should only be taken after students successfully pass Fundamentals of Metal Fabrication.

Course Description: Theory of Metal Fabrication

Theory of Metal Fabrication includes a study of precision machining techniques. This course also reinforces safety related to the manufacturing industry. This one-Carnegie-unit course should only be taken after students successfully pass Application of Metal Fabrication.

Course Description: Advanced Skills of Metal Fabrication

Advanced Skills of Metal Fabrication includes a study of basic oxy-fuel cutting, plasma arc cutting, gas metal arc, flux core arc, and introduction to gas tungsten arc and shielded metal arc welding. This course also reinforces safety related to the manufacturing industry. This one-Carnegie-unit course should only be taken after students successfully pass Theory of Metal Fabrication.

Fundamentals of Metal Fabrication - Course Code: 993208

Unit	Unit Name	Hours
1	Introduction and Orientation	15
2	Basic Safety	24
3	Introduction to Construction Math	29
4	Hand and Power Tools	24
5	Introduction to Construction Drawings	24
6	Introduction to Materials Handling	24
Total		140

Application of Metal Fabrication - Course Code: 993209

Unit	Unit Name	Hours
7	Lathe Theory and Operation	60
8	Milling Machine Theory and Operation	30
9	Drill Press and Band Saw Theory and Operation	20
10	Introduction to Welding	30
Total		140

Theory of Metal Fabrication - Course Code: 993210

Unit	Unit Name	Hours
11	Orientation, Advanced Leadership, and Employability Skills	10
12	Basic Safety (Review and Reinforcement)	10
13	Advanced Lathe Operation	60
14	Advanced Milling Operation	40
15	Introduction to Shielded Metal Arc Welding (SMAW)	20
Total		140

Advanced Skills of Metal Fabrication - Course Code: 993211

Unit	Unit Name	Hours
16	Shielded Metal Arc Welding (SMAW)	30
17	Gas Metal Arc Welding (GMAW) and Flux Core Arc Welding (FCAW)	35
18	Introduction to Gas Tungsten Arc Welding (GTAW)	20
19	Basic Oxy-fuel Cutting and Plasma Arc Cutting (PAC)	20
20	Grinding Theory and Operation	25
21	Computerized Numerical Control	10
Total		140

Option 2—Two Two-Carnegie-Unit Courses

This curriculum consists of two two-credit courses, which should be completed in the following sequence:

1. **Metal Fabrication I - Course Code: 993206**
2. **Metal Fabrication II - Course Code: 993207**

Course Description: Metal Fabrication I

Metal Fabrication I content includes orientation and leadership, basic safety, math, measuring tools, and instruments, blueprints, hand and power tools, lathe theory and operation, milling machine theory and operation, drill press and band saw, and introduction to welding. Safety is emphasized in each unit and every activity.

Course Description: Metal Fabrication II

Metal Fabrication II includes grinding theory and operations, advanced precision machining techniques and an emphasis on welding processes. Welding topics include employability skills, safety, basic oxy-fuel cutting, plasma arc cutting (PAC), gas metal arc welding (GMAW), flux core arc welding (FCAW), gas tungsten arc welding (GTAW), and shielded metal arc welding (SMAW). The course should be taken after the student has successfully passed Fabrication I.

Metal Fabrication I - Course Code: 993206

Unit	Unit Name	Hours
1	Introduction and Orientation	15
2	Basic Safety	24
3	Introduction to Construction Math	29
4	Hand and Power Tools	24
5	Introduction to Construction Drawings	24
6	Introduction to Materials Handling	24
7	Lathe Theory and Operation	60
8	Milling Machine Theory and Operation	30
9	Drill Press and Band Saw Theory and Operation	20
10	Introduction to Welding	30
Total		280

Metal Fabrication II - Course Code: 993207

Unit Number	Unit Name	Hours
11	Orientation, Advanced Leadership, and Employability Skills	10
12	Basic Safety (Review and Reinforcement)	10
13	Advanced Lathe Operation	60
14	Advanced Milling Operation	40
15	Introduction to Shielded Metal Arc Welding (SMAW)	20
16	Shielded Metal Arc Welding (SMAW)	30

17	Gas Metal Arc Welding (GMAW) and Flux Core Arc Welding (FCAW)	35
18	Introduction to Gas Tungsten Arc Welding (GTAW)	20
19	Basic Oxy-fuel Cutting and Plasma Arc Cutting (PAC)	20
20	Grinding Theory and Operation	25
21	Computerized Numerical Control	10
Total		280

Metal Fabrication

Program CIP: 48.0503

Ordering Information

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Mississippi State University
Mississippi State, MS 39762

The Research and Curriculum Unit (RCU), located in Starkville, MS, as part of Mississippi State University, was established to foster educational enhancements and innovations. In keeping with the land grant mission of Mississippi State University, the RCU is dedicated to improving the quality of life for Mississippians. The RCU enhances intellectual and professional development of Mississippi students and educators, while applying knowledge and educational research to the lives of the people of the state. The RCU works within the contexts of curriculum development and revision, research, assessment, professional development, and industrial training.

