2010 Mississippi Curriculum Framework

Postsecondary Precision Manufacturing and Machining Technology

(Program CIP: 48.0501 – Machine Shop Technology/Assistant)

Direct inquiries to

Shawn Mackey, EdD
Director for Career and Technical Education
State Board for Community and Junior Colleges
3825 Ridgewood Road
Jackson, MS 39211
(601) 432-6518
smackey@sbcjc.cc.ms.us

Doug Ferguson
Instructional Design Specialist
Research and Curriculum Unit
P.O. Drawer DX
Mississippi State
, MS 39762
(662) 325-2510
doug.ferguson@rcu.msstate.edu

Additional copies

Research and Curriculum Unit for Workforce Development
Vocational and Technical Education
Attention: Reference Room and Media Center Coordinator
P.O. Drawer DX
Mississippi State, MS 39762
https://cia.rcu.msstate.edu/curriculum/download.asp
(662) 325-2510

Published by

Office of Vocational Education and Workforce Development
Mississippi Department of Education
Jackson, MS 39205

Research and Curriculum Unit for Workforce Development
Vocational and Technical Education
Mississippi State University
Mississippi State, MS 39762

359, Jackson, Mississippi 39201, (601) 359-3511.

Acknowledgments

Writing Team

Kenny Adams, Pearl River Community College
Craig Baker, Holmes- Grenada
John M. Cockrell, Hinds Community College–Raymond
Danny C. Gressett, East Central Community College
Jerry Hamm, Jones County Jr. College
Howard Johnson, Co-Lin Wesson
Steve Malone, East Mississippi CC – Mayhew
Willy Showah, Mississippi Gulf Coast CC, Jackson County Campus
Brian Warren, Meridian Community College

RCU Staff

Jo Ann Watts – Instructional Design Specialist
Robin Parker, EdD – Workforce Education Coordinator
Ashleigh Barbee Murdock – Editor

Professional Curriculum Advisory Team

C. B. Holder, Hol-Mac Corporation, Bay Springs, MS
Donal Holliman, Hattiesburg, MS
Barry Howse, Howse Implement Company, Laurel, MS
Denny Johnson, A. P. Fatheree Vocational Center, Laurel, MS
Charles Logan, Delphi, Laurel, MS
Daryl L. Maskew, Georgia Pacific, New Augusta, MS
Gene Mulloy, Laurel Machine & Foundry, Laurel, MS
Randy Powe, Ellisville, MS

Standards in this document are based on information from the following organizations:

Standards for National Institute for Metalworking Skills

Reproduced with permission of the National Institute for Metalworking Skills, copyright © 2001, NIMS (National Institute for Metalworking Skills), 3251 Old Lee Highway, Suite 205, Fairfax, VA 22030, www.nims-skills.org. Permission does not constitute an endorsement by NIMS.

Related Academic Standards

CTB/McGraw-Hill LLC. (1994). *Tests of adult basic education, forms 7 and 8.* Monterey, CA: Author. Reproduced with permission of CTB/McGraw-Hill LLC. TABE is a registered trademark of The McGraw-Hill Companies, Inc. Copyright © 1994 by CTB/McGraw-Hill LLC. Reproduction of this material is permitted for educational purposes only.

21st Century Skills

Reproduced with permission of the Partnership for 21st

Century Skills. Further information may be found at www.21stcenturyskills.org.

Preface

Precision Manufacturing and Machining Technology Research Synopsis

Articles, books, Web sites, and other materials listed at the end of each course were considered during the revision process. Machining and CNC Technology, Machine Tool Practices, College Mathematics, Blueprint Reading for the Machine Trades, CNC Programming: Principles and Applications, and Engineering Materials: Properties and Selection were especially useful in providing insight into trends and issues in the field. These references are suggested for use by instructors and students during the study of the topics outlined.

Industry advisory team members from colleges throughout the state were asked to give input related to changes to be made to the curriculum framework. Specific comments related to soft skills needed in this program included eagerness to learn, initiative, team centered, punctual, positive attitude, flexibility, adaptability, tolerant of cultural differences, personal appearance, attendance, creativity, and drive. Occupational-specific skills stated included Programming CNC equipment, blueprint reading, precision measurement, diesel engine operation, quality focused, computer skills, math calculations and formulas for different operations, reading a tape measure, and welding. Safety practices emphasized included electrical hazards, personal protection equipment, guards, pinch points, standard OSHA safety practices, MSDS sheets, equipment safety, lock/out tag/out, first responder, ergonomics, and housekeeping.

Instructors from colleges throughout the state were also asked to give input on changes to be made to the curriculum framework. Specific comments related to this program included statements from Advisory Committee members. Some say we need more CNC equipment and instruction while others think we need to stay with the fundamentals on manual machines. This is more costly to the program but is what students will see when they enter industry. While reviewing the curricula and the NIMS sample test and certifications, the committee recommended that the four Power Machinery courses be broken up into smaller courses and renamed to meet direct course objectives. The courses are basically prerequisites of each other and pose schedule problems with a timely certification testing through NIMS. Changes suggested for the curriculum included Power Machinery I, II, III, IV, and they should be reworked into smaller more manageable courses to help with scheduling. There is a need for a "Geometric Tolerance" and a "Special Problems in Master Cam" to aid in meeting some of the NIMS objectives for our students.

Curriculum

The following national standards were referenced in each course of the curriculum:

- CTB/McGraw-Hill LLC *Tests of Adult Basic Education, forms 7 and 8* Academic Standards *21st Century Skills*
- *National Institute for Metalworking Skills*

Industry and instructor comments, along with current research, were considered by the curriculum revision team during the revision process, and changes were made as needed and appropriate. Many of the skills and topics noted in the research were already included in the

curriculum framework. Specific changes made to the curriculum at the March 5–6, 2009 curriculum revision meeting included the following:

- Competencies and objectives were reviewed to ensure accuracy and appropriateness.
- The name was changed from Machine Tool Technology to Precision Manufacturing and Machining Technology.
- A Modular option was added. Courses in the Modular Option may be taken in lieu of the Power Machinery I–IV courses.
- Fundamental of Geometric Tolerancing and Fundamentals of CAD/CAM were added as electives.
- The MS-CPAS blueprint was updated to reflect changes in the curriculum.
- The Recommended Tools and Equipment list was updated.

Assessment

Students will be assessed using the Precision Manufacturing and Machining Technology MS-CPAS 2.

Professional Learning

It is suggested that instructors participate in professional learning related to the following concepts:

- CNC WIRE EDM training
- CAD/CAM software training
- Haas control training
- Cutting tool training from suppliers (Kenametal, Craboloy or Valenite, etc.)
- Industry tours
- Training on industrial lubricants and coolants
- How to use the program Blackboard site
- Differentiated instruction – To learn more about differentiated instruction, please go to http://www.paec.org/teacher2teacher/additional_subjects.html, and click on Differentiated Instruction. Work through this online course, and review the additional resources.

Articulation

Articulation credit from Secondary Metal Trades – Machine Shop Option to Postsecondary Precision Manufacturing and Machining Technology will be awarded upon implementation of this curriculum by the college. The course to be articulated is Power Machinery I (MST 1114-6) or corresponding courses from the modular option that may be taken in lieu of Power Machinery I, with the stipulation of passing the MS-CPAS2 according to SBCJC guidelines.

Articulation credit from Secondary Machine Tool Operation to Postsecondary Precision Manufacturing and Machining Technology will be awarded upon implementation of this curriculum by the college. The course to be articulated is Power Machinery I (MST 1114-6) or corresponding courses from the modular option that may be taken in lieu of Power Machinery I, with the stipulation of passing the MS-CPAS2 according to SBCJC guidelines.

Articulation credit from Secondary *Redesign* Manufacturing Trades I to Postsecondary Precision Manufacturing and Machining Technology will be awarded upon implementation of this

curriculum by the college. The course to be articulated is Power Machinery I (MST 1114-6) or corresponding courses from the modular option that may be taken in lieu of Power Machinery I, with the stipulation of passing the MS-CPAS2 according to SBCJC guidelines.

Statewide articulations are subject to change as secondary and postsecondary curriculum revisions occur.
All articulations listed in this document are effective as of July 1, 2008, unless otherwise noted.

SEC Program	PS Program	PS Courses
S Machine Tool Operation (CIP 48.0503)	PS Precision Manufacturing and Machining Technology (CIP 48.0501)	MST 1114-6 - Power Machinery I
	PS Industrial Maintenance Trades(CIP 47.0303)	IMM 1224 - Power Tool Applications
	PS Tool and Die Technology (CIP 48.0507)	MST 1114-6 - Power Machinery I

Statewide Guidelines on Articulated Credit

Eligibility

- To be eligible for articulated credit, a student must do the following:
  - Complete the articulated Secondary Vocational Program
  - Score 80% or higher on the Mississippi Career Planning and Assessment System (MS CPAS) in his or her secondary program of study
- To be awarded articulated credit, a student must do the following:
  - Complete application for articulated credit at the community or junior college
  - Enroll in the community or junior college within 18 months of graduation
  - Successfully complete 12 non-developmental career/technical or academic credit hours in the corresponding articulated postsecondary career–technical program of study

How MS CPAS will be documented

- The Research and Curriculum Unit of Mississippi State University will provide the SBCJC a list of all secondary CTE students scoring at or above the 80 percentile for the articulated programs.
- The SBCJC will forward the list of students eligible for articulated credit to the colleges.

Transcripting of Articulated Credit

- Students must complete 12 non-developmental career/technical or academic credit hours in the articulated postsecondary career–technical program of study before the articulated credit is transcripted.
- No grade will be given on the transcript for articulated courses; only hours granted will be transcripted (thus resulting in no change in quality points).

Time Limit

- MS CPAS scores will be accepted to demonstrate competencies for up to 18 months after high school graduation.

Cost

- No costs will be assessed on hours earned through articulated credit.

Foreword

As the world economy continues to evolve, businesses and industries must adopt new practices and processes in order to survive. Quality and cost control, work teams and participatory management, and an infusion of technology are transforming the way people work and do business. Employees are now expected to read, write, and communicate effectively; think creatively, solve problems, and make decisions; and interact with each other and the technologies in the workplace. Vocational–technical programs must also adopt these practices in order to provide graduates who can enter and advance in the changing work world.

The curriculum framework in this document reflects these changes in the workplace and a number of other factors that impact on local vocational–technical programs. Federal and state legislation calls for articulation between high school and community college programs, integration of academic and vocational skills, and the development of sequential courses of study that provide students with the optimum educational path for achieving successful employment. National skills standards, developed by industry groups and sponsored by the U.S. Department of Education and Labor, provide vocational educators with the expectations of employers across the United States. All of these factors are reflected in the framework found in this document.

Referenced throughout the courses of the curriculum are the 21st Century Skills, which were developed by the Partnership for 21st Century Skills, a group of business and education organizations concerned about the gap between the knowledge and skills learned in school and those needed in communities and the workplace. A portion of the 21st Century Skills addresses learning skills needed in the 21st century, including information and communication skills, thinking and problem-solving skills, and interpersonal and self-directional skills. The need for these types of skills has been recognized for some time, and the 21st Century Skills are adapted in part from the 1991 report from the U.S. Secretary of Labor's Commission on Achieving Necessary Skills (SCANS). Another important aspect of learning and working in the 21st century involves technology skills, and the International Society for Technology in Education, developers of the National Educational Technology Standards (NETS), were strategic partners in the Partnership for 21st Century Skills.

Each postsecondary program of instruction consists of a program description and a suggested sequence of courses that focus on the development of occupational competencies. Each vocational–technical course in this sequence has been written using a common format that includes the following components:

- Course Name – A common name that will be used by all community/junior colleges in reporting students

- Course Abbreviation – A common abbreviation that will be used by all community/junior colleges in reporting students

- Classification – Courses may be classified as the following:
    - Vocational–technical core – A required vocational–technical course for all students

  - Area of concentration (AOC) core – A course required in an area of concentration of a cluster of programs
  - Vocational–technical elective – An elective vocational–technical course
  - Related academic course – An academic course that provides academic skills and knowledge directly related to the program area
  - Academic core – An academic course that is required as part of the requirements for an associate degree

- Description – A short narrative that includes the major purpose(s) of the course and the recommended number of hours of lecture and laboratory activities to be conducted each week during a regular semester

- Prerequisites – A listing of any courses that must be taken prior to or on enrollment in the course

- Corequisites – A listing of courses that may be taken while enrolled in the course

- Competencies and Suggested Objectives – A listing of the competencies (major concepts and performances) and of the suggested student objectives that will enable students to demonstrate mastery of these competencies

The following guidelines were used in developing the program(s) in this document and should be considered in compiling and revising course syllabi and daily lesson plans at the local level:

- The content of the courses in this document reflects approximately 75% of the time allocated to each course. The remaining 25% of each course should be developed at the local district level and may reflect the following:
  - Additional competencies and objectives within the course related to topics not found in the State framework, including activities related to specific needs of industries in the community college district
  - Activities that develop a higher level of mastery on the existing competencies and suggested objectives
  - Activities and instruction related to new technologies and concepts that were not prevalent at the time the current framework was developed/revised
  - Activities that implement components of the Mississippi Tech Prep initiative, including integration of academic and vocational–technical skills and coursework, school-to-work transition activities, and articulation of secondary and postsecondary vocational–technical programs.
  - Individualized learning activities, including worksite learning activities, to better prepare individuals in the courses for their chosen occupational area

- Sequencing of the course within a program is left to the discretion of the local district. Naturally, foundation courses related to topics such as safety, tool and equipment usage, and other fundamental skills should be taught first. Other courses related to specific skill areas

and related academics, however, may be sequenced to take advantage of seasonal and climatic conditions, resources located outside of the school, and other factors.

- Programs that offer an Associate of Applied Science degree must include a minimum 15 semester credit hour academic core. Specific courses to be taken within this core are to be determined by the local district. Minimum academic core courses are as follows:
    - 3 semester credit hours — Math/Science Elective
    - 3 semester credit hours — Written Communications Elective
    - 3 semester credit hours — Oral Communications Elective
    - 3 semester credit hours — Humanities/Fine Arts Elective
    - 3 semester credit hours — Social/Behavioral Science Elective

  It is recommended that courses in the academic core be spaced out over the entire length of the program so that students complete some academic and vocational–technical courses each semester. Each community/junior college has the discretion to select the actual courses that are required to meet this academic core requirement.

- In instances where secondary programs are directly related to community and junior college programs, competencies and suggested objectives from the high school programs are listed as Baseline Competencies. These competencies and objectives reflect skills and knowledge that are directly related to the community and junior college vocational–technical program. In adopting the curriculum framework, each community and junior college is asked to give assurances that:
    - Students who can demonstrate mastery of the Baseline Competencies do not receive duplicate instruction and
    - Students who cannot demonstrate mastery of this content will be given the opportunity to do so.

- The roles of the Baseline Competencies are to do the following:
    - Assist community/junior college personnel in developing articulation agreements with high schools
    - Ensure that all community and junior college courses provide a higher level of instruction than their secondary counterparts

- The Baseline Competencies may be taught as special "Introduction" courses for 3–6 semester hours of institutional credit that will not count toward associate degree requirements. Community and junior colleges may choose to integrate the Baseline Competencies into ongoing courses in lieu of offering the "Introduction" courses or may offer the competencies through special projects or individualized instruction methods.

- Technical elective courses have been included to allow community colleges and students to customize programs to meet the needs of industries and employers in their area.

In order to provide flexibility within the districts, individual courses within a framework may be customized by doing the following:

- Adding new competencies and suggested objectives

- Revising or extending the suggested objectives for individual competencies
- Integrating baseline competencies from associated high school programs
- Adjusting the semester credit hours of a course to be up 1 hour or down 1 hour (after informing the State Board for Community and Junior Colleges [SBCJC] of the change)

In addition, the curriculum framework as a whole may be customized by doing the following:

- Resequencing courses within the suggested course sequence
- Developing and adding a new course that meets specific needs of industries and other clients in the community or junior college district (with SBCJC approval)
- Utilizing the technical elective options in many of the curricula to customize programs

Table of Contents

Program Description

Precision Manufacturing and Machining Technology is an instructional program that prepares individuals to manufacture metal parts on machines such as lathes, grinders, drill presses, milling machines, and Computer Numerical Control equipment. Included is instruction in making computations related to work dimensions, testing, feeds, and speeds of machines; using precision measuring instruments such as layout tools, micrometers, and gauges; machining and heat-treating various metals; and laying out machine parts. Also included is instruction in the operation and maintenance of computerized equipment.

The uniform program structure for Precision Manufacturing and Machining Technology is designed to serve as the core of instruction for approximately 75% of each major machine tool operation course. The remaining 25% of each course is to be added at the local level based upon needs of students and local employers.

The Modular Option for Precision Manufacturing and Machining Technology is designed to provide flexibility in scheduling and timely certification testing through NIMS. This curriculum revision was developed by utilizing the national standards for machining skills as developed and approved by the National Institute for Metalworking Skills (NIMS). Industry standards are based on the *National Institute for Metalworking Skills.*

Articulation

Articulation credit from Secondary Metal Trades – Machine Shop Option to Postsecondary Precision Manufacturing and Machining Technology will be awarded upon implementation of this curriculum by the college. The course to be articulated is Power Machinery I (MST 1114-6) or corresponding courses from the modular option that may be taken in lieu of Power Machinery I, with the stipulation of passing the MS-CPAS2 according to SBCJC guidelines.

Articulation credit from Secondary Machine Tool Operation to Postsecondary Precision Manufacturing and Machining Technology will be awarded upon implementation of this curriculum by the college. The course to be articulated is Power Machinery I (MST 1114-6) or corresponding courses from the modular option that may be taken in lieu of Power Machinery I, with the stipulation of passing the MS-CPAS2 according to SBCJC guidelines.

Articulation credit from Secondary Redesign Manufacturing Trades I to Postsecondary Precision Manufacturing and Machining Technology will be awarded upon implementation of this curriculum by the college. The course to be articulated is Power Machinery I (MST 1114-6) or corresponding courses from the modular option that may be taken in lieu of Power Machinery I, with the stipulation of passing the MS-CPAS2 according to SBCJC guidelines.

Articulated Secondary Course	Articulated Postsecondary Course
[S] Metal Trades – Machine Shop Option [S] Secondary Machine Tool Operation [S] Secondary Redesign Manufacturing Trades	MST 1114-6 – Power Machinery I

Suggested Course Sequence*

PRECISION MANUFACTURING AND MACHINING TECHNOLOGY

1-YEAR CERTIFICATE OF PRECISION MANUFACTURING AND MACHINING TECHNOLOGY

Baseline Competencies for Precision Manufacturing and Machining Technology***

FIRST YEAR

3 sch	Machine Tool Mathematics (MST 1313)	4–6 sch	Power Machinery II (MST 1124-6)
2–3 sch	Blueprint Reading (MST 1412-3)	3 sch	Precision Layout (MST 1613)
4–6 sch	Power Machinery I (MST 1114-6)	3 sch	Advanced Blueprint Reading (MST 1423)
3–5 sch	Electives	3–5 sch	Electives
12–17 sch		13–17 sch	

* Students who lack entry-level skills in math, English, science, and so forth will be provided related studies.

** Baseline competencies are taken from the high school Metal Trades or Machine Shop program. Students who can document mastery of these competencies should not receive duplicate instruction. Students who cannot demonstrate mastery will be required to do so.

*** Drill Press & Band Saw Operations MST 121(1-3), Lathe Turning Knowledge MST 122(1-3), and Milling Machines Knowledge MST 123(1-3) may be taken in lieu of Power Machinery I MST 111(4-6).

**** Precision Lathe Operations MST 124(2-3), Surface Grinding Operations MST 125(1-2), and Milling Machine Operations MST 126(2-3) may be taken in lieu of Power Machinery II MST 112(4-6).

ELECTIVES

Keyboarding/Beginning Computer Concepts (BOA 1413)
Metallurgy (MST 2811-3)
Quality Assurance (DDT 2263)
Fundamentals of Microcomputer Applications (CPT 1113)
Fundamentals of Drafting (DDT 1114)
Principles of CAD (DDT 1313)
Safety and Fundamentals of Die Fabrication (TDT 1113)
Die Repair (TDT 1123)
Die Design I (TDT 1133)
Jigs, Fixtures, and Tools (TDT 2183)

Fundamentals of Geometric Design and Tolerance (MST 1624-6)
Applied Math for Industrial (CTE 1113)
Fundamentals of CAD/CAM (MST 2734-6)
Industrial Maintenance Safety (IMM 1112)
Power Tool Applications (IMM 1224)
Industrial Hand Tools (IMM 1213)
Machine Drafting I (DDT 1133)
Intermediate CAD (DDT 1323)
Gas Metal Arc Welding (WLV 1124)
Fluid Power (INT 1214)
Principles of Hydraulics and Pneumatics (IMM 1314)
Preventative Maintenance and Service of Equipment (IMM 1524)
Equipment Maintenance, Troubleshooting, and Repair (IMM 2114)
Microcomputer Applications (BOT 1133)
Survey of Microcomputer Applications (CPT 1323)
Computer Concepts (CSC 1113)
Computer Applications I (CSC 1123)
Computer Fundamentals for Electronics (EET 1613)
Seminar I, II, III, IV (MST 1911, 1921, 1931, 1941)
Special Problem in Precision Manufacturing and Machining Technology [MST 291(1-4)]

Any other technical or academic course as approved by the instructor

Suggested Course Sequence*
Precision Manufacturing AND Machining Technology

2-YEAR CERTIFICATE OF PRECISION MANUFACTURING AND MACHINING TECHNOLOGY

Baseline Competencies for Precision Manufacturing and Machining Technology**

FIRST YEAR

3 sch	Machine Tool Mathematics (MST 1313)	4–6 sch	Power Machinery II (MST 1124-6)
2–3 sch	Blueprint Reading (MST 1412-3)	3 sch	Precision Layout (MST 1613)
4–6 sch	Power Machinery I (MST 1114-6)	3 sch	Advanced Blueprint Reading (MST 1423)
3–5 sch	Elective	3–5 sch	Elective
12–17 sch		13–17 sch	

SECOND YEAR

4–6 sch	Power Machinery III (MST 2134-6)	4–6 sch	Power Machinery IV (MST 2144-6)
4–6 sch	Computer Numerical Control Operations I (MST 2714-6)	4–6 sch	Computer Numerical Control Operations II (MST 2724-6)
4–6 sch	Electives	4–6 sch	Electives
12–18 sch		12–18 sch	

* Students who lack entry-level skills in math, English, science, and so forth will be provided related studies.

** Baseline competencies are taken from the high school Metal Trades or Machine Shop Assistant program. Students who can document mastery of these competencies should not receive duplicate instruction. Students who cannot demonstrate mastery will be required to do so.

*** Drill Press & Band Saw Operations MST 121(1-3), Lathe Turning Knowledge MST 122(1-3), and Milling Machines Knowledge MST 123(1-3) may be taken in lieu of Power Machinery I MST 111(4-6).

**** Precision Lathe Operations MST 124(2-3), Surface Grinding Operations MST 125(1-2), and Milling Machine Operations MST 126(2-3) may be taken in lieu of Power Machinery II MST 112(4-6).

***** Advanced Lathe Operations MST 251(2-3) and Advanced Milling Operations MST 252(1-3) may be taken in lieu of Power Machinery III MST 113(4-6).

****** Precision Grinding Operations MST 253(1-2), Gear Types and Manufacturing MST 254(1-2), and Advanced Machining Technologies MST 255(1-2) may be taken in lieu of Power Machinery IV MST 114(4-6).

ELECTIVES

Keyboarding/Beginning Computer Concepts (BOA 1413)
Metallurgy (MST 2811-3)
Fundamentals of Microcomputer Applications (CPT 1113)
Principles of CAD (DDT 1313)
Fundamentals of Drafting (DDT 1114)
Safety and Fundamentals of Die Fabrication (TDT 1113)
Die Repair (TDT 1123)
Die Design I (TDT 1133)
Jigs, Fixtures, and Tools (TDT 2183)
Fundamentals of Geometric Design and Tolerance (MST 1624-6)
Applied Math for Industrial (CTE 1113)
Fundamentals of CAD/CAM (MST 2734-6)
Industrial Maintenance Safety (IMM 1112)
Power Tool Applications (IMM 1224)
Industrial Hand Tools (IMM 1213)
Machine Drafting I (DDT 1133)
Intermediate CAD (DDT 1323)
Gas Metal Arc Welding (WLV 1124)
Fluid Power (INT 1214)
Principles of Hydraulics and Pneumatics (IMM 1314)
Preventative Maintenance and Service of Equipment (IMM 1524)
Equipment Maintenance, Troubleshooting and Repair (IMM 2114)
Microcomputer Applications (BOT 1133)
Survey of Microcomputer Applications (CPT 1323)
Computer Concepts (CSC 1113)
Computer Applications I (CSC 1123)
Computer Fundamentals for Electronics (EET 1613)
Seminar I, II, III, IV (MST 1911, 1921, 1931, 1941)
Supervised Work Experience in Precision Manufacturing and Machining Technology [MST 292(1-6)]
Special Problem in Precision Manufacturing and Machining Technology [MST 291(1-4)]

Work-Based Learning I, II, III, IV, V, VI [WBL 191(1-3), WBL 192(1-3), WBL 193(1-3), WBL 291(1-3), WBL 292(1-3), WBL 293(1-3)]

Any other technical or academic course as approved by the instructor

Suggested Course Sequence*

PRECISION MANUFACTURING AND MACHINING TECHNOLOGY

ASSOCIATE DEGREE IN PRECISION MANUFACTURING AND MACHINING TECHNOLOGY

Baseline Competencies for Precision Manufacturing and Machining Technology

FIRST YEAR

3 sch	Machine Tool Mathematics (MST 1313)
2–3 sch	Blueprint Reading (MST 1412-3)
4–6 sch	Power Machinery I (MST 1114-6)
3 sch	Written Communications Elective
12–15 sch	

4–6 sch	Power Machinery II (MST 1124-6)
3 sch	Precision Layout (MST 1613)
3 sch	Advanced Blueprint Reading (MST 1423)
3 sch	Math/Science Elective
3 sch	Humanities/Fine Arts Elective
16–18 sch	

SECOND YEAR

3–5 sch	Elective
4–6 sch	Power Machinery III (MST 2134-6)
4–6 sch	Computer Numerical Control Operations I (MST 2714-6)
3 sch	Oral Communications Elective
14–20 sch	

4–6 sch	Power Machinery IV (MST 2144-6)
4–6 sch	Computer Numerical Control Operations II (MST 2724-6)
3–5 sch	Elective
3 sch	Social/Behavioral Science Elective
14–20 sch	

* Students who lack entry-level skills in math, English, science, and so forth will be provided related studies.

** Baseline competencies are taken from the high school Metal Trades or Machine Shop program. Students who can document mastery of these competencies should not receive duplicate instruction. Students who cannot demonstrate mastery will be required to do so.

*** Drill Press & Band Saw Operations MST 121(1-3), Lathe Turning Knowledge MST 122(1-3), and Milling Machines Knowledge MST 123(1-3) may be taken in lieu of Power Machinery I MST 111(4-6).

**** Precision Lathe Operations MST 124(2-3), Surface Grinding Operations MST 125(1-2), and Milling Machine Operations MST 126(2-3) may be taken in lieu of Power Machinery II MST 112(4-6).

***** Advanced Lathe Operations MST 251(2-3) and Advanced Milling Operations MST 252(1-3) may be taken in lieu of Power Machinery III MST 113(4-6).

****** Precision Grinding Operations MST 253(1-2), Gear Types and Manufacturing MST 254(1-2), and Advanced Machining Technologies MST 255(1-2) may be taken in lieu of Power Machinery IV MST 114(4-6).

ELECTIVES

Keyboarding/Beginning Computer Concepts (BOA 1413)
Metallurgy (MST 2811-3)
Fundamentals of Microcomputer Applications (CPT 1113)
Principles of CAD (DDT 1313)
Fundamentals of Drafting (DDT 1114)
Safety and Fundamentals of Die Fabrication (TDT 1113)
Die Repair (TDT 1123)
Die Design I (TDT 1133)
Jigs, Fixtures, and Tools (TDT 2183)
Fundamentals of Geometric Design and Tolerance (MST 1624-6)
Applied Math for Industrial (CTE 1113)
Fundamentals of CAD/CAM (MST 2734-6)
Industrial Maintenance Safety (IMM 1112)
Power Tool Applications (IMM 1224)
Industrial Hand Tools (IMM 1213)
Machine Drafting I (DDT 1133)
Intermediate CAD (DDT 1323)
Gas Metal Arc Welding (WLV 1124)
Fluid Power (INT 1214)
Principles of Hydraulics and Pneumatics (IMM 1314)
Preventative Maintenance and Service of Equipment (IMM 1524)
Equipment Maintenance, Troubleshooting, and Repair (IMM 2114)
Microcomputer Applications (BOT 1133)
Survey of Microcomputer Applications (CPT 1323)
Computer Concepts (CSC 1113)
Computer Applications I (CSC 1123)
Computer Fundamentals for Electronics (EET 1613)
Seminar I, II, III, IV (MST 1911, 1921, 1931, 1941)
Supervised Work Experience in Precision Manufacturing and Machining Technology [MST 292(1-6)]
Special Problem in Precision Manufacturing and Machining Technology [(MST 29(1-4)]

Work-Based Learning I, II, III, IV, V, VI [WBL 191(1-3), WBL 192(1-3), WBL 193(1-3), WBL 291(1-3), WBL 292(1-3), WBL 293(1-3)]

Any other technical or academic course as approved by the instructor

Precision Manufacturing and Machining Technology Courses

Course Name: Power Machinery I

Course Abbreviation: MST 1114-6

Classification: Vocational–Technical Core

Description: This course provides instruction of general shop safety as well as the operation of power machinery, which includes instruction and practice in the safe operation of lathes, power saws, drill presses, and vertical mills. (4–6 sch: 2-hr lecture, 4-hr lab; 2-hr lecture, 6-hr lab; 3-hr lecture, 6-hr lab)

Prerequisite: None

Competencies and Suggested Objectives
1. Discuss and apply general machine shop safety and job planning. a. Identify, discuss, and test safety procedures. b. Demonstrate safety procedures. c. Explain the sequence in job planning. d. List the steps to follow in developing a plan. e. Lay out the steps in an assigned job.
2. Discuss, set up, and perform operations using a band saw and drill press safely. a. Discuss and utilize safety procedures. b. Identify types of band saws and accessories. c. Calculate speeds and feeds. d. Determine the type and length of a blade. e. Fabricate and install the blade. f. Cut a part to specifications using proper feeds and speeds. g. Identify and describe the types and parts of a drill press. h. Identify and re-sharpen different types of drill bits. i. Describe the use of layout instruments. j. Perform project layout using various instruments. k. Set up and perform various drilling operations to include counter boring and counter sinking. l. Perform a tapping operation to specifications.
3. Perform cutting operations to project specifications safely. a. Use shop formulas and charts to determine lathe speed and feed rates, and make application to production. b. Perform measurements with precision instruments. c. Explain the procedures for preparing an engine lathe. d. Sharpen a cutoff tool blade, and perform recessing and cutoff operations. e. Grind cutting tools to satisfy special job requirements. f. Identify, select, and use carbide cutting tools. g. Use an engine lathe to turn a taper using the compound. h. Discuss and perform boring operations safely.

i. Cut various external threads to specified class of fit.
j. Measure thread pitch diameter using thread micrometers and three wire method.

4. Set up a milling machine, and perform milling operations safely.
   a. Identify and study parts of a vertical milling machine.
   b. Tram the head of a vertical mill.
   c. Perform measurements with precision instruments.
   d. Mount and align a swivel-base vise on a milling machine using a dial indicator.
   e. Identify various cutters and accessories used in milling.
   f. Perform selected milling operations according to project specifications.

STANDARDS

National Institute for Metalworking Skills

NIMS1	Job Planning and Management
NIMS2	Job Execution
NIMS3	Quality Control and Inspection
NIMS4	Process Adjustment and Improvement
NIMS5	General Maintenance
NIMS6	Industrial Safety and Environmental Protection

Related Academic Standards

R1	Interpret Graphic Information (forms, maps, reference sources)
R2	Words in Context (same and opposite meaning)
R3	Recall Information (details, sequence)
R4	Construct Meaning (main idea, summary/paraphrase, compare–contrast, cause–effect)
R5	Evaluate/Extend Meaning (fact/opinion, predict outcomes, point of view)
M1	Addition of Whole Numbers (no regrouping, regrouping)
M2	Subtraction of Whole Numbers (no regrouping, regrouping)
M3	Multiplication of Whole Numbers (no regrouping, regrouping)
M4	Division of Whole Numbers (no remainder, remainder)
M5	Decimals (addition, subtraction, multiplication, division)
M6	Fractions (addition, subtraction, multiplication, division)
M7	Integers (addition, subtraction, multiplication, division)
M8	Percents
M9	Algebraic Operations
A1	Numeration (ordering, place value, scientific notation)
A2	Number Theory (ratio, proportion)
A3	Data Interpretation (graph, table, chart, diagram)
A4	Pre-Algebra and Algebra (equations, inequality)
A5	Measurement (money, time, temperature, length, area, volume)
A6	Geometry (angles, Pythagorean theory)
A7	Computation in Context (whole numbers, decimals, fractions, algebraic operations)

A8 Estimation (rounding, estimation)
L1 Usage (pronoun, tense, subject–verb agreement, adjective, adverb)
L2 Sentence Formation (fragments, run-on, clarity)
L3 Paragraph Development (topic sentence, supporting sentence, sequence)
L4 Capitalization (proper noun, titles)
L5 Punctuation (comma, semicolon)
L6 Writing Conventions (quotation marks, apostrophe, parts of a letter)
S1 Vowel (short, long)
S2 Consonant (variant spelling, silent letter)
S3 Structural Unit (root, suffix)

21st Century Skills

CS1 Global Awareness
CS2 Financial, Economic, and Business Literacy
CS3 Civic Literacy
CS4 Information and Communication Skills
CS5 Thinking and Problem-Solving Skills
CS6 Interpersonal and Self-Directional Skills

SUGGESTED REFERENCES

General Machine Tool

Fitzpatrick, M. (2005). *Machining and CNC technology.* Boston, MA: McGraw-Hill.