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Table of Contents

Acknowledgments	17
Preface	20
Executive Summary	21
Blueprint	Error! Bookmark not defined.
Research Synopsis	Error! Bookmark not defined.
Using This Document	Error! Bookmark not defined.
Metal Fabrication	Error! Bookmark not defined.
Unit 1: Orientation, Leadership, and Basic Safety	Error! Bookmark not defined.
Unit 2: Math, Measuring Tools, and Instruments	Error! Bookmark not defined.
Unit 3: Introduction to Blueprints and Hand and Power Tools	Error! Bookmark not defined.
Unit 4: Drill Press and Band Saw Theory and Operation	Error! Bookmark not defined.
Unit 5: Milling Machine Theory and Operation	Error! Bookmark not defined.
Unit 6: Lathe Theory and Operation	Error! Bookmark not defined.
Unit 7: Grinding Theory and Operation	Error! Bookmark not defined.
Unit 8: Orientation, Advanced Leadership, and Employability Skills	Error! Bookmark not defined.
Unit 9: Basic Safety (Review and Reinforcement)	Error! Bookmark not defined.
Unit 10: Advanced Lathe Operation	Error! Bookmark not defined.
Unit 11: Advanced Milling Operation	Error! Bookmark not defined.
Unit 12: Power Machinery – Computerized Numerical Control	Error! Bookmark not defined.
Unit 13: Gas Welding/Cutting Processes – Basic Oxy-fuel and Plasma Arc Cutting (PAC)	Error!
Bookmark not defined.	
Unit 14: Gas Welding/Cutting Processes – Shielded Metal Arc Welding (SMAW)	Error! Bookmark not defined.
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Unit 15: Gas Welding/Cutting Processes – Gas Metal Arc Welding (GMAW) and Flux Core Arc Welding (FCAW)	Error! Bookmark not defined.

[Unit 16: Gas Welding/Cutting Processes — Introduction to Gas Tungsten Arc Welding \(GTAW\)](#) **Error!**
Bookmark not defined.

[Student Competency Profile for Metal Fabrication](#)..... **Error! Bookmark not defined.**

[Recommended Tools and Equipment](#)..... **Error! Bookmark not defined.**

[Appendix A: 21st Century Skills Standards](#) **Error! Bookmark not defined.**

[Appendix B: Mississippi Academic Standards](#)..... **Error! Bookmark not defined.**

[Appendix C: ACT College Readiness Standards](#)..... **Error! Bookmark not defined.**

[Appendix D: National Industry Standards](#)..... **Error! Bookmark not defined.**

[Appendix E: National Educational Technology Standards for Students](#) **Error! Bookmark not defined.**

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The Metal Fabrication (originally referred to as Manufacturing) curriculum was presented to the Mississippi Board of Education on March 2011. The following persons were serving on the state board at the time:

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Mr. William Harold Jones
Ms. Kami Bumgarner
Mr. Howell “Hal” N. Gage
Mr. Claude Hartley
Dr. Sue Matheson
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Gary Bambauer, Mississippi Construction Education Foundation
Mike Barkett, Mississippi Construction Education Foundation
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Dale Box, Greene County Career Technical Center
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Andy Sims, Program Coordinator, Office of Vocational Education and Workforce Development, Mississippi Department of Education, Jackson, MS

Finally, standards in the *Metal Fabrication Curriculum Framework and Supporting Materials* are based on the following:

National Institute for Metalworking Skills, Inc.

The NIMS is the nation's only ANSI-accredited developer of precision manufacturing skills standards and competency assessments. NIMS certify individual skills against standards and accredit programs that meet its quality requirements. Reprinted with permission from NIMS, Copyright © 2008, National Institute for Metalworking Skills, Inc., (703) 352-4971, <http://www.nims-skills.org/home/index.htm>

Contren Learning Series from the National Center for Construction Education and Research

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Applied Academic Credit Benchmarks

Mississippi Department of Education 2007 Mississippi Mathematics Framework Revised

21st Century Skills and Information and Communication Technologies Literacy Standards

In defining 21st century learning, the Partnership for 21st Century Skills has embraced five content and skill areas that represent the essential knowledge for the 21st century: global awareness; civic engagement; financial, economic, and business literacy; learning skills that encompass problem-solving, critical-thinking, and self-directional skills; and Information and Communication Technology (ICT) literacy.