Kibbe, R., Neely, J., Meyer, R., & White, W. (2010). *Machine tool practices* [With workbook]. Upper Saddle River, NJ: Prentice Hall.

Krar, S., Gill, A., & Smid, P. (2005). *Technology of machine tools.* Boston, MA: McGraw-Hill.

Krar, S., Rapisarda, M., & Check, A. (1998). *Machine tool and manufacturing technology.* Albany, NY: Delmar Learning.

Oberg, E., Jones, F., Horton, H., & Ryffel, H. (2005). *Machinery's handbook.* New York, NY: Industrial Press.

Walker, J. (2004). *Machining fundamentals* [With workbook]. Tinley Park, IL: Goodheart-Willcox.

Weingartner, C., & Effner, J. (2001). *Machinist's ready reference*. Ann Arbor, MI: Prakken Publications, Inc.

Wentzell, T. (2004). *Machine design.* Albany, NY: Delmar Learning.

Journals

CNC Machining. (n.d.). Oxnard, CA: Haas Automation.

The Home Shop Machinist. (n.d.). Travers City, MI: Village Press.

Live Steam. (n.d.). Travers City, MI: Village Press.

The Machinist's Workshop. (n.d.). Travers City, MI: Village Press.

Manufacturing Engineering. (n.d.). Dearborn, MI: Society of Manufacturing Engineers. Retrieved April 8, 2009, from http://www.sme.org/cgi-bin/find-issues.pl?&&ME&%20http%20SME&

Manufacturing News. (n.d.). Grapevine, TX: Southeast Manufacturing News.

Video

RMI Media Productions. (n.d.). *Machine shop series* [Videotape]. (Available from RMI Media Productions, 2807 West 47th Street, Shawnee Mission, KS 66205)

Web Sites

Society of Manufacturing Engineers. (n.d.). *Manufacturing engineering*. Retrieved April 9, 2009, from http://www.sme.org/manufacturingengineering

Course Name: Power Machinery II

Course Abbreviation: MST 1124-6

Classification: Vocational–Technical Core

Description: A continuation of Power Machinery I with emphasis on advanced applications of lathes, mills, and precision grinders (4–6 sch: 2-hr lecture, 4-hr lab; 2-hr lecture, 6-hr lab; 3-hr lecture, 6-hr lab)

Prerequisite: Power Machinery I (MST 1114-6) or by consent of instructor

Competencies and Suggested Objectives
1. Discuss and apply general machine shop safety. a. Identify, discuss, and test safety procedures. b. Demonstrate safety procedures.
2. Prepare the engine lathe, and perform various operations according to specifications safely. a. Use taper formulas to calculate dimensions, and perform taper turning operation using the taper attachment. b. Set up and turn work between centers. c. Chase an unfinished or damaged thread. d. Calculate bore size for various types and sizes of internal threads. e. Turn internal threads to specified class of fit.
3. Explain and use a precision surface grinder safely. a. Describe surface grinding types and operations. b. Identify, select, install, and use the different types of grinding wheels for various precision grinding operations. c. Grind different shaped parts using various holding devices.
4. Set up and perform vertical milling operations safely according to project specifications. a. Perform boring operations using the precision boring head. b. Perform a compound angling operation. c. Set up work piece in mill using sine bar and gauge blocks.

STANDARDS

National Institute for Metalworking Skills

NIMS1	Job Planning and Management
NIMS2	Job Execution
NIMS3	Quality Control and Inspection
NIMS4	Process Adjustment and Improvement
NIMS5	General Maintenance
NIMS6	Industrial Safety and Environmental Protection

Related Academic Standards

R1 Interpret Graphic Information (forms, maps, reference sources)
R2 Words in Context (same and opposite meaning)
R3 Recall Information (details, sequence)
R4 Construct Meaning (main idea, summary/paraphrase, compare–contrast, cause–effect)
R5 Evaluate/Extend Meaning (fact/opinion, predict outcomes, point of view)
M1 Addition of Whole Numbers (no regrouping, regrouping)
M2 Subtraction of Whole Numbers (no regrouping, regrouping)
M3 Multiplication of Whole Numbers (no regrouping, regrouping)
M4 Division of Whole Numbers (no remainder, remainder)
M5 Decimals (addition, subtraction, multiplication, division)
M6 Fractions (addition, subtraction, multiplication, division)
M7 Integers (addition, subtraction, multiplication, division)
M8 Percents
M9 Algebraic Operations
A1 Numeration (ordering, place value, scientific notation)
A2 Number Theory (ratio, proportion)
A3 Data Interpretation (graph, table, chart, diagram)
A4 Pre-Algebra and Algebra (equations, inequality)
A5 Measurement (money, time, temperature, length, area, volume)
A6 Geometry (angles, Pythagorean theory)
A7 Computation in Context (whole numbers, decimals, fractions, algebraic operations)
A8 Estimation (rounding, estimation)
L1 Usage (pronoun, tense, subject–verb agreement, adjective, adverb)
L2 Sentence Formation (fragments, run-on, clarity)
L3 Paragraph Development (topic sentence, supporting sentence, sequence)
L4 Capitalization (proper noun, titles)
L5 Punctuation (comma, semicolon)
L6 Writing Conventions (quotation marks, apostrophe, parts of a letter)
S1 Vowel (short, long)
S2 Consonant (variant spelling, silent letter)
S3 Structural Unit (root, suffix)

21st Century Skills

CS1 Global Awareness
CS2 Financial, Economic, and Business Literacy
CS3 Civic Literacy
CS4 Information and Communication Skills
CS5 Thinking and Problem-Solving Skills
CS6 Interpersonal and Self-Directional Skills

SUGGESTED REFERENCES

General Machine Tool

Fitzpatrick, M. (2005). *Machining and CNC technology.* Boston, MA: McGraw-Hill.

Kibbe, R., Neely, J., Meyer, R., & White, W. (2010). *Machine tool practices* [With workbook]. Upper Saddle River, NJ: Prentice Hall.

Krar, S., Gill, A., & Smid, P. (2005). *Technology of machine tools.* Boston, MA: McGraw-Hill.

Krar, S., Rapisarda, M., & Check, A. (1998). *Machine tool and manufacturing technology.* Albany, NY: Delmar Learning.

Oberg, E., Jones, F., Horton, H., & Ryffel, H. (2005). *Machinery's handbook.* New York, NY: Industrial Press.

Walker, J. (2004). *Machining fundamentals* [With workbook]. Tinley Park, IL: Goodheart-Willcox.

Weingartner, C., & Effner, J. (2001). *Machinist's ready reference*. Ann Arbor, MI: Prakken Publications, Inc.

Wentzell, T. (2004). *Machine design.* Albany, NY: Delmar Learning.

Journals

CNC Machining. (n.d.). Oxnard, CA: Haas Automation.

The Home Shop Machinist. (n.d.). Travers City, MI: Village Press.

Live Steam. (n.d.). Travers City, MI: Village Press.

The Machinist's Workshop. (n.d.). Travers City, MI: Village Press.

Manufacturing Engineering. (n.d.). Dearborn, MI: Society of Manufacturing Engineers. Retrieved April 8, 2009, from http://www.sme.org/cgi-bin/find-issues.pl?&&ME&%20http%20SME&

Manufacturing News. (n.d.). Grapevine, TX: Southeast Manufacturing News.

Video

RMI Media Productions. (n.d.). *Machine shop series* [Videotape]. (Available from RMI Media Productions, 2807 West 47th Street, Shawnee Mission, KS 66205)

Web Sites

Society of Manufacturing Engineers. (n.d.). *Manufacturing engineering*. Retrieved April 9, 2009, from http://www.sme.org/manufacturingengineering

Course Name: Machine Tool Mathematics

Course Abbreviation: MST 1313

Classification: Vocational–Technical Core

Description: An applied mathematics course designed for machinists that includes instruction and practice in algebraic and trigonometric operations (3 sch: 2-hr lecture, 2-hr lab)

Prerequisite: None

Competencies and Suggested Objectives
1. Solve mathematical problems relating to machine tool activities. a. Set up formulas, and solve reading problems. b. Transpose components of algebraic formulas.
2. Describe and apply trigonometric functions. a. Describe the trigonometric functions, and state their relationship to the sides and angles of a triangle. b. Use the trigonometric functions to solve for unknown sides and angles of a triangle.
3. Identify properties of a circle, and solve mathematical problems relating to the properties, and calculate area and volume for geometric objects. a. Identify the properties of a circle, and solve problems relating to these properties. b. Calculate area and volume for various geometrically shaped objects.

STANDARDS

National Institute for Metalworking Skills

NIMS1 Job Planning and Management

Related Academic Standards

R1 Interpret Graphic Information (forms, maps, reference sources)
R2 Words in Context (same and opposite meaning)
R3 Recall Information (details, sequence)
R4 Construct Meaning (main idea, summary/paraphrase, compare–contrast, cause–effect)
R5 Evaluate/Extend Meaning (fact/opinion, predict outcomes, point of view)
M1 Addition of Whole Numbers (no regrouping, regrouping)
M2 Subtraction of Whole Numbers (no regrouping, regrouping)
M3 Multiplication of Whole Numbers (no regrouping, regrouping)
M4 Division of Whole Numbers (no remainder, remainder)
M5 Decimals (addition, subtraction, multiplication, division)
M6 Fractions (addition, subtraction, multiplication, division)
M7 Integers (addition, subtraction, multiplication, division)
M8 Percents

M9 Algebraic Operations
A1 Numeration (ordering, place value, scientific notation)
A2 Number Theory (ratio, proportion)
A3 Data Interpretation (graph, table, chart, diagram)
A4 Pre-Algebra and Algebra (equations, inequality)
A5 Measurement (money, time, temperature, length, area, volume)
A6 Geometry (angles, Pythagorean theory)
A7 Computation in Context (whole numbers, decimals, fractions, algebraic operations)
A8 Estimation (rounding, estimation)
L1 Usage (pronoun, tense, subject–verb agreement, adjective, adverb)
L2 Sentence Formation (fragments, run-on, clarity)
L3 Paragraph Development (topic sentence, supporting sentence, sequence)
L4 Capitalization (proper noun, titles)
L5 Punctuation (comma, semicolon)
L6 Writing Conventions (quotation marks, apostrophe, parts of a letter)
S1 Vowel (short, long)
S2 Consonant (variant spelling, silent letter)
S3 Structural Unit (root, suffix)

21st Century Skills

CS1 Global Awareness
CS2 Financial, Economic, and Business Literacy
CS3 Civic Literacy
CS4 Information and Communication Skills
CS5 Thinking and Problem-Solving Skills
CS6 Interpersonal and Self-Directional Skills

SUGGESTED REFERENCES

Math

Boyce, J., Margolis, L., & Slade, S. (2000). *Mathematics for technical and vocational students*. Upper Saddle River, NJ: Prentice Hall.

Carman, R., & Saunders, H. (2008). *Mathematics for the trades: A guided approach*. Upper Saddle River, NJ: Pearson Prentice Hall.

Cleaves, C., & Hobbs, M. (2009). *College mathematics* [With MyMathLab/MyStatLab student access code card]. Upper Saddle River, NJ: Prentice Hall.

Cook, N. (2004). *Mathematics for technical trades.* Upper Saddle River, NJ: Pearson Prentice Hall.

Davis, D. (1995). *Practical problems in mathematics for manufacturing.* Albany, NY: Delmar Learning.

Mrachek, L. (2004). *Basic technical college mathematics.* Upper Saddle River, NJ: Prentice Hall.

Smith, R. (2004). *Mathematics for machine technology.* Albany, NY: Delmar Learning.

Spangler, R. (2001). *Basic mathematics for occupational and vocational students.* Upper Saddle River, NJ: Pearson Prentice Hall.

Video

Coastal Skills Training. (n.d.). *Basic shop math* [Videotape]. (Available from Coastal Skills Training, 3083 Brickhouse Court, Virginia Beach, VA 23452)

Course Name: Blueprint Reading

Course Abbreviation: MST 1412-3

Classification: Vocational–Technical Core

Description: Plans and specifications interpretation designed for machinists. Includes instruction and practice in reading plans and applying specifications (2–3 sch: 1-hr lecture, 2-hr lab; 2-hr lecture, 2-hr lab)

Prerequisite: None

Competencies and Suggested Objectives
1. Identify, describe, and apply dimensions and tolerances. a. Identify, describe, and apply industrial methods for showing dimensions and tolerances. b. Describe and apply the International System of Units (SI) as used in plans. c. Describe and apply the need for metric dimensioning. d. Describe and apply specifications found on plans.
2. Identify, describe, and apply auxiliary views, finishes, materials, section lines, and cutting plane lines. a. Identify, distinguish, and apply primary and secondary auxiliary views on a drawing. b. Identify, describe, and apply surface finishes shown on a plan. c. Identify materials used as indicated by section lines, and demonstrate correct selection. d. Describe and apply the use of the cutting plane line.

STANDARDS

National Institute for Metalworking Skills

NIMS1 Job Planning and Management
NIMS3 Quality Control and Inspection

Related Academic Standards

R1 Interpret Graphic Information (forms, maps, reference sources)
R2 Words in Context (same and opposite meaning)
R3 Recall Information (details, sequence)
R4 Construct Meaning (main idea, summary/paraphrase, compare–contrast, cause–effect)
R5 Evaluate/Extend Meaning (fact/opinion, predict outcomes, point of view)
M1 Addition of Whole Numbers (no regrouping, regrouping)
M2 Subtraction of Whole Numbers (no regrouping, regrouping)
M3 Multiplication of Whole Numbers (no regrouping, regrouping)
M4 Division of Whole Numbers (no remainder, remainder)
M5 Decimals (addition, subtraction, multiplication, division)

M6 Fractions (addition, subtraction, multiplication, division)
M7 Integers (addition, subtraction, multiplication, division)
M8 Percents
M9 Algebraic Operations
A1 Numeration (ordering, place value, scientific notation)
A2 Number Theory (ratio, proportion)
A3 Data Interpretation (graph, table, chart, diagram)
A4 Pre-Algebra and Algebra (equations, inequality)
A5 Measurement (money, time, temperature, length, area, volume)
A6 Geometry (angles, Pythagorean theory)
A7 Computation in Context (whole numbers, decimals, fractions, algebraic operations)
A8 Estimation (rounding, estimation)
L1 Usage (pronoun, tense, subject–verb agreement, adjective, adverb)
L2 Sentence Formation (fragments, run-on, clarity)
L3 Paragraph Development (topic sentence, supporting sentence, sequence)
L4 Capitalization (proper noun, titles)
L5 Punctuation (comma, semicolon)
L6 Writing Conventions (quotation marks, apostrophe, parts of a letter)
S1 Vowel (short, long)
S2 Consonant (variant spelling, silent letter)
S3 Structural Unit (root, suffix)

21st Century Skills

CS1 Global Awareness
CS2 Financial, Economic, and Business Literacy
CS3 Civic Literacy
CS4 Information and Communication Skills
CS5 Thinking and Problem-Solving Skills
CS6 Interpersonal and Self-Directional Skills

SUGGESTED REFERENCES

Blueprint Reading

Barsmian, M., & Gizelbach, R. (2001). *Machine trades print reading.* Tinley Park, IL: Goodheart-Willcox.

Brown, W., & Brown, R. (2002). *Print reading for industry.* Tinley Park, IL: Goodheart-Willcox.

Madsen, D. (2005). *Print reading for engineering and manufacturing technology.* Albany, NY: Delmar Learning.

Olivo, T., & Olivo, C. T. (2005). *Basic blueprint reading and sketching.* Albany, NY: Delmar Learning.

Schultz, R., & Smith, L. (2009). *Blueprint reading for the machine trades.* Upper Saddle River, NJ: Prentice Hall.

Taylor, D. (2005). *Blueprint reading for machine trades.* Albany, NY: Delmar Learning.

Taylor, D. (2003). *Blueprint reading for machinists—elementary.* Albany, NY: Delmar Learning.

Taylor, D. (2004). *Blueprint reading for machinists—intermediate.* Albany, NY: Delmar Learning.

Course Name: Advanced Blueprint Reading

Course Abbreviation: MST 1423

Classification: Vocational–Technical Core

Description: A continuation of Blueprint Reading with emphasis on advanced features of plans and specifications. Includes instruction on the identification of various projections, views, and assembly components (3 sch: 2-hr lecture, 2-hr lab)

Prerequisite: Blueprint Reading (MST 1413) or by consent of instructor

Competencies and Suggested Objectives
1. Describe features related to alterations, chamfers, and knurls. a. Recognize alterations and changes in size and specifications made on a drawing, and describe how these alterations and changes are recorded. b. Explain how a chamfer is represented and dimensioned. c. Identify and describe how knurls are dimensioned.
2. Describe the purpose and use of assembly drawings.
3. Identify and apply the use of geometric tolerance symbols.