National Educational Technology Standards for Students

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ACT College Readiness Standards



The College Readiness Standards are sets of statements intended to help students understand what is expected of them in preparation for the ACT. These standards are integrated into teaching and assessment strategies throughout the curriculum framework.

Preface

~~Secondary vocational–technical education programs in Mississippi are faced with many challenges resulting from sweeping educational reforms at the national and state levels. Schools and teachers are increasingly being held accountable for providing true learning activities to every student in the classroom. This accountability is measured through increased requirements for mastery and attainment of competency as documented through both formative and summative assessments.~~

~~The courses in this document reflect the statutory requirements as found in Section 37-3-49, Mississippi Code of 1972, as amended (Section 37-3-46). In addition, this curriculum reflects guidelines imposed by federal and state mandates (Laws, 1988, ch. 487, §14; Laws, 1991, ch. 423, §1; Laws, 1992, ch. 519, §4 eff. from and after July 1, 1992; Carl D. Perkins Vocational Education Act IV, 2007; and No Child Left Behind Act of 2001).~~

Metal Fabrication Executive Summary

Program Description

The Metal Fabrication pathway is designed as a secondary program for preparation to enter the field of metalworking. The Metal Fabrication program includes an introduction to the basic machining metalworking processes as well as an introduction to the basic welding profession. The purpose of the course is to prepare students to continue study in a postsecondary metals program (Welding or Machine Tool Operation) or to begin work at the entry level in a metal occupation. The machining courses in this curriculum is written to the National Institute for Metalworking Skills (NIMS) credentialing standards and the welding courses are written to the National Center for Construction Education and Research (NCCER) certification standards.

Industry Certification

The NIMS is a nationally recognized nonprofit organization that was established in 1995 to help develop industry standards to maintain the United States' global competitiveness. NIMS sets industry standards and certifies individuals who meet the quality requirements contained in the industry standards. NIMS also accredit training programs and facilities that meet NIMS quality requirements. The NIMS organization and standards are accredited by the American National Standards Institute (ANSI) in the metalworking field.

NIMS metalworking standards reflect expertise in areas such as stamping, press brake, roll forming, machining, tool and die making, mold making, screw machining, and machine maintenance and repair. All NIMS standards are industry written and industry validated and subjected to regular, periodic reviews under the procedures accredited and audited by ANSI.

The NIMS Level 1 credential consists of bench work, layout, milling, drill press, surface grinding, and lathing between centers. The students are required to perform a NIMS approved project in each area in order to attain credentialing in those areas. The student must be able to complete the NIMS project with 100% accuracy before being allowed to take an additional online written test. Once both the performance evaluation and the online test are administered and passed, the student will receive a NIMS certification for each area successfully completed, i.e. bench work, layout, milling, drill press, surface grinding, and lathing between centers. The NIMS organization awards credentials for each area of competency in the Level 1 module after successful completion of projects and written tests.

NIMS credentials are used throughout the United States by industry to recruit, hire, place, and promote individual workers. NIMS may also be used to measure performance of individuals pursuing metalworking careers. Articulation may be established using the NIMS credentials for articulation among training programs.

Students who study basic machine metalworking processes may pursue, at their cost, a certification with the National Institute for Metalworking Skills, Inc. (NIMS). Students who study this curriculum may pursue certification of the NIMS Level 1 standards for machining. Attaining this certification is an option for the student; therefore, the student is responsible for the financial costs attributed with achievement of the certification.

This curriculum has also been aligned to modules in the Contren program as endorsed by the National Center for Construction Education and Research (NCCER). Students who study this curriculum using the CONTREN materials under the supervision of an instructor who has been certified by the NCCER are eligible to be tested on each module in the welding area. Students who successfully pass these tests may be certified to the NCCER by the instructor and will receive documentation from NCCER. The Manufacturing welding curriculum framework is aligned to the NCCER Core and Welding.

Articulation

This program was designed to articulate to postsecondary Automotive Machinist Tech and postsecondary Machine Tool Operations.

High School Program	Community College Program	Community College Course
Metal Fabrication	Automotive Machinist Tech	MST 1114—Power Machinery I
	Machine Tool Operations	AUV 1116—Fundamentals for Automotive Machinists

Assessment

Students will be assessed using the Metal Fabrication MS CPAS2 test. The MS CPAS2 blueprint can be found at <http://info.rcu.msstate.edu/services/curriculum.asp>. If there are questions regarding assessment of this program, please contact the Manufacturing Cluster Instructional Design Specialists at the Research and Curriculum Unit at 662.325.2510.

Student Prerequisites

In order for students to be successful in the Metal Fabrication program, the following student prerequisites are in place:

1. C or Higher in English (the previous year)
 2. C or Higher in Math
 3. Instructor Approval and TABE Reading Score (eighth grade or higher)
- OR
4. Instructor Approval

Proposed Applied Academic Credit

The mathematics content in the Metal Fabrication program is meaningful and useful to students who are entering the manufacturing industry. Applied mathematics content was aligned to the 2007 Mississippi Mathematics Framework Revised Academic Benchmarks. It is proposed that upon the completion of this program, students will earn 1/2 Applied Mathematics Credit that can be used for graduation requirements.

The applied academic credit has not been approved by the Mississippi Commission on School Accreditation or by the State Board of Education. If there are questions regarding applied academic credit, please contact the Coordinator of Workforce Education at the Research and Curriculum Unit at 662.325.2510.

Licensure Requirements

The 976 licensure endorsement is needed to teach the Metal Fabrication program. The requirements for the 976 licensure endorsement are listed below:

1. Applicant must hold a 2-year college degree (associate's degree) or higher from an accredited institution of higher education*.
2. Applicant with an associate's degree must have at least 2 years of verifiable occupational experience in the past 10 years. Experience must be appropriate to the subject to be taught.
Applicant with a bachelor's or higher degree must have at least 1 year of verifiable occupational experience in the past 10 years. Experience must be appropriate to the subject to be taught.
3. Applicant must enroll immediately in the Vocational Instructor Preparation (VIP) or the Redesign Education Program (REP).
4. Applicant must complete the individualized professional development plan (PDP) requirements of the VIP or REP prior to the expiration date of the 3-year vocational license.
5. Applicant must successfully complete the Certificate of Special Merit from the National Institution for Metalworking Skills (NIMS).
6. Applicant must successfully complete the Contren Instructor Certification Training Program (ICTP).
7. Applicant must successfully complete an MDE-approved computer literacy certification exam.
8. Applicant must successfully complete certification for an online learning workshop, module, or course that is approved by the MDE.
9. Applicant must successfully complete the manufacturing certification workshop, module, or course that is approved by the MDE.

Note: ~~If the applicant meets all requirements listed above, that applicant will be issued a 976 endorsement—a 5-year license. If the applicant does not meet all requirements, the applicant will be issued a 3-year endorsement (license), and all requirements stated above must be satisfied prior to the ending date of that license.~~

*Exception: ~~Teachers with a currently valid license and endorsement #359 Machine Shop or #361 Metal Trades may earn this endorsement based on that #359 or #361 endorsement even if a 2-year college degree is not earned. All other requirements for this endorsement must be satisfied.~~

Professional Learning

~~The Professional Learning itinerary for the middle school or individual pathways can be found at <http://redesign.rcu.msstate.edu>. If you have specific questions about the content of each training session provided, you will need to contact the Research and Curriculum Unit at 662.325.2510 and ask for the Professional Learning Specialist.~~

Course Outlines

This curriculum framework allows options for local school districts to meet students' needs and scheduling demands. A discussion of each option is listed in the following material.

Option 1

Upon completion of this option, the student will be trained to take the **NIMS Level 1 Certification and Contren Welding Module certification** exams. This curriculum consists of four one-credit courses, which should be completed in the following sequence:

1. Manufacturing Machining I (Course Code: 993202)
2. Manufacturing Machining II (Course Code: 993203)
3. Metal Fabrication I (Course Code: 993204)
4. Metal Fabrication II (Course Code: 993205)

Course Description: Manufacturing Machining I (Course Code: 993202) includes an introduction to the field as well as fundamentals of safety, tools, math, blueprint reading, and milling machinery. This is a one-Carnegie-unit course.

Course Description: Manufacturing Machining II (Course Code: 993203) emphasizes an overview of safety and leadership, the lathe theory, and grinding operations. This course gives student's real-world, hands-on practice in these areas. This one-Carnegie-unit course should only be taken after students successfully pass Metal Fabrication I.