STANDARDS

National Institute for Metalworking Skills

NIMS1 Job Planning and Management
NIMS3 Quality Control and Inspection

Related Academic Standards

R1 Interpret Graphic Information (forms, maps, reference sources)
R2 Words in Context (same and opposite meaning)
R3 Recall Information (details, sequence)
R4 Construct Meaning (main idea, summary/paraphrase, compare–contrast, cause–effect)
R5 Evaluate/Extend Meaning (fact/opinion, predict outcomes, point of view)
M1 Addition of Whole Numbers (no regrouping, regrouping)
M2 Subtraction of Whole Numbers (no regrouping, regrouping)
M3 Multiplication of Whole Numbers (no regrouping, regrouping)
M4 Division of Whole Numbers (no remainder, remainder)
M5 Decimals (addition, subtraction, multiplication, division)
M6 Fractions (addition, subtraction, multiplication, division)
M7 Integers (addition, subtraction, multiplication, division)
M8 Percents
M9 Algebraic Operations
A1 Numeration (ordering, place value, scientific notation)

A2 Number Theory (ratio, proportion)
A3 Data Interpretation (graph, table, chart, diagram)
A4 Pre-Algebra and Algebra (equations, inequality)
A5 Measurement (money, time, temperature, length, area, volume)
A6 Geometry (angles, Pythagorean theory)
A7 Computation in Context (whole numbers, decimals, fractions, algebraic operations)
A8 Estimation (rounding, estimation)
L1 Usage (pronoun, tense, subject–verb agreement, adjective, adverb)
L2 Sentence Formation (fragments, run-on, clarity)
L3 Paragraph Development (topic sentence, supporting sentence, sequence)
L4 Capitalization (proper noun, titles)
L5 Punctuation (comma, semicolon)
L6 Writing Conventions (quotation marks, apostrophe, parts of a letter)
S1 Vowel (short, long)
S2 Consonant (variant spelling, silent letter)
S3 Structural Unit (root, suffix)

21st Century Skills

CS1 Global Awareness
CS2 Financial, Economic, and Business Literacy
CS3 Civic Literacy
CS4 Information and Communication Skills
CS5 Thinking and Problem-Solving Skills
CS6 Interpersonal and Self-Directional Skills

SUGGESTED REFERENCES

Blueprint Reading

Barsmian, M., & Gizelbach, R. (2001). *Machine trades print reading.* Tinley Park, IL: Goodheart-Willcox.

Brown, W., & Brown, R. (2002). *Print reading for industry.* Tinley Park, IL: Goodheart-Willcox.

Madsen, D. (2005). *Print reading for engineering and manufacturing technology.* Albany, NY: Delmar Learning.

Olivo, T., & Olivo, C. T. (2005). *Basic blueprint reading and sketching.* Albany, NY: Delmar Learning.

Schultz, R., & Smith, L. (2009). *Blueprint reading for the machine trades.* Upper Saddle River, NJ: Prentice Hall.

Taylor, D. (2005). *Blueprint reading for machine trades.* Albany, NY: Delmar Learning.

Taylor, D. (2003). *Blueprint reading for machinists—elementary.* Albany, NY: Delmar Learning.

Taylor, D. (2004). *Blueprint reading for machinists—intermediate.* Albany, NY: Delmar Learning.

Course Name: Precision Layout

Course Abbreviation: MST 1613

Classification: Vocational–Technical Core

Description: Precision layout for machining operations that includes instruction and practice in the use of layout instruments (3 sch: 2-hr lecture, 2-hr lab)

Prerequisite: None

Competencies and Suggested Objectives
1. Discuss and apply general machine shop safety. a. Identify, discuss, and test safety procedures. b. Demonstrate safety procedures.
2. Identify precision layout instruments. a. Describe the use of instruments used for precision layout. b. Explain upkeep and preventive maintenance.
3. Perform precision layout safely. a. Explain the steps in layout. b. Perform a precision layout to specifications and tolerances.

STANDARDS

National Institute for Metalworking Skills

NIMS1	Job Planning and Management
NIMS2	Job Execution
NIMS3	Quality Control and Inspection
NIMS4	Process Adjustment and Improvement
NIMS5	General Maintenance
NIMS6	Industrial Safety and Environmental Protection

Related Academic Standards

R1	Interpret Graphic Information (forms, maps, reference sources)
R2	Words in Context (same and opposite meaning)
R3	Recall Information (details, sequence)
R4	Construct Meaning (main idea, summary/paraphrase, compare–contrast, cause–effect)
R5	Evaluate/Extend Meaning (fact/opinion, predict outcomes, point of view)
M1	Addition of Whole Numbers (no regrouping, regrouping)
M2	Subtraction of Whole Numbers (no regrouping, regrouping)
M3	Multiplication of Whole Numbers (no regrouping, regrouping)
M4	Division of Whole Numbers (no remainder, remainder)
M5	Decimals (addition, subtraction, multiplication, division)

M6 Fractions (addition, subtraction, multiplication, division)
M7 Integers (addition, subtraction, multiplication, division)
M8 Percents
M9 Algebraic Operations
A1 Numeration (ordering, place value, scientific notation)
A2 Number Theory (ratio, proportion)
A3 Data Interpretation (graph, table, chart, diagram)
A4 Pre-Algebra and Algebra (equations, inequality)
A5 Measurement (money, time, temperature, length, area, volume)
A6 Geometry (angles, Pythagorean theory)
A7 Computation in Context (whole numbers, decimals, fractions, algebraic operations)
A8 Estimation (rounding, estimation)
L1 Usage (pronoun, tense, subject–verb agreement, adjective, adverb)
L2 Sentence Formation (fragments, run-on, clarity)
L3 Paragraph Development (topic sentence, supporting sentence, sequence)
L4 Capitalization (proper noun, titles)
L5 Punctuation (comma, semicolon)
L6 Writing Conventions (quotation marks, apostrophe, parts of a letter)
S1 Vowel (short, long)
S2 Consonant (variant spelling, silent letter)
S3 Structural Unit (root, suffix)

21st Century Skills

CS1 Global Awareness
CS2 Financial, Economic, and Business Literacy
CS3 Civic Literacy
CS4 Information and Communication Skills
CS5 Thinking and Problem-Solving Skills
CS6 Interpersonal and Self-Directional Skills

SUGGESTED REFERENCES

General Machine Tool

Fitzpatrick, M. (2005). *Machining and CNC technology.* Boston, MA: McGraw-Hill.

Kibbe, R., Neely, J., Meyer, R., & White, W. (2010). *Machine tool practices* [With workbook]. Upper Saddle River, NJ: Prentice Hall.

Krar, S., Gill, A., & Smid, P. (2005). *Technology of machine tools.* Boston, MA: McGraw-Hill.

Krar, S., Rapisarda, M., & Check, A. (1998). *Machine tool and manufacturing technology.* Albany, NY: Delmar Learning.

Oberg, E., Jones, F., Horton, H., & Ryffel, H. (2005). *Machinery's handbook.* New York, NY: Industrial Press.

Walker, J. (2004). *Machining fundamentals* [With workbook]. Tinley Park, IL: Goodheart-Willcox.

Weingartner, C., & Effner, J. (2001). *Machinist's ready reference*. Ann Arbor, MI: Prakken Publications, Inc.

Wentzell, T. (2004). *Machine design.* Albany, NY: Delmar Learning.

Course Name: Fundamentals of GD&T (Geometric Dimensioning and Tolerancing)

Course Abbreviation: MST 162(4-6)

Classification: Vocational–Technical Elective

Description: This course is designed to provide students with a solid foundation in the fundamentals of geometric dimensioning and tolerancing. Includes emphasis on measurement theory, common terms and definitions, profile tolerances, orientation tolerances, locational tolerances, runout tolerances, and form tolerances as they relate to Machine Tool Technology (4–6 sch: 3-hr lecture, 2–6-hr lab)

Prerequisite: None

Competencies and Suggested Objectives
1. Discuss and apply general machine shop safety. a. Identify, discuss, and test safety procedures. b. Demonstrate safety procedures.
2. Identify, describe, and apply dimensions and tolerances relating to GD&T. a. Identify, describe, and apply GD&T symbols. b. Describe rules relating to GD&T. c. Identify datums. d. Identify and describe material conditions. e. Perform measurements according to GD&T callouts.

STANDARDS

National Institute for Metalworking Skills

NIMS1	Job Planning Management
NIMS3	Quality Control and Inspection
NIMS4	Process Adjustment and Control
NIMS5	General Maintenance
NIMS6	Industrial Safety and Environmental Protection

Related Academic Standards

R1	Interpret Graphic Information (forms, maps, reference sources)
R2	Words in Context (same and opposite meaning)
R3	Recall Information (details, sequence)
R4	Construct Meaning (main idea, summary/paraphrase, compare–contrast, cause–effect)
R5	Evaluate/Extend Meaning (fact/opinion, predict outcomes, point of view)
M1	Addition of Whole Numbers (no regrouping, regrouping)
M2	Subtraction of Whole Numbers (no regrouping, regrouping)

M3 Multiplication of Whole Numbers (no regrouping, regrouping)
M4 Division of Whole Numbers (no remainder, remainder)
M5 Decimals (addition, subtraction, multiplication, division)
M6 Fractions (addition, subtraction, multiplication, division)
M7 Integers (addition, subtraction, multiplication, division)
M8 Percents
M9 Algebraic Operations
A1 Numeration (ordering, place value, scientific notation)
A2 Number Theory (ratio, proportion)
A3 Data Interpretation (graph, table, chart, diagram)
A4 Pre-Algebra and Algebra (equations, inequality)
A5 Measurement (money, time, temperature, length, area, volume)
A6 Geometry (angles, Pythagorean theory)
A7 Computation in Context (whole numbers, decimals, fractions, algebraic operations)
A8 Estimation (rounding, estimation)
L1 Usage (pronoun, tense, subject–verb agreement, adjective, adverb)
L2 Sentence Formation (fragments, run-on, clarity)
L3 Paragraph Development (topic sentence, supporting sentence, sequence)
L4 Capitalization (proper noun, titles)
L5 Punctuation (comma, semicolon)
L6 Writing Conventions (quotation marks, apostrophe, parts of a letter)
S1 Vowel (short, long)
S2 Consonant (variant spelling, silent letter)
S3 Structural Unit (root, suffix)

21st Century Skills

CS1 Global Awareness
CS2 Financial, Economic, and Business Literacy
CS3 Civic Literacy
CS4 Information and Communication Skills
CS5 Thinking and Problem-Solving Skills
CS6 Interpersonal and Self-Directional Skills

SUGGESTED REFERENCES

Griffin, G. (2002). *Geometric dimensioning and tolerancing: Applications and inspection.* Upper Saddle River, NJ: Pearson Education.

Krulikowski, A. (1998). *Geometric dimensioning and tolerancing*. Albany, NY: Cengage.

Krulikowski, A. (n.d.). *Geometric dimensioning and tolerancing*. Westland, MI: Effective Training.

Madsen, D. (2003). *Geometric dimensioning and tolerancing*. Tinley Park, NY: Goodheart-Willcox.

Course Name: Power Machinery III

Course Abbreviation: MST 2134-6

Classification: Vocational–Technical Core (Precision Manufacturing and Machining 2-Year Certificate and Associate Degree)

Description: A continuation of Power Machinery II with emphasis on safety and advanced applications of the engine lathe, milling, and grinding machine (4–6 sch: 2-hr lecture, 4-hr lab; 2-hr lecture, 6-hr lab; 3-hr lecture, 6-hr lab)

Prerequisite: Power Machinery II (MST 1124-6) or by consent of instructor

Competencies and Suggested Objectives
1. Discuss and apply general machine shop safety. a. Identify, discuss, and test safety procedures. b. Demonstrate safety procedures.
2. Calculate and fabricate commonly used threads safely. a. Calculate dimensions and machine additional internal and external thread form types.
3. Describe and fabricate various tapers safely. a. Discuss the different types of tapers and the methods used to produce and measure them. b. Machine different types of internal and external tapers to specifications using the taper attachment and/or tailstock offset method.
4. Perform eccentric turning operations safely. a. Describe the procedure for eccentric turning. b. Manufacture eccentric parts to specifications.
5. Prepare and use a lathe to perform various operations safely. a. Install, set up, and use lathe accessories to include the following: steady rest, follower rest, and tool post grinder (when applicable).
6. Perform key cutting operation using a vertical mill. a. Cut a keyway to specifications. b. Cut a keyseat to specifications. c. Set up and manufacture parts correctly using an indexable dividing head. d. Discuss and demonstrate the uses of a rotary table and vertical slotting head.

STANDARDS

National Institute for Metalworking Skills

NIMS1	Job Planning and Management
NIMS2	Job Execution
NIMS3	Quality Control and Inspection
NIMS4	Process Adjustment and Improvement
NIMS5	General Maintenance
NIMS6	Industrial Safety and Environmental Protection

Related Academic Standards

R1 Interpret Graphic Information (forms, maps, reference sources)
R2 Words in Context (same and opposite meaning)
R3 Recall Information (details, sequence)
R4 Construct Meaning (main idea, summary/paraphrase, compare–contrast, cause–effect)
R5 Evaluate/Extend Meaning (fact/opinion, predict outcomes, point of view)
M1 Addition of Whole Numbers (no regrouping, regrouping)
M2 Subtraction of Whole Numbers (no regrouping, regrouping)
M3 Multiplication of Whole Numbers (no regrouping, regrouping)
M4 Division of Whole Numbers (no remainder, remainder)
M5 Decimals (addition, subtraction, multiplication, division)
M6 Fractions (addition, subtraction, multiplication, division)
M7 Integers (addition, subtraction, multiplication, division)
M8 Percents
M9 Algebraic Operations
A1 Numeration (ordering, place value, scientific notation)
A2 Number Theory (ratio, proportion)
A3 Data Interpretation (graph, table, chart, diagram)
A4 Pre-Algebra and Algebra (equations, inequality)
A5 Measurement (money, time, temperature, length, area, volume)
A6 Geometry (angles, Pythagorean theory)
A7 Computation in Context (whole numbers, decimals, fractions, algebraic operations)
A8 Estimation (rounding, estimation)
L1 Usage (pronoun, tense, subject–verb agreement, adjective, adverb)
L2 Sentence Formation (fragments, run-on, clarity)
L3 Paragraph Development (topic sentence, supporting sentence, sequence)
L4 Capitalization (proper noun, titles)
L5 Punctuation (comma, semicolon)
L6 Writing Conventions (quotation marks, apostrophe, parts of a letter)
S1 Vowel (short, long)
S2 Consonant (variant spelling, silent letter)
S3 Structural Unit (root, suffix)

21st Century Skills

CS1 Global Awareness
CS2 Financial, Economic, and Business Literacy
CS3 Civic Literacy
CS4 Information and Communication Skills
CS5 Thinking and Problem-Solving Skills
CS6 Interpersonal and Self-Directional Skills

SUGGESTED REFERENCES

General Machine Tool

Fitzpatrick, M. (2005). *Machining and CNC technology.* Boston, MA: McGraw-Hill.

Kibbe, R., Neely, J., Meyer, R., & White, W. (2010). *Machine tool practices* [With workbook]. Upper Saddle River, NJ: Prentice Hall.

Krar, S., Gill, A., & Smid, P. (2005). *Technology of machine tools.* Boston, MA: McGraw-Hill.

Krar, S., Rapisarda, M., & Check, A. (1998). *Machine tool and manufacturing technology.* Albany, NY: Delmar Learning.

Oberg, E., Jones, F., Horton, H., & Ryffel, H. (2005). *Machinery's handbook.* New York, NY: Industrial Press.

Walker, J. (2004). *Machining fundamentals* [With workbook]. Tinley Park, IL: Goodheart-Willcox.

Weingartner, C., & Effner, J. (2001). *Machinist's ready reference*. Ann Arbor, MI: Prakken Publications, Inc.

Wentzell, T. (2004). *Machine design.* Albany, NY: Delmar Learning.

Journals

CNC Machining. (n.d.). Oxnard, CA: Haas Automation.

The Home Shop Machinist. (n.d.). Travers City, MI: Village Press.

Live Steam. (n.d.). Travers City, MI: Village Press.

The Machinist's Workshop. (n.d.). Travers City, MI: Village Press.

Manufacturing Engineering. (n.d.). Dearborn, MI: Society of Manufacturing Engineers. Retrieved April 8, 2009, from http://www.sme.org/cgi-bin/find-issues.pl?&&ME&%20http%20SME&

Manufacturing News. (n.d.). Grapevine, TX: Southeast Manufacturing News.

Video

Coastal Skills Training. (n.d.). *Intermediate lathe* [Videotape]. (Available from Coastal Skills Training, 3083 Brickhouse Center, Virginia Beach, VA 23452)

Web Sites

Society of Manufacturing Engineers. (n.d.). *Manufacturing engineering*. Retrieved April 9, 2009, from http://www.sme.org/manufacturingengineering

Course Name: Power Machinery IV

Course Abbreviation: MST 2144-6

Classification: Vocational–Technical Core (Precision Manufacturing and Machining 2-Year Certificate and Associate Degree)

Description: A continuation of Power Machinery III with emphasis on highly advanced safe operations on the milling machine and engine lathe as well as discussion of advanced machining technologies (4–6 sch: 2-hr lecture, 4-hr lab; 2-hr lecture, 6-hr lab; 3-hr lecture, 6-hr lab)

Prerequisite: Power Machinery III (MST 2134-6) or by consent of instructor

Competencies and Suggested Objectives
1. Discuss and apply general machine shop safety. a. Identify, discuss, and test safety procedures. b. Demonstrate safety procedures.
2. Discuss and operate indexing safely. a. Identify the various types of gears including spur, helical, bevel, and herringbone. b. Calculate needed gear tooth elements and sizes using the *Machinist Ready Reference* or *Machinery Handbook*. c. Manufacture parts to specifications using direct, simple, and angular indexing.
3. Discuss electrical discharge machine (EDM) technology. a. Identify the uses of the EDM. b. Discuss the various types and applications of EDM. c. Discuss the advantages and disadvantages of EDM. d. Manufacture a part to specifications.
4. Discuss emerging technologies in Machine Tool Technology. a. Discuss various types and applications of laser cutting equipment. b. Discuss types and applications of CNC plasma cutting equipment. c. Identify and discuss types and applications of water jet cutting. d. Manufacture a part to specifications.
5. Operate grinding machinery safely. a. Describe precision grinding operations. b. Discuss and calculate math constants and formulas related to grinding required clearance angles and lands using the *Machinist Ready Reference* or *Machinery Handbook*. c. Perform setup and grind surfaces according to specifications. d. Set up and grind milling machine cutters.

STANDARDS

National Institute for Metalworking Skills

NIMS1 Job Planning and Management
NIMS2 Job Execution

NIMS3 Quality Control and Inspection
NIMS4 Process Adjustment and Improvement
NIMS5 General Maintenance
NIMS6 Industrial Safety and Environmental Protection
NIMS7 Career Management and Employment Relations

Related Academic Standards

R1 Interpret Graphic Information (forms, maps, reference sources)
R2 Words in Context (same and opposite meaning)
R3 Recall Information (details, sequence)
R4 Construct Meaning (main idea, summary/paraphrase, compare–contrast, cause–effect)
R5 Evaluate/Extend Meaning (fact/opinion, predict outcomes, point of view)
M1 Addition of Whole Numbers (no regrouping, regrouping)
M2 Subtraction of Whole Numbers (no regrouping, regrouping)
M3 Multiplication of Whole Numbers (no regrouping, regrouping)
M4 Division of Whole Numbers (no remainder, remainder)
M5 Decimals (addition, subtraction, multiplication, division)
M6 Fractions (addition, subtraction, multiplication, division)
M7 Integers (addition, subtraction, multiplication, division)
M8 Percents
M9 Algebraic Operations
A1 Numeration (ordering, place value, scientific notation)
A2 Number Theory (ratio, proportion)
A3 Data Interpretation (graph, table, chart, diagram)
A4 Pre-Algebra and Algebra (equations, inequality)
A5 Measurement (money, time, temperature, length, area, volume)
A6 Geometry (angles, Pythagorean theory)
A7 Computation in Context (whole numbers, decimals, fractions, algebraic operations)
A8 Estimation (rounding, estimation)
L1 Usage (pronoun, tense, subject–verb agreement, adjective, adverb)
L2 Sentence Formation (fragments, run-on, clarity)
L3 Paragraph Development (topic sentence, supporting sentence, sequence)
L4 Capitalization (proper noun, titles)
L5 Punctuation (comma, semicolon)
L6 Writing Conventions (quotation marks, apostrophe, parts of a letter)
S1 Vowel (short, long)
S2 Consonant (variant spelling, silent letter)
S3 Structural Unit (root, suffix)

21st Century Skills

CS1 Global Awareness
CS2 Financial, Economic, and Business Literacy

CS3 Civic Literacy
CS4 Information and Communication Skills
CS5 Thinking and Problem-Solving Skills
CS6 Interpersonal and Self-Directional Skills

SUGGESTED REFERENCES

General Machine Tool

Fitzpatrick, M. (2005). *Machining and CNC technology.* Boston, MA: McGraw-Hill.

Kibbe, R., Neely, J., Meyer, R., & White, W. (2010). *Machine tool practices* [With workbook]. Upper Saddle River, NJ: Prentice Hall.

Krar, S., Gill, A., & Smid, P. (2005). *Technology of machine tools.* Boston, MA: McGraw-Hill.

Krar, S., Rapisarda, M., & Check, A. (1998). *Machine tool and manufacturing technology.* Albany, NY: Delmar Learning.

Oberg, E., Jones, F., Horton, H., & Ryffel, H. (2005). *Machinery's handbook.* New York, NY: Industrial Press.

Walker, J. (2004). *Machining fundamentals* [With workbook]. Tinley Park, IL: Goodheart-Willcox.

Weingartner, C., & Effner, J. (2001). *Machinist's ready reference*. Ann Arbor, MI: Prakken Publications, Inc.

Wentzell, T. (2004). *Machine design.* Albany, NY: Delmar Learning.

Journals

CNC Machining. (n.d.). Oxnard, CA: Haas Automation.

The Home Shop Machinist. (n.d.). Travers City, MI: Village Press.

Live Steam. (n.d.). Travers City, MI: Village Press.

The Machinist's Workshop. (n.d.). Travers City, MI: Village Press.

Manufacturing Engineering. (n.d.). Dearborn, MI: Society of Manufacturing Engineers. Retrieved April 8, 2009, from http://www.sme.org/cgi-bin/find-issues.pl?&&ME&%20http%20SME&

Manufacturing News. (n.d.). Grapevine, TX: Southeast Manufacturing News.

Web Sites

Society of Manufacturing Engineers. (n.d.). *Manufacturing engineering*. Retrieved April 9, 2009, from http://www.sme.org/manufacturingengineering

Course Name: Computer Numerical Control Operations I

Course Abbreviation: MST 2714-6

Classification: Vocational–Technical Core (Precision Manufacturing and Machining 2-Year Certificate and Associate Degree)

Description: An introduction of computer numerical control (CNC) and computer assisted manufacturing (CAM) techniques and practices. Includes the use of the Cartesian coordinate system, programming codes and command, and tooling requirements for CNC/CAM machines (4–6 sch: 2-hr lecture, 4-hr lab; 2-hr lecture, 6-hr lab; 3-hr lecture, 6-hr lab)

Prerequisite: None

Competencies and Suggested Objectives
1. Discuss and apply general machine shop safety. a. Identify, discuss, and test safety procedures. b. Demonstrate safety procedures.
2. Describe CNC machining, uses, and applications of CNC program. a. Describe the capabilities and limitations of computer numerical control (CNC)/computer assisted manufacturing (CAM) equipment. b. Describe the Cartesian coordinate system as used in a CNC machine program. c. Describe the differences in absolute and incremental dimensioning as related to an ISO programming of a CNC machine. d. Describe procedures for CNC machine start-up.
3. Discuss commands for CNC machine codes. a. List and describe the purpose or function of the preparatory commands for a CNC machine (G-codes). b. Explain the purpose or function of the miscellaneous commands used with a CNC machine (M-codes). c. State the purpose of other alphabetical commands used in programming operations of a CNC machine.
4. Discuss tooling for CNC operations, and safely use CNC mill, CNC lathe, and CNC machine centers to project specifications. a. Describe the different types of tooling required for CNC mills, CNC lathes, and CNC machine centers. b. Select tooling required for a specific job on a CNC mill, CNC machine centers, and CNC lathe. c. Write and manually input program data. d. Execute programs for CNC mill, CNC lathe, and CNC machine center according to project specifications.

STANDARDS

National Institute for Metalworking Skills

NIMS1	Job Planning and Management
NIMS2	Job Execution
NIMS3	Quality Control and Inspection
NIMS4	Process Adjustment and Improvement
NIMS5	General Maintenance
NIMS6	Industrial Safety and Environmental Protection

Related Academic Standards

R1	Interpret Graphic Information (forms, maps, reference sources)
R2	Words in Context (same and opposite meaning)
R3	Recall Information (details, sequence)
R4	Construct Meaning (main idea, summary/paraphrase, compare–contrast, cause–effect)
R5	Evaluate/Extend Meaning (fact/opinion, predict outcomes, point of view)
M1	Addition of Whole Numbers (no regrouping, regrouping)
M2	Subtraction of Whole Numbers (no regrouping, regrouping)
M3	Multiplication of Whole Numbers (no regrouping, regrouping)
M4	Division of Whole Numbers (no remainder, remainder)
M5	Decimals (addition, subtraction, multiplication, division)
M6	Fractions (addition, subtraction, multiplication, division)
M7	Integers (addition, subtraction, multiplication, division)
M8	Percents
M9	Algebraic Operations
A1	Numeration (ordering, place value, scientific notation)
A2	Number Theory (ratio, proportion)
A3	Data Interpretation (graph, table, chart, diagram)
A4	Pre-Algebra and Algebra (equations, inequality)
A5	Measurement (money, time, temperature, length, area, volume)
A6	Geometry (angles, Pythagorean theory)
A7	Computation in Context (whole numbers, decimals, fractions, algebraic operations)
A8	Estimation (rounding, estimation)
L1	Usage (pronoun, tense, subject–verb agreement, adjective, adverb)
L2	Sentence Formation (fragments, run-on, clarity)
L3	Paragraph Development (topic sentence, supporting sentence, sequence)
L4	Capitalization (proper noun, titles)
L5	Punctuation (comma, semicolon)
L6	Writing Conventions (quotation marks, apostrophe, parts of a letter)
S1	Vowel (short, long)
S2	Consonant (variant spelling, silent letter)
S3	Structural Unit (root, suffix)

21st Century Skills

CS1 Global Awareness
CS2 Financial, Economic, and Business Literacy
CS3 Civic Literacy
CS4 Information and Communication Skills
CS5 Thinking and Problem-Solving Skills
CS6 Interpersonal and Self-Directional Skills

SUGGESTED REFERENCES

CNC

Curran, K., & Stenerson, J. (2007). *Computer numerical control operation and programming.* Upper Saddle River, NJ: Prentice Hall.

Mattson, M. (2010). *CNC programming: Principles and applications.* Albany, NY: Delmar Learning.

Quesada, R. (2005). *Computer numerical control: Machining and turning centers.* Upper Saddle River, NJ: Prentice Hall.

Seames, W. (2002). *Computer numerical control concepts and programming.* Albany, NY: Delmar Learning.

Valentino, J., & Goldbenberg, J. (2008). *Introduction to computer numerical control.* Upper Saddle River, NJ: Prentice Hall.

Journals

CNC Machining. (n.d.). Oxnard, CA: Haas Automation.

The Home Shop Machinist. (n.d.). Travers City, MI: Village Press.

Live Steam. (n.d.). Travers City, MI: Village Press.

The Machinist's Workshop. (n.d.). Travers City, MI: Village Press.

Manufacturing Engineering. (n.d.). Dearborn, MI: Society of Manufacturing Engineers. Retrieved April 8, 2009, from http://www.sme.org/cgi-bin/find-issues.pl?&&ME&%20http%20SME&

Manufacturing News. (n.d.). Grapevine, TX: Southeast Manufacturing News.

Web Sites

Society of Manufacturing Engineers. (n.d.). *Manufacturing engineering*. Retrieved April 9, 2009, from http://www.sme.org/manufacturingengineering

Course Name: Computer Numerical Control Operations II

Course Abbreviation: MST 2724-6

Classification: Vocational–Technical Core (Precision Manufacturing and Machining 2-Year Certificate and Associate Degree)

Description: A continuation of Computer Numerical Control Operations I. Includes instruction in writing and editing CNC programs, machine setup and operation, and use of CAM equipment to program and operate CNC machines (CNC lathes, CNC mills, and CNC machine centers) (4–6 sch: 2-hr lecture, 4-hr lab; 2-hr lecture, 6-hr lab; 3-hr lecture, 6-hr lab)

Prerequisite: Computer Numerical Control Operations I (MST 2714-6) or by consent of instructor

Competencies and Suggested Objectives
1. Discuss and apply general machine shop safety. a. Identify, discuss, and test safety procedures. b. Demonstrate safety procedures.
2. Manipulate CNC machine programs to specifications safely. a. Describe and perform procedures for editing, altering, inserting, and deleting steps in a CNC program using computer aided design, CAM, and internal machine control unit. b. Write and execute CNC programs to manufacture parts to meet specifications. c. Inspect parts, and adjust program. d. Use a computer assisted manufacturing (CAM) system to generate a program for a CNC machine. e. Interface a CAM system to a CNC machine, and download the program.
3. Perform CNC procedures safely to specifications. a. Set up (mount workpiece and tooling) a CNC machine, enter program into memory, and manufacture parts. b. Set up (mount workpiece and tooling) the CNC machine, and execute the CAM program.
4. Apply preventive maintenance procedures for CNC machines. a. Discuss safety procedures involving preventive maintenance. b. Lubricate, clean the machine, check coolant, and remove chip debris.
5. Discuss operation of CMM (coordinant measuring machine).
6. Discuss the theories of flexible manufacturing equipment.

STANDARDS

National Institute for Metalworking Skills

NIMS1 Job Planning and Management
NIMS2 Job Execution
NIMS3 Quality Control and Inspection

NIMS4 Process Adjustment and Improvement
NIMS5 General Maintenance
NIMS6 Industrial Safety and Environmental Protection
NIMS7 Career Management and Employment Relations

Related Academic Standards

R1 Interpret Graphic Information (forms, maps, reference sources)
R2 Words in Context (same and opposite meaning)
R3 Recall Information (details, sequence)
R4 Construct Meaning (main idea, summary/paraphrase, compare–contrast, cause–effect)
R5 Evaluate/Extend Meaning (fact/opinion, predict outcomes, point of view)
M1 Addition of Whole Numbers (no regrouping, regrouping)
M2 Subtraction of Whole Numbers (no regrouping, regrouping)
M3 Multiplication of Whole Numbers (no regrouping, regrouping)
M4 Division of Whole Numbers (no remainder, remainder)
M5 Decimals (addition, subtraction, multiplication, division)
M6 Fractions (addition, subtraction, multiplication, division)
M7 Integers (addition, subtraction, multiplication, division)
M8 Percents
M9 Algebraic Operations
A1 Numeration (ordering, place value, scientific notation)
A2 Number Theory (ratio, proportion)
A3 Data Interpretation (graph, table, chart, diagram)
A4 Pre-Algebra and Algebra (equations, inequality)
A5 Measurement (money, time, temperature, length, area, volume)
A6 Geometry (angles, Pythagorean theory)
A7 Computation in Context (whole numbers, decimals, fractions, algebraic operations)
A8 Estimation (rounding, estimation)
L1 Usage (pronoun, tense, subject–verb agreement, adjective, adverb)
L2 Sentence Formation (fragments, run-on, clarity)
L3 Paragraph Development (topic sentence, supporting sentence, sequence)
L4 Capitalization (proper noun, titles)
L5 Punctuation (comma, semicolon)
L6 Writing Conventions (quotation marks, apostrophe, parts of a letter)
S1 Vowel (short, long)
S2 Consonant (variant spelling, silent letter)
S3 Structural Unit (root, suffix)

21st Century Skills

CS1 Global Awareness
CS2 Financial, Economic, and Business Literacy
CS3 Civic Literacy

CS4 Information and Communication Skills
CS5 Thinking and Problem-Solving Skills
CS6 Interpersonal and Self-Directional Skills

SUGGESTED REFERENCES

CNC

Curran, K., & Stenerson, J. (2007). *Computer numerical control operation and programming.* Upper Saddle River, NJ: Prentice Hall.

Mattson, M. (2010). *CNC programming: Principles and applications.* Albany, NY: Delmar Learning.

Quesada, R. (2005). *Computer numerical control: Machining and turning centers.* Upper Saddle River, NJ: Prentice Hall.

Seames, W. (2002). *Computer numerical control concepts and programming.* Albany, NY: Delmar Learning.

Valentino, J., & Goldbenberg, J. (2008). *Introduction to computer numerical control.* Upper Saddle River, NJ: Prentice Hall.

Journals

CNC Machining. (n.d.). Oxnard, CA: Haas Automation.

The Home Shop Machinist. (n.d.). Travers City, MI: Village Press.

Live Steam. (n.d.). Travers City, MI: Village Press.

The Machinist's Workshop. (n.d.). Travers City, MI: Village Press.

Manufacturing Engineering. (n.d.). Dearborn, MI: Society of Manufacturing Engineers. Retrieved April 8, 2009, from http://www.sme.org/cgi-bin/find-issues.pl?&&ME&%20http%20SME&

Manufacturing News. (n.d.). Grapevine, TX: Southeast Manufacturing News.

Web Sites

Society of Manufacturing Engineers. (n.d.). *Manufacturing engineering*. Retrieved April 9, 2009, from http://www.sme.org/manufacturingengineering

Course Name: Fundamentals of CAD/CAM

Course Abbreviation: MST 273(4-6)

Classification: Vocational–Technical Elective

Description: This course is designed to provide the students with the fundamental knowledge and skills of Computer Aided Design Manufacturing using various CAD/CAM software packages as they relate to Machine Tool Technology. (3 sch: 3-hr lecture, 2–6-hr lab)

Prerequisite: None

Competencies and Suggested Objectives
1. Discuss and apply general machine shop safety. a. Identify, discuss, and test safety procedures. b. Demonstrate safety procedures.
2. Develop a general understanding of fundamental CAD/CAM concepts. a. Describe the current industrial uses of CAD/CAM. b. Describe the major differences between Computer Aided Design and Computer Aided Manufacturing. c. List the major steps in Computer Aided Design. d. List the major steps in Computer Aided Manufacturing.
3. Perform basic operations using CAD/CAM software. a. Create basic graphic objects: lines, circles, arcs, curves solids, and surfaces. b. Modify objects with edit commands. c. Create and manipulate features (tool paths). d. Create and implement CNC programs.