Course Description: Metal Fabrication I (Course Code: 993204) includes a study of precision machining techniques. This course also reinforces safety related to the construction industry. This one-Carnegie-unit course should only be taken after students successfully pass Metal Fabrication II.

Course Description: Metal Fabrication II (Course Code: 993205) includes a study of basic oxy-fuel cutting, plasma arc cutting, gas metal arc, flux core arc, and introduction to gas tungsten arc and shielded metal arc welding. This course also reinforces safety related to the construction industry. This one-Carnegie-unit course should only be taken after students successfully pass Metal Fabrication III.

Option 1

Manufacturing Machining I (Course Code: 993202)

Unit	Title	Hours
1	Orientation, Leadership, and Basic Safety	15
2	Math, Measuring Tools, and Instruments	20
3	Introduction to Blueprints and Hand and Power Tools	25
4	Drill Press and Band Saw Theory and Operation	20
5	Milling Machine Theory and Operation	30
		110

Manufacturing Machining II (Course Code: 993203)

Unit	Title	Hours
8	Orientation, Advanced Leadership, and Employability Skills	5
9	Basic Safety (Review and Reinforcement)	5
4	Drill Press and Band Saw Theory and Operation	75
6	Lathe Theory and Operation	25
		110

Metal Fabrication I (Course Code: 993204)

Unit	Title	Hours
7	Grinding Theory and Operation	5
8	Orientation, Advanced Leadership, and Employability Skills	5
10	Advanced Lathe Operation	55
11	Advanced Milling Operation	35
12	Power Machinery – Computerized Numerical Control	10
		110

Metal Fabrication II (Course Code: 993205)

Unit	Title	Hours
7	Grinding Theory and Operation	5
8	Orientation, Advanced Leadership, and Employability Skills	5
13	Gas Welding/Cutting Processes – Basic Oxy-fuel Cutting and Plasma Arc Cutting (PAC)	15
14	Gas Welding/Cutting Processes – Shielded Metal Arc Welding (SMAW)	45

15	Gas Welding/Cutting Processes – Gas Metal Arc Welding (GMAW) and Flux Core Arc Welding (FCAW)	25
16	Gas Welding/Cutting Processes – Introduction to Gas Tungsten Arc Welding (GTAW)	15
		110

Option 2

This curriculum consists of two two Carnegie unit courses.

Course Description: Manufacturing Fundamentals I content includes orientation and leadership; basic safety; math, measuring tools, and instruments; blueprints; hand and power tools; lathe theory and operation; milling machine theory and operation; and grinding operations. Safety is emphasized in each unit and every activity.

Course Description: Metal Fabrication includes advanced precision machining techniques and an emphasis on welding processes. Welding topics include employability skills, safety, basic oxy-fuel cutting, plasma arc cutting (PAC), gas metal arc welding (GMAW), flux core arc welding (FCAW), gas tungsten arc welding (GTAW), and shielded metal arc welding (SMAW). The course should be taken after the student has successfully passed Metal Fabrication I.

- Scheduling and operating more than one course in the same classroom/laboratory with the same teacher is not allowed.
- Safety will be reinforced and tested at the beginning of each course.
- Students must complete Metal Fabrication courses with a score of 80/C or higher in class work to advance to the next level.

Option 2

Manufacturing Fundamentals (Course Code: 993200)

Unit	Title	Hours
1	Orientation, Leadership, and Basic Safety	25
2	Math, Measuring Tools, and Instruments	20
3	Introduction to Blueprints and Hand and Power Tools	25
4	Drill Press and Band Saw Theory and Operation	20
5	Milling Machine Theory and Operation	30
6	Lathe Theory and Operation	75
7	Grinding Theory and Operation	25
		220

Metal Fabrication (Course Code: 993201)

Unit	Title	Hours
8	Orientation, Advanced Leadership, and Employability Skills	10
9	Basic Safety (Review and Reinforcement)	10
10	Advanced Lathe Operation	55
11	Advanced Milling Operation	35
12	Power Machinery – Computerized Numerical Control	10
13	Gas Welding/Cutting Processes – Basic Oxy-fuel Cutting and Plasma Arc Cutting (PAC)	15
14	Gas Welding/Cutting Processes – Shielded Metal Arc Welding (SMAW)	45
15	Gas Welding/Cutting Processes – Gas Metal Arc Welding (GMAW) and Flux Core Arc Welding (FCAW)	25
16	Gas Welding/Cutting Processes – Introduction to Gas Tungsten Arc Welding (GTAW)	15
		220