STANDARDS

National Institute for Metalworking Skills

NIMS1 Job Planning Management
NIMS3 Quality Control and Inspection
NIMS4 Process Adjustment and Control
NIMS5 General Maintenance
NIMS6 Industrial Safety and Environmental Protection

Related Academic Standards

R1 Interpret Graphic Information (forms, maps, reference sources)
R2 Words in Context (same and opposite meaning)
R3 Recall Information (details, sequence)
R4 Construct Meaning (main idea, summary/paraphrase, compare–contrast, cause–effect)

R5 Evaluate/Extend Meaning (fact/opinion, predict outcomes, point of view)
M1 Addition of Whole Numbers (no regrouping, regrouping)
M2 Subtraction of Whole Numbers (no regrouping, regrouping)
M3 Multiplication of Whole Numbers (no regrouping, regrouping)
M4 Division of Whole Numbers (no remainder, remainder)
M5 Decimals (addition, subtraction, multiplication, division)
M6 Fractions (addition, subtraction, multiplication, division)
M7 Integers (addition, subtraction, multiplication, division)
M8 Percents
M9 Algebraic Operations
A1 Numeration (ordering, place value, scientific notation)
A2 Number Theory (ratio, proportion)
A3 Data Interpretation (graph, table, chart, diagram)
A4 Pre-Algebra and Algebra (equations, inequality)
A5 Measurement (money, time, temperature, length, area, volume)
A6 Geometry (angles, Pythagorean theory)
A7 Computation in Context (whole numbers, decimals, fractions, algebraic operations)
A8 Estimation (rounding, estimation)
L1 Usage (pronoun, tense, subject–verb agreement, adjective, adverb)
L2 Sentence Formation (fragments, run-on, clarity)
L3 Paragraph Development (topic sentence, supporting sentence, sequence)
L4 Capitalization (proper noun, titles)
L5 Punctuation (comma, semicolon)
L6 Writing Conventions (quotation marks, apostrophe, parts of a letter)
S1 Vowel (short, long)
S2 Consonant (variant spelling, silent letter)
S3 Structural Unit (root, suffix)

21st Century Skills

CS1 Global Awareness
CS2 Financial, Economic, and Business Literacy
CS3 Civic Literacy
CS4 Information and Communication Skills
CS5 Thinking and Problem-Solving Skills
CS6 Interpersonal and Self-Directional Skills

SUGGESTED REFERENCES

In-House Solutions. (n.d.). MastercamX3: *Lathe training tutorial.* Cambridge, ON: Author.

In-House Solutions. (n.d.). MastercamX3: *Beginning tutorial milling machines*. Cambridge, ON: Author.

Course Name: Metallurgy

Course Abbreviation: MST 2811-3

Classification: Vocational–Technical Elective

Description: Concepts of metallurgy including instruction and practice in safety, metal identification, heat treatment, and hardness testing (1–3 sch: 1-hr lecture; 1-hr lecture, 2-hr lab; 1-hr lecture, 4-hr lab)

Prerequisite: None

Competencies and Suggested Objectives
1. Discuss and apply general machine shop safety. a. Identify, discuss, and test safety procedures. b. Demonstrate safety procedures.
2. Explain heat treatment of metals. a. List different types of metals, their characteristics, and uses. b. Describe the different methods for heat treatment of metals. c. Identify heat treating equipment. d. Harden and temper metal to meet specifications.
3. Perform hardness testing safely. a. List the types of hardness testing equipment. b. Describe the use of hardness testing equipment. c. Perform hardness testing procedures.

STANDARDS

National Institute for Metalworking Skills

NIMS1 Job Planning and Management
NIMS2 Job Execution
NIMS3 Quality Control and Inspection
NIMS4 Process Adjustment and Improvement
NIMS5 General Maintenance
NIMS6 Industrial Safety and Environmental Protection

Related Academic Standards

R1 Interpret Graphic Information (forms, maps, reference sources)
R2 Words in Context (same and opposite meaning)
R3 Recall Information (details, sequence)
R4 Construct Meaning (main idea, summary/paraphrase, compare–contrast, cause–effect)
R5 Evaluate/Extend Meaning (fact/opinion, predict outcomes, point of view)
M1 Addition of Whole Numbers (no regrouping, regrouping)

M2 Subtraction of Whole Numbers (no regrouping, regrouping)
M3 Multiplication of Whole Numbers (no regrouping, regrouping)
M4 Division of Whole Numbers (no remainder, remainder)
M5 Decimals (addition, subtraction, multiplication, division)
M6 Fractions (addition, subtraction, multiplication, division)
M7 Integers (addition, subtraction, multiplication, division)
M8 Percents
M9 Algebraic Operations
A1 Numeration (ordering, place value, scientific notation)
A2 Number Theory (ratio, proportion)
A3 Data Interpretation (graph, table, chart, diagram)
A4 Pre-Algebra and Algebra (equations, inequality)
A5 Measurement (money, time, temperature, length, area, volume)
A6 Geometry (angles, Pythagorean theory)
A7 Computation in Context (whole numbers, decimals, fractions, algebraic operations)
A8 Estimation (rounding, estimation)
L1 Usage (pronoun, tense, subject–verb agreement, adjective, adverb)
L2 Sentence Formation (fragments, run-on, clarity)
L3 Paragraph Development (topic sentence, supporting sentence, sequence)
L4 Capitalization (proper noun, titles)
L5 Punctuation (comma, semicolon)
L6 Writing Conventions (quotation marks, apostrophe, parts of a letter)
S1 Vowel (short, long)
S2 Consonant (variant spelling, silent letter)
S3 Structural Unit (root, suffix)

21st Century Skills

CS1 Global Awareness
CS2 Financial, Economic, and Business Literacy
CS3 Civic Literacy
CS4 Information and Communication Skills
CS5 Thinking and Problem-Solving Skills
CS6 Interpersonal and Self-Directional Skills

SUGGESTED REFERENCES

Metallurgy

Brandt, D., & Warner, J. (2009). *Metallurgy fundamentals.* Tinley Park, IL: Goodheart-Willcox.

Budinski, K., & Budinski, M. (2010). *Engineering materials: Properties and selection.* Upper Saddle River, NJ: Prentice Hall.

Bruce, R., Dalton, W., Neely, J., & Kibbe, R. (2004). *Modern materials and manufacturing processes.* Upper Saddle River, NJ: Prentice Hall.

Colling, D., & Vasilos, T. (1995). *Industrial materials: Volume 1, metals and alloys.* Upper Saddle River, NJ: Prentice Hall.

Neely, J., & Bertone, T. (2003). *Practical metallurgy and materials of industry.* Upper Saddle River, NJ: Prentice Hall.

Journals

CNC Machining. (n.d.). Oxnard, CA: Haas Automation.

The Home Shop Machinist. (n.d.). Travers City, MI: Village Press.

Live Steam. (n.d.). Travers City, MI: Village Press.

The Machinist's Workshop. (n.d.). Travers City, MI: Village Press.

Manufacturing Engineering. (n.d.). Dearborn, MI: Society of Manufacturing Engineers. Retrieved April 8, 2009, from http://www.sme.org/cgi-bin/find-issues.pl?&&ME&%20http%20SME&

Manufacturing News. (n.d.). Grapevine, TX: Southeast Manufacturing News.

Web Sites

Society of Manufacturing Engineers. (n.d.). *Manufacturing engineering*. Retrieved April 9, 2009, from http://www.sme.org/manufacturingengineering

Course Name: Special Problem in Precision Manufacturing and Machining Technology

Course Abbreviation: MST 291(1-4)

Classification: Vocational–Technical Elective

Description: A course to provide students with an opportunity to utilize skills and knowledge gained in other Precision Manufacturing and Machining Technology courses. The instructor and student work closely together to select a topic and establish criteria for completion of the project. (1–4 sch: 2–8-hr lab)

Prerequisite: Consent of instructor

Competencies and Suggested Objectives
1. Develop a written plan that details the activities and projects to be completed. a. Use a written plan that details the activities and projects to be completed. b. Perform written occupational objectives in the special problem.
2. Assess accomplishment of objectives. a. Prepare daily written assessments of accomplishment of objectives. b. Present weekly written reports to the instructor of activities performed and objectives accomplished.
3. Use and follow a set of written guidelines for the special problem. a. Develop and follow a set of written guidelines for the special problem.

STANDARDS

Specific standards for this course will depend upon the nature of the problem under investigation.

SUGGESTED REFERENCES

Specific references for this course will depend upon the nature of the problem under investigation.

Course Name: Supervised Work Experience in Precision Manufacturing and Machining Technology

Course Abbreviation: MST 292(1-6)

Classification: Vocational–Technical Elective (Precision Manufacturing and Machining Technology 2-Year certificate and Associate Degree)

Description: A course that is a cooperative program between industry and education designed to integrate the student's technical studies with industrial experience. Variable credit is awarded on the basis of 1 semester hour per 45 industrial contact hours. (1–6 sch: 3–18-hr externship)

Prerequisite: Consent of instructor and completion of at least one semester of advanced coursework in Precision Manufacturing and Machining Technology.

Competencies and Suggested Objectives
1. Follow a set of instructor-written guidelines for the supervised work experience program.
2. Apply skills needed to be a viable member of the workforce. a. Prepare a description of skills to be developed in the supervised work experience program. b. Practice skills needed to be a viable member of the workforce.
3. Practice human relationship skills in the supervised work experience program.
4. Practice positive work habits, responsibilities, and ethics.
5. Develop written occupational objectives in the supervised work experience program.
6. Assess performance of occupational skills. a. Prepare daily written assessments of work performance as specified in the occupational objectives. b. Present weekly written reports to the instructor of activities performed and objectives accomplished.

STANDARDS

Specific standards for this course will depend upon the nature of the problem under investigation.

SUGGESTED REFERENCES

Specific references for this course will depend upon the nature of the problem under investigation.

Precision Manufacturing and Machining Technology Modular Option Courses

Suggested Course Sequence*

PRECISION MANUFACTURING AND MACHINING TECHNOLOGY

1-YEAR CERTIFICATE OF PRECISION MANUFACTURING AND MACHINING TECHNOLOGY
MODULAR OPTION

Baseline Competencies for Precision Manufacturing and Machining Technology***

FIRST YEAR

3 sch	Machine Tool Mathematics (MST 1313)	2–3 sch	Precision Lathe Operations MST 124(2-3)****
2–3 sch	Blueprint Reading (MST 1412-3)	1–2 sch	Surface Grinding Operations MST 125(1-2)****
1–3 sch	Drill Press & Band Saw Operations [MST 121(1-3)]***	2–3 sch	Milling Machine Operations MST 126(2-3)****
1–3 sch	Lathe Turning Knowledge [MST 122(1-3)]***	3 sch	Precision Layout (MST 1613)
1–3 sch	Milling Machines Knowledge MST 1231-3)***	3 sch	Advanced Blueprint Reading (MST 1423)
3–5 sch	Electives	3–5 sch	Electives
11–20 sch		14–19 sch	

* Students who lack entry-level skills in math, English, science, and so forth will be provided related studies.

** Baseline competencies are taken from the high school Metal Trades or Machine Shop program. Students who can document mastery of these competencies should not receive duplicate instruction. Students who cannot demonstrate mastery will be required to do so.

*** Drill Press & Band Saw Operations (MST 121(1-3), Lathe Turning Knowledge (MST 122(1-3), and Milling Machines Knowledge (MST 1231-3) may be taken in lieu of Power Machinery I MST 111(4-6).

**** Precision Lathe Operations MST 124(2-3), Surface Grinding Operations MST 125(1-2), and Milling Machine Operations MST 126(2-3) may be taken in lieu of Power Machinery II MST 112(4-6).

ELECTIVES

Keyboarding/Beginning Computer Concepts (BOA 1413)
Metallurgy (MST 2811-3)
Quality Assurance (DDT 2263)
Fundamentals of Microcomputer Applications (CPT 1113)
Fundamentals of Drafting (DDT 1114)
Principles of CAD (DDT 1313)
Safety and Fundamentals of Die Fabrication (TDT 1113)
Die Repair (TDT 1123)
Die Design I (TDT 1133)
Jigs, Fixtures, and Tools (TDT 2183)
Fundamentals of Geometric Design and Tolerance (MST 1624-6)
Applied Math for Industrial (CTE 1113)
Fundamentals of CAD/CAM (MST 2734-6)
Industrial Maintenance Safety (IMM 1112)
Power Tool Applications (IMM 1224)
Industrial Hand Tools (IMM 1213)
Machine Drafting I (DDT 1133)
Intermediate CAD (DDT 1323)
Gas Metal Arc Welding (WLV 1124)
Fluid Power (INT 1214)
Principles of Hydraulics and Pneumatics (IMM 1314)
Preventative Maintenance and Service of Equipment (IMM 1524)
Equipment Maintenance, Troubleshooting and Repair (IMM 2114)
Microcomputer Applications (BOT 1133)
Survey of Microcomputer Applications (CPT 1323)
Computer Concepts (CSC 1113)
Computer Applications I (CSC 1123)
Computer Fundamentals for Electronics (EET 1613)
Seminar I, II, III, IV (MST 1911, 1921, 1931, 1941)
Special Problem in Precision Manufacturing and Machining Technology [MST 291(1 4)]

Any other technical or academic course as approved by the instructor

Suggested Course Sequence*

Precision Manufacturing AND Machining Technology

2-YEAR CERTIFICATE OF PRECISION MANUFACTURING AND MACHINING TECHNOLOGY
MODULAR OPTION

Baseline Competencies for Precision Manufacturing and Machining Technology**

FIRST YEAR

3 sch	Machine Tool Mathematics (MST 1313)
2–3 sch	Blueprint Reading (MST 1412-3)
1–3 sch	Drill Press & Band Saw Operations [MST 121(1-3)]***
1–3 sch	Lathe Turning Knowledge [MST 122(1-3)]***
1–3 sch	Milling Machines Knowledge (MST 1231-3)***
3–5 sch	Elective
11–20 sch	

2–3 sch	Precision Lathe Operations MST 124(2-3)****
1–2 sch	Surface Grinding Operations MST 125(1-2)****
2–3 sch	Milling Machine Operations MST 126(2-3)****
3 sch	Precision Layout (MST 1613)
3 sch	Advanced Blueprint Reading (MST 1423)
3–5 sch	Elective
14–19 sch	

SECOND YEAR

2–3 sch	Advanced Lathe Operations MST 251(2-3)*****
1–3 sch	Advanced Milling Operations MST 252(1-3)*****
4–6 sch	Computer Numerical Control Operations I (MST 2714-6)
4–6 sch	Electives
11–18 sch	

1–2 sch	Precision Grinding Operations MST 253(1-2)******
1–2 sch	Gear Types and Manufacturing MST 254(1-2)******
1–2 sch	Advanced Machining Technologies MST 255(1-2)******
4–6 sch	Computer Numerical Control Operations II (MST 2724-6)
4–6 sch	Electives
11–18 sch	

* Students who lack entry-level skills in math, English, science, and so forth will be provided related studies.

** Baseline competencies are taken from the high school Metal Trades or Machine Shop Assistant program. Students who can document mastery of these competencies should not

receive duplicate instruction. Students who cannot demonstrate mastery will be required to do so.

*** Drill Press & Band Saw Operations (MST 121(1-3), Lathe Turning Knowledge (MST 122(1-3), and Milling Machines Knowledge (MST 1231-3) may be taken in lieu of Power Machinery I MST 111(4-6).
**** Precision Lathe Operations MST 124(2-3), Surface Grinding Operations MST 125(1-2), and Milling Machine Operations MST 126(2-3) may be taken in lieu of Power Machinery II MST 112(4-6).
***** Advanced Lathe Operations MST 251(2-3) and Advanced Milling Operations MST 252(1-3) may be taken in lieu of Power Machinery III MST 113(4-6).
****** Precision Grinding Operations MST 253(1-2), Gear Types and Manufacturing MST 254(1-2), and Advanced Machining Technologies MST 255(1-2) may be taken in lieu of Power Machinery IV MST 114(4-6).

ELECTIVES

Keyboarding/Beginning Computer Concepts (BOA 1413)
Metallurgy (MST 2811-3)
Fundamentals of Microcomputer Applications (CPT 1113)
Principles of CAD (DDT 1313)
Fundamentals of Drafting (DDT 1114)
Safety and Fundamentals of Die Fabrication (TDT 1113)
Die Repair (TDT 1123)
Die Design I (TDT 1133)
Jigs, Fixtures, and Tools (TDT 2183)
Fundamentals of Geometric Design and Tolerance (MST 1624-6)
Applied Math for Industrial (CTE 1113)
Fundamentals of CAD/CAM (MST 2734-6)
Industrial Maintenance Safety (IMM 1112)
Power Tool Applications (IMM 1224)
Industrial Hand Tools (IMM 1213)
Machine Drafting I (DDT 1133)
Intermediate CAD (DDT 1323)
Gas Metal Arc Welding (WLV 1124)
Fluid Power (INT 1214)
Principles of Hydraulics and Pneumatics (IMM 1314)
Preventative Maintenance and Service of Equipment (IMM 1524)
Equipment Maintenance, Troubleshooting and Repair (IMM 2114)
Microcomputer Applications (BOT 1133)
Survey of Microcomputer Applications (CPT 1323)
Computer Concepts (CSC 1113)
Computer Applications I (CSC 1123)
Computer Fundamentals for Electronics (EET 1613)
Seminar I, II, III, IV (MST 1911, 1921, 1931, 1941)

Supervised Work Experience in Precision Manufacturing and Machining Technology [MST 292(1-6)]
Special Problem in Precision Manufacturing and Machining Technology [MST 291(1-4)]
Work-Based Learning I, II, III, IV, V, VI [WBL 191(1-3), WBL 192(1-3), WBL 193(1-3), WBL 291(1-3), WBL 292(1-3), WBL 293(1-3)]

Any other technical or academic course as approved by the instructor

Suggested Course Sequence*

PRECISION MANUFACTURING AND MACHINING TECHNOLOGY

ASSOCIATE DEGREE IN PRECISION MANUFACTURING AND MACHINING TECHNOLOGY
MODULAR OPTION

Baseline Competencies for Precision Manufacturing and Machining Technology

FIRST YEAR

3 sch	Machine Tool Mathematics (MST 1313)
2–3 sch	Blueprint Reading (MST 1412-3)
1–3 sch	Drill Press & Band Saw Operations (MST 121(1-3)
1–3 sch	Lathe Turning Knowledge (MST 122(1-3)
1–3 sch	Milling Machines Knowledge (MST 1231-3)
3 sch	Written Communications Elective
11–18 sch	

2–3 sch	Precision Lathe Operations MST 124(2-3)
1–2 sch	Surface Grinding Operations MST 125(1-2)
2–3 sch	Milling Machine Operations MST 126(2-3)
3 sch	Precision Layout (MST 1613)
3 sch	Advanced Blueprint Reading (MST 1423)
3 sch	Math/Science Elective
3 sch	Humanities/Fine Arts Elective
17–20 sch	

SECOND YEAR

3–5 sch	Elective
2–3 sch	Advanced Lathe Operations MST 251(2-3)
1–3 sch	Advanced Milling Operations MST 252(1-3)
4–6 sch	Computer Numerical Control Operations I (MST 271(4-6)
3 sch	Oral Communications Elective
13–20 sch	

1–2 sch	Precision Grinding Operations MST 253(1-2)
1–2 sch	Gear Types and Manufacturing MST 254(1-2)
1–2 sch	Advanced Machining Technologies MST 255(1-2)
4–6 sch	Computer Numerical Control Operations II (MST 272(4-6)
3–5 sch	Elective
3 sch	Social/Behavioral Science Elective
13–20 sch	

* Students who lack entry-level skills in math, English, science, and so forth will be provided related studies.

** Baseline competencies are taken from the high school Metal Trades or Machine Shop program. Students who can document mastery of these competencies should not receive duplicate instruction. Students who cannot demonstrate mastery will be required to do so.

*** Drill Press & Band Saw Operations (MST 121(1-3), Lathe Turning Knowledge (MST 122(1-3), and Milling Machines Knowledge (MST 1231-3) may be taken in lieu of Power Machinery I MST 111(4-6).

**** Precision Lathe Operations MST 124(2-3), Surface Grinding Operations MST 125(1-2), and Milling Machine Operations MST 126(2-3) may be taken in lieu of Power Machinery II MST 112(4-6).

***** Advanced Lathe Operations MST 251(2-3) and Advanced Milling Operations MST 252(1-3) may be taken in lieu of Power Machinery III MST 113(4-6).

****** Precision Grinding Operations MST 253(1-2), Gear Types and Manufacturing MST 254(1-2), and Advanced Machining Technologies MST 255(1-2) may be taken in lieu of Power Machinery IV MST 114(4-6).

ELECTIVES

Keyboarding/Beginning Computer Concepts (BOA 1413)
Metallurgy (MST 2811-3)
Fundamentals of Microcomputer Applications (CPT 1113)
Principles of CAD (DDT 1313)
Fundamentals of Drafting (DDT 1114)
Safety and Fundamentals of Die Fabrication (TDT 1113)
Die Repair (TDT 1123)
Die Design I (TDT 1133)
Jigs, Fixtures, and Tools (TDT 2183)
Fundamentals of Geometric Design and Tolerance (MST 1624-6)
Applied Math for Industrial (CTE 1113)
Fundamentals of CAD/CAM (MST 2734-6)
Industrial Maintenance Safety (IMM 1112)
Power Tool Applications (IMM 1224)
Industrial Hand Tools (IMM 1213)
Machine Drafting I (DDT 1133)
Intermediate CAD (DDT 1323)
Gas Metal Arc Welding (WLV 1124)
Fluid Power (INT 1214)
Principles of Hydraulics and Pneumatics (IMM 1314)
Preventative Maintenance and Service of Equipment (IMM 1524)
Equipment Maintenance, Troubleshooting and Repair (IMM 2114)
Microcomputer Applications (BOT 1133)
Survey of Microcomputer Applications (CPT 1323)
Computer Concepts (CSC 1113)
Computer Applications I (CSC 1123)
Computer Fundamentals for Electronics (EET 1613)
Seminar I, II, III, IV (MST 1911, 1921, 1931, 1941)

Supervised Work Experience in Precision Manufacturing and Machining Technology [(MST 292(1-6)]
Special Problem in Precision Manufacturing and Machining Technology [(MST 29(1-4)]
Work-Based Learning I, II, III, IV, V, VI [WBL 191(1-3), WBL 192(1-3), WBL 193(1-3), WBL 291(1-3), WBL 292(1-3), WBL 293(1-3)]

Any other technical or academic course as approved by the instructor

Precision Manufacturing and Machining Technology Modular Option Courses

Course Name: Drill Press and Band Saw Operations

Course Abbreviation: MST 121(1-3)

Classification: Vocational–Technical Core

Description: This course provides instruction of general shop safety as well as the operation of power machinery that includes instruction and practice in the safe operation of power saws and drill presses. (1–3 sch: 1-hr lecture; 1-hr lecture, 2-hr lab; 2-hr lecture, 2-hr lab)

Prerequisite: None

Competencies and Suggested Objectives
1. Discuss and apply general machine shop safety and job planning. a. Identify, discuss, and test safety procedures. b. Demonstrate safety procedures. c. Explain the sequence in job planning. d. List the steps to follow in developing a plan. e. Lay out the steps in an assigned job.
2. Discuss, set up, and perform operations using a band saw and drill press safely. a. Discuss and utilize safety procedures. b. Identify types of band saws and accessories. c. Calculate speeds and feeds. d. Determine the type and length of a blade. e. Fabricate and install the blade. f. Cut a part to specifications using proper feeds and speeds. g. Identify and describe the types and parts of a drill press. h. Identify and re-sharpen different types of drill bits. i. Describe the use of layout instruments. j. Perform project layout using various instruments. k. Set up and perform various drilling operations to include counter boring and counter sinking. l. Perform a tapping operation to specifications.

STANDARDS

National Institute for Metalworking Skills

NIMS1	Job Planning and Management
NIMS2	Job Execution
NIMS3	Quality Control and Inspection
NIMS4	Process Adjustment and Improvement

NIMS5 General Maintenance
NIMS6 Industrial Safety and Environmental Protection

Related Academic Standards

R1 Interpret Graphic Information (forms, maps, reference sources)
R2 Words in Context (same and opposite meaning)
R3 Recall Information (details, sequence)
R4 Construct Meaning (main idea, summary/paraphrase, compare–contrast, cause–effect)
R5 Evaluate/Extend Meaning (fact/opinion, predict outcomes, point of view)
M1 Addition of Whole Numbers (no regrouping, regrouping)
M2 Subtraction of Whole Numbers (no regrouping, regrouping)
M3 Multiplication of Whole Numbers (no regrouping, regrouping)
M4 Division of Whole Numbers (no remainder, remainder)
M5 Decimals (addition, subtraction, multiplication, division)
M6 Fractions (addition, subtraction, multiplication, division)
M7 Integers (addition, subtraction, multiplication, division)
M8 Percents
M9 Algebraic Operations
A1 Numeration (ordering, place value, scientific notation)
A2 Number Theory (ratio, proportion)
A3 Data Interpretation (graph, table, chart, diagram)
A4 Pre-Algebra and Algebra (equations, inequality)
A5 Measurement (money, time, temperature, length, area, volume)
A6 Geometry (angles, Pythagorean theory)
A7 Computation in Context (whole numbers, decimals, fractions, algebraic operations)
A8 Estimation (rounding, estimation)
L1 Usage (pronoun, tense, subject–verb agreement, adjective, adverb)
L2 Sentence Formation (fragments, run-on, clarity)
L3 Paragraph Development (topic sentence, supporting sentence, sequence)
L4 Capitalization (proper noun, titles)
L5 Punctuation (comma, semicolon)
L6 Writing Conventions (quotation marks, apostrophe, parts of a letter)
S1 Vowel (short, long)
S2 Consonant (variant spelling, silent letter)
S3 Structural Unit (root, suffix)

21st Century Skills

CS1 Global Awareness
CS2 Financial, Economic, and Business Literacy
CS3 Civic Literacy
CS4 Information and Communication Skills
CS5 Thinking and Problem-Solving Skills

CS6 Interpersonal and Self-Directional Skills

SUGGESTED REFERENCES

General Machine Tool

Fitzpatrick, M. (2005). *Machining and CNC technology.* Boston, MA: McGraw-Hill.

Kibbe, R., Neely, J., Meyer, R., & White, W. (2010). *Machine tool practices* [with workbook]. Upper Saddle River, NJ: Prentice Hall.

Krar, S., Gill, A., & Smid, P. (2005). *Technology of machine tools.* Boston, MA: McGraw-Hill.

Krar, S., Rapisarda, M., & Check, A. (1998). *Machine tool and manufacturing technology.* Albany, NY: Delmar Learning.

Oberg, E., Jones, F., Horton, H., & Ryffel, H. (2005). *Machinery's handbook.* New York, NY: Industrial Press.

Walker, J. (2004). *Machining fundamentals* [with workbook]. Tinley Park, IL: Goodheart-Willcox.

Weingartner, C., & Effner, J. (2001). *Machinist's ready reference*. Ann Arbor, MI: Prakken Publications, Inc.

Wentzell, T. (2004). *Machine design.* Albany, NY: Delmar Learning.

Journals

CNC Machining. Oxnard, CA: Haas Automation.

The Home Shop Machinist. Travers City, MI: Village Press.

Live Steam. Travers City, MI: Village Press.

The Machinist Workshop. Travers City, MI: Village Press.

Manufacturing Engineering. Dearborn, MI: Society of Manufacturing Engineers. Retrieved April 8, 2009, from http://www.sme.org/cgi-bin/find-issues.pl?&&ME&%20http%20SME&

Manufacturing News. Grapevine, TX: Southeast Manufacturing News.

Video

RMI Media Productions. (n.d.). *Machine shop series* [Videotape]. (Available from RMI Media Productions, 2807 West 47th Street, Shawnee Mission, KS 66205)

Web Site

Society of Manufacturing Engineering. Retrieved April 9, 2009, from http://www.sme.org/manufacturingengineering

Course Name: Lathe Turning Knowledge

Course Abbreviation: MST 1221-3

Classification: Vocational–Technical Core

Description: This course provides instruction of general shop safety as well as the operation of the lathe. The course will implement the performance of lathe operations resulting in the manufacture of various parts.(1–3 sch: 1-hr lecture; 1-hr lecture, 2-hr lab; 2-hr lecture, 2-hr lab)

Prerequisite: None

Competencies and Suggested Objectives
1. Discuss and apply general machine shop safety and job planning. a. Identify, discuss, and test safety procedures. b. Demonstrate safety procedures. c. Explain the sequence in job planning. d. List the steps to follow in developing a plan. e. Lay out the steps in an assigned job.
2. Perform cutting operations to project specifications safely. a. Use shop formulas and charts to determine lathe speed and feed rates, and make application to production. b. Perform measurements with precision instruments. c. Explain the procedures for preparing an engine lathe. d. Sharpen a cutoff tool blade, and perform recessing and cutoff operations. e. Grind cutting tools to satisfy special job requirements. f. Identify, select, and use carbide cutting tools. g. Use an engine lathe to turn a taper using the compound. h. Discuss and perform boring operations safely. i. Cut various external threads to specified class of fit. j. Measure thread pitch diameter using thread micrometers and three wire method.

STANDARDS

National Institute for Metalworking Skills

NIMS1	Job Planning and Management
NIMS2	Job Execution
NIMS3	Quality Control and Inspection
NIMS4	Process Adjustment and Improvement
NIMS5	General Maintenance
NIMS6	Industrial Safety and Environmental Protection

Related Academic Standards

R1 Interpret Graphic Information (forms, maps, reference sources)
R2 Words in Context (same and opposite meaning)
R3 Recall Information (details, sequence)
R4 Construct Meaning (main idea, summary/paraphrase, compare–contrast, cause–effect)
R5 Evaluate/Extend Meaning (fact/opinion, predict outcomes, point of view)
M1 Addition of Whole Numbers (no regrouping, regrouping)
M2 Subtraction of Whole Numbers (no regrouping, regrouping)
M3 Multiplication of Whole Numbers (no regrouping, regrouping)
M4 Division of Whole Numbers (no remainder, remainder)
M5 Decimals (addition, subtraction, multiplication, division)
M6 Fractions (addition, subtraction, multiplication, division)
M7 Integers (addition, subtraction, multiplication, division)
M8 Percents
M9 Algebraic Operations
A1 Numeration (ordering, place value, scientific notation)
A2 Number Theory (ratio, proportion)
A3 Data Interpretation (graph, table, chart, diagram)
A4 Pre-Algebra and Algebra (equations, inequality)
A5 Measurement (money, time, temperature, length, area, volume)
A6 Geometry (angles, Pythagorean theory)
A7 Computation in Context (whole numbers, decimals, fractions, algebraic operations)
A8 Estimation (rounding, estimation)
L1 Usage (pronoun, tense, subject–verb agreement, adjective, adverb)
L2 Sentence Formation (fragments, run-on, clarity)
L3 Paragraph Development (topic sentence, supporting sentence, sequence)
L4 Capitalization (proper noun, titles)
L5 Punctuation (comma, semicolon)
L6 Writing Conventions (quotation marks, apostrophe, parts of a letter)
S1 Vowel (short, long)
S2 Consonant (variant spelling, silent letter)
S3 Structural Unit (root, suffix)

21st Century Skills

CS1 Global Awareness
CS2 Financial, Economic, and Business Literacy
CS3 Civic Literacy
CS4 Information and Communication Skills
CS5 Thinking and Problem-Solving Skills
CS6 Interpersonal and Self-Directional Skills

SUGGESTED REFERENCES

General Machine Tool

Fitzpatrick, M. (2005). *Machining and CNC technology.* Boston, MA: McGraw-Hill.

Kibbe, R., Neely, J., Meyer, R., & White, W. (2010). *Machine tool practices* [with workbook]. Upper Saddle River, NJ: Prentice Hall.

Krar, S., Gill, A., & Smid, P. (2005). *Technology of machine tools.* Boston, MA: McGraw-Hill.

Krar, S., Rapisarda, M., & Check, A. (1998). *Machine tool and manufacturing technology.* Albany, NY: Delmar Learning.

Oberg, E., Jones, F., Horton, H., & Ryffel, H. (2005). *Machinery's handbook.* New York, NY: Industrial Press.

Walker, J. (2004). *Machining fundamentals* [with workbook]. Tinley Park, IL: Goodheart-Willcox.

Weingartner, C., & Effner, J. (2001). *Machinist's ready reference*. Ann Arbor, MI: Prakken Publications, Inc.

Wentzell, T. (2004). *Machine design.* Albany, NY: Delmar Learning.

Journals

CNC Machining. Oxnard, CA: Haas Automation.

The Home Shop Machinist. Travers City, MI: Village Press.

Live Steam. Travers City, MI: Village Press.

The Machinist Workshop. Travers City, MI: Village Press.

Manufacturing Engineering. Dearborn, MI: Society of Manufacturing Engineers. Retrieved April 8, 2009, from http://www.sme.org/cgi-bin/find-issues.pl?&&ME&%20http%20SME&

Manufacturing News. Grapevine, TX: Southeast Manufacturing News.

Video

RMI Media Productions. (n.d.). *Machine shop series* [Videotape]. (Available from RMI Media Productions, 2807 West 47th Street, Shawnee Mission, KS 66205)

Web Site

Society of Manufacturing Engineering. Retrieved April 9, 2009, from http://www.sme.org/manufacturingengineering

Course Name: Milling Machines Knowledge

Course Abbreviation: MST 1231-3

Classification: Vocational–Technical Core

Description: This course provides instruction of general shop safety as well as the operation of vertical milling machines. The course will implement the performance of milling operations resulting in the manufacture of various parts. (1–3 sch: 1-hr lecture; 1-hr lecture, 2-hr lab; 2-hr lecture, 2-hr lab)

Prerequisite: None

Competencies and Suggested Objectives
1. Discuss and apply general machine shop safety and job planning. a. Identify, discuss, and test safety procedures. b. Demonstrate safety procedures. c. Explain the sequence in job planning. d. List the steps to follow in developing a plan. e. Lay out the steps in an assigned job.
2. Set up a milling machine, and perform milling operations safely. a. Identify and study parts of the vertical milling machine. b. Tram the head of a vertical mill. c. Perform measurements with precision instruments. d. Mount and align a swivel-base vise on a milling machine using a dial indicator. e. Identify various cutters and accessories used in milling. f. Perform selected milling operations according to project specifications.

STANDARDS

National Institute for Metalworking Skills

NIMS1	Job Planning and Management
NIMS2	Job Execution
NIMS3	Quality Control and Inspection
NIMS4	Process Adjustment and Improvement
NIMS5	General Maintenance
NIMS6	Industrial Safety and Environmental Protection

Related Academic Standards

R1	Interpret Graphic Information (forms, maps, reference sources)
R2	Words in Context (same and opposite meaning)
R3	Recall Information (details, sequence)

R4 Construct Meaning (main idea, summary/paraphrase, compare–contrast, cause–effect)
R5 Evaluate/Extend Meaning (fact/opinion, predict outcomes, point of view)
M1 Addition of Whole Numbers (no regrouping, regrouping)
M2 Subtraction of Whole Numbers (no regrouping, regrouping)
M3 Multiplication of Whole Numbers (no regrouping, regrouping)
M4 Division of Whole Numbers (no remainder, remainder)
M5 Decimals (addition, subtraction, multiplication, division)
M6 Fractions (addition, subtraction, multiplication, division)
M7 Integers (addition, subtraction, multiplication, division)
M8 Percents
M9 Algebraic Operations
A1 Numeration (ordering, place value, scientific notation)
A2 Number Theory (ratio, proportion)
A3 Data Interpretation (graph, table, chart, diagram)
A4 Pre-Algebra and Algebra (equations, inequality)
A5 Measurement (money, time, temperature, length, area, volume)
A6 Geometry (angles, Pythagorean theory)
A7 Computation in Context (whole numbers, decimals, fractions, algebraic operations)
A8 Estimation (rounding, estimation)
L1 Usage (pronoun, tense, subject–verb agreement, adjective, adverb)
L2 Sentence Formation (fragments, run-on, clarity)
L3 Paragraph Development (topic sentence, supporting sentence, sequence)
L4 Capitalization (proper noun, titles)
L5 Punctuation (comma, semicolon)
L6 Writing Conventions (quotation marks, apostrophe, parts of a letter)
S1 Vowel (short, long)
S2 Consonant (variant spelling, silent letter)
S3 Structural Unit (root, suffix)

21st Century Skills

CS1 Global Awareness
CS2 Financial, Economic, and Business Literacy
CS3 Civic Literacy
CS4 Information and Communication Skills
CS5 Thinking and Problem-Solving Skills
CS6 Interpersonal and Self-Directional Skills

SUGGESTED REFERENCES

General Machine Tool

Fitzpatrick, M. (2005). *Machining and CNC technology*. Boston, MA: McGraw-Hill.

Kibbe, R., Neely, J., Meyer, R., & White, W. (2010). *Machine tool practices* [with workbook]. Upper Saddle River, NJ: Prentice Hall.

Krar, S., Gill, A., & Smid, P. (2005). *Technology of machine tools.* Boston, MA: McGraw-Hill.

Krar, S., Rapisarda, M., & Check, A. (1998). *Machine tool and manufacturing technology.* Albany, NY: Delmar Learning.

Oberg, E., Jones, F., Horton, H., & Ryffel, H. (2005). *Machinery's handbook.* New York, NY: Industrial Press.

Walker, J. (2004). *Machining fundamentals* [with workbook]. Tinley Park, IL: Goodheart-Willcox.

Weingartner, C., & Effner, J. (2001). *Machinist's ready reference*. Ann Arbor, MI: Prakken Publications, Inc.

Wentzell, T. (2004). *Machine design.* Albany, NY: Delmar Learning.

Journals

CNC Machining. Oxnard, CA: Haas Automation.

The Home Shop Machinist. Travers City, MI: Village Press.

Live Steam. Travers City, MI: Village Press.

The Machinist Workshop. Travers City, MI: Village Press.

Manufacturing Engineering. Dearborn, MI: Society of Manufacturing Engineers. Retrieved April 8, 2009, from http://www.sme.org/cgi-bin/find-issues.pl?&&ME&%20http%20SME&

Manufacturing News. Grapevine, TX: Southeast Manufacturing News.

Video

RMI Media Productions. (n.d.). *Machine shop series* [Videotape]. (Available from RMI Media Productions, 2807 West 47th Street, Shawnee Mission, KS 66205)

Web Site

Society of Manufacturing Engineering. Retrieved April 9, 2009, from http://www.sme.org/manufacturingengineering

Course Name: Precision Lathe Operations

Course Abbreviation: MST 1242-3

Classification: Vocational–Technical Core

Description: This course is a continuation of lathe tuning knowledge and provides instruction of general shop safety as well as additional instruction in lathe operations. (1–3 sch: 1-hr lecture; 1-hr lecture, 2-hr lab; 2-hr lecture, 2-hr lab)

Prerequisite: Consent of Instructor

Competencies and Suggested Objectives
1. Discuss and apply general machine shop safety. a. Identify, discuss, and test safety procedures. b. Demonstrate safety procedures.
2. Prepare the engine lathe, and perform various operations according to specifications safely. a. Use taper formulas to calculate dimensions, and perform taper turning operation using the taper attachment. b. Set up and turn work between centers. c. Chase an unfinished or damaged thread. d. Calculate bore size for various types and sizes of internal threads. e. Turn internal threads to specified class of fit.

STANDARDS

National Institute for Metalworking Skills

NIMS1	Job Planning and Management
NIMS2	Job Execution
NIMS3	Quality Control and Inspection
NIMS4	Process Adjustment and Improvement
NIMS5	General Maintenance
NIMS6	Industrial Safety and Environmental Protection

Related Academic Standards

R1	Interpret Graphic Information (forms, maps, reference sources)
R2	Words in Context (same and opposite meaning)
R3	Recall Information (details, sequence)
R4	Construct Meaning (main idea, summary/paraphrase, compare–contrast, cause–effect)
R5	Evaluate/Extend Meaning (fact/opinion, predict outcomes, point of view)
M1	Addition of Whole Numbers (no regrouping, regrouping)
M2	Subtraction of Whole Numbers (no regrouping, regrouping)
M3	Multiplication of Whole Numbers (no regrouping, regrouping)

M4 Division of Whole Numbers (no remainder, remainder)
M5 Decimals (addition, subtraction, multiplication, division)
M6 Fractions (addition, subtraction, multiplication, division)
M7 Integers (addition, subtraction, multiplication, division)
M8 Percents
M9 Algebraic Operations
A1 Numeration (ordering, place value, scientific notation)
A2 Number Theory (ratio, proportion)
A3 Data Interpretation (graph, table, chart, diagram)
A4 Pre-Algebra and Algebra (equations, inequality)
A5 Measurement (money, time, temperature, length, area, volume)
A6 Geometry (angles, Pythagorean theory)
A7 Computation in Context (whole numbers, decimals, fractions, algebraic operations)
A8 Estimation (rounding, estimation)
L1 Usage (pronoun, tense, subject–verb agreement, adjective, adverb)
L2 Sentence Formation (fragments, run-on, clarity)
L3 Paragraph Development (topic sentence, supporting sentence, sequence)
L4 Capitalization (proper noun, titles)
L5 Punctuation (comma, semicolon)
L6 Writing Conventions (quotation marks, apostrophe, parts of a letter)
S1 Vowel (short, long)
S2 Consonant (variant spelling, silent letter)
S3 Structural Unit (root, suffix)

21st Century Skills

CS1 Global Awareness
CS2 Financial, Economic, and Business Literacy
CS3 Civic Literacy
CS4 Information and Communication Skills
CS5 Thinking and Problem-Solving Skills
CS6 Interpersonal and Self-Directional Skills

SUGGESTED REFERENCES

General Machine Tool

Fitzpatrick, M. (2005). *Machining and CNC technology.* Boston, MA: McGraw-Hill.

Kibbe, R., Neely, J., Meyer, R., & White, W. (2010). *Machine tool practices* [with workbook]. Upper Saddle River, NJ: Prentice Hall.

Krar, S., Gill, A., & Smid, P. (2005). *Technology of machine tools.* Boston, MA: McGraw-Hill.

Krar, S., Rapisarda, M., & Check, A. (1998). *Machine tool and manufacturing technology.* Albany, NY: Delmar Learning.

Oberg, E., Jones, F., Horton, H., & Ryffel, H. (2005). *Machinery's handbook.* New York, NY: Industrial Press.

Walker, J. (2004). *Machining fundamentals* [with workbook]. Tinley Park, IL: Goodheart-Willcox.

Weingartner, C., & Effner, J. (2001). *Machinist's ready reference*. Ann Arbor, MI: Prakken Publications, Inc.

Wentzell, T. (2004). *Machine design.* Albany, NY: Delmar Learning.

Journals

CNC Machining. Oxnard, CA: Haas Automation.

The Home Shop Machinist. Travers City, MI: Village Press.

Live Steam. Travers City, MI: Village Press.

The Machinist Workshop. Travers City, MI: Village Press.

Manufacturing Engineering. Dearborn, MI: Society of Manufacturing Engineers. Retrieved April 8, 2009, from http://www.sme.org/cgi-bin/find-issues.pl?&&ME&%20http%20SME&

Manufacturing News. Grapevine, TX: Southeast Manufacturing News.

Video

RMI Media Productions. (n.d.). *Machine shop series* [Videotape]. (Available from RMI Media Productions, 2807 West 47th Street, Shawnee Mission, KS 66205)

Web Site

Society of Manufacturing Engineering. Retrieved April 9, 2009, from http://www.sme.org/manufacturingengineering

Course Name: Surface Grinding Operations

Course Abbreviation: MST 1251-2

Classification: Vocational–Technical Core

Description: This course provides instruction in general shop safety as well as emphasis on advanced applications of precision grinders. (1–2 sch: 1-hr lecture; 1-hr lecture, 2-hr lab)

Prerequisite: Consent of Instructor

Competencies and Suggested Objectives
1. Discuss and apply general machine shop safety. a. Identify, discuss, and test safety procedures. b. Demonstrate safety procedures.
2. Explain and use a precision surface grinder safely. a. Describe surface grinding types and operations. b. Identify, select, install, and use the different types of grinding wheels for various precision grinding operations. c. Grind different shaped parts using various holding devices.

STANDARDS

National Institute for Metalworking Skills

NIMS1	Job Planning and Management
NIMS2	Job Execution
NIMS3	Quality Control and Inspection
NIMS4	Process Adjustment and Improvement
NIMS5	General Maintenance
NIMS6	Industrial Safety and Environmental Protection

Related Academic Standards

R1	Interpret Graphic Information (forms, maps, reference sources)
R2	Words in Context (same and opposite meaning)
R3	Recall Information (details, sequence)
R4	Construct Meaning (main idea, summary/paraphrase, compare–contrast, cause–effect)
R5	Evaluate/Extend Meaning (fact/opinion, predict outcomes, point of view)
M1	Addition of Whole Numbers (no regrouping, regrouping)
M2	Subtraction of Whole Numbers (no regrouping, regrouping)
M3	Multiplication of Whole Numbers (no regrouping, regrouping)
M4	Division of Whole Numbers (no remainder, remainder)
M5	Decimals (addition, subtraction, multiplication, division)

M6 Fractions (addition, subtraction, multiplication, division)
M7 Integers (addition, subtraction, multiplication, division)
M8 Percents
M9 Algebraic Operations
A1 Numeration (ordering, place value, scientific notation)
A2 Number Theory (ratio, proportion)
A3 Data Interpretation (graph, table, chart, diagram)
A4 Pre-Algebra and Algebra (equations, inequality)
A5 Measurement (money, time, temperature, length, area, volume)
A6 Geometry (angles, Pythagorean theory)
A7 Computation in Context (whole numbers, decimals, fractions, algebraic operations)
A8 Estimation (rounding, estimation)
L1 Usage (pronoun, tense, subject–verb agreement, adjective, adverb)
L2 Sentence Formation (fragments, run-on, clarity)
L3 Paragraph Development (topic sentence, supporting sentence, sequence)
L4 Capitalization (proper noun, titles)
L5 Punctuation (comma, semicolon)
L6 Writing Conventions (quotation marks, apostrophe, parts of a letter)
S1 Vowel (short, long)
S2 Consonant (variant spelling, silent letter)
S3 Structural Unit (root, suffix)

21st Century Skills

CS1 Global Awareness
CS2 Financial, Economic, and Business Literacy
CS3 Civic Literacy
CS4 Information and Communication Skills
CS5 Thinking and Problem-Solving Skills
CS6 Interpersonal and Self-Directional Skills

SUGGESTED REFERENCES

General Machine Tool

Fitzpatrick, M. (2005). *Machining and CNC technology.* Boston, MA: McGraw-Hill.

Kibbe, R., Neely, J., Meyer, R., & White, W. (2010). *Machine tool practices* [with workbook]. Upper Saddle River, NJ: Prentice Hall.

Krar, S., Gill, A., & Smid, P. (2005). *Technology of machine tools.* Boston, MA: McGraw-Hill.

Krar, S., Rapisarda, M., & Check, A. (1998). *Machine tool and manufacturing technology.* Albany, NY: Delmar Learning.

Oberg, E., Jones, F., Horton, H., & Ryffel, H. (2005). *Machinery's handbook.* New York, NY: Industrial Press.

Walker, J. (2004). *Machining fundamentals* [with workbook]. Tinley Park, IL: Goodheart-Willcox.

Weingartner, C., & Effner, J. (2001). *Machinist's ready reference*. Ann Arbor, MI: Prakken Publications, Inc.

Wentzell, T. (2004). *Machine design.* Albany, NY: Delmar Learning.

Journals

CNC Machining. Oxnard, CA: Haas Automation.

The Home Shop Machinist. Travers City, MI: Village Press.

Live Steam. Travers City, MI: Village Press.

The Machinist Workshop. Travers City, MI: Village Press.

Manufacturing Engineering. Dearborn, MI: Society of Manufacturing Engineers. Retrieved April 8, 2009, from http://www.sme.org/cgi-bin/find-issues.pl?&&ME&%20http%20SME&

Manufacturing News. Grapevine, TX: Southeast Manufacturing News.

Video

RMI Media Productions. (n.d.). *Machine shop series* [Videotape]. (Available from RMI Media Productions, 2807 West 47th Street, Shawnee Mission, KS 66205)

Web Site

Society of Manufacturing Engineering. Retrieved April 9, 2009, from http://www.sme.org/manufacturingengineering

Course Name: Milling Machine Operations

Course Abbreviation: MST 1262-3

Classification: Vocational–Technical Core

Description This course provides instruction in general shop safety as well as emphasis on advanced applications of milling machine operations. (2–3 sch: 1-hr lecture, 2-hr lab; 2-hr lecture, 2-hr lab)

Prerequisite: Consent of Instructor

Competencies and Suggested Objectives
1. Discuss and apply general machine shop safety. a. Identify, discuss, and test safety procedures. b. Demonstrate safety procedures.
2. Set up and perform vertical milling operations safely according to project specifications. a. Perform boring operations using the precision boring head. b. Perform a compound angling operation. c. Set up and machine work piece in mill using sine bar and gauge blocks.

STANDARDS

National Institute for Metalworking Skills

NIMS1	Job Planning and Management
NIMS2	Job Execution
NIMS3	Quality Control and Inspection
NIMS4	Process Adjustment and Improvement
NIMS5	General Maintenance
NIMS6	Industrial Safety and Environmental Protection

Related Academic Standards

R1	Interpret Graphic Information (forms, maps, reference sources)
R2	Words in Context (same and opposite meaning)
R3	Recall Information (details, sequence)
R4	Construct Meaning (main idea, summary/paraphrase, compare–contrast, cause–effect)
R5	Evaluate/Extend Meaning (fact/opinion, predict outcomes, point of view)
M1	Addition of Whole Numbers (no regrouping, regrouping)
M2	Subtraction of Whole Numbers (no regrouping, regrouping)
M3	Multiplication of Whole Numbers (no regrouping, regrouping)
M4	Division of Whole Numbers (no remainder, remainder)
M5	Decimals (addition, subtraction, multiplication, division)
M6	Fractions (addition, subtraction, multiplication, division)

M7 Integers (addition, subtraction, multiplication, division)
M8 Percents
M9 Algebraic Operations
A1 Numeration (ordering, place value, scientific notation)
A2 Number Theory (ratio, proportion)
A3 Data Interpretation (graph, table, chart, diagram)
A4 Pre-Algebra and Algebra (equations, inequality)
A5 Measurement (money, time, temperature, length, area, volume)
A6 Geometry (angles, Pythagorean theory)
A7 Computation in Context (whole numbers, decimals, fractions, algebraic operations)
A8 Estimation (rounding, estimation)
L1 Usage (pronoun, tense, subject–verb agreement, adjective, adverb)
L2 Sentence Formation (fragments, run-on, clarity)
L3 Paragraph Development (topic sentence, supporting sentence, sequence)
L4 Capitalization (proper noun, titles)
L5 Punctuation (comma, semicolon)
L6 Writing Conventions (quotation marks, apostrophe, parts of a letter)
S1 Vowel (short, long)
S2 Consonant (variant spelling, silent letter)
S3 Structural Unit (root, suffix)

21st Century Skills

CS1 Global Awareness
CS2 Financial, Economic, and Business Literacy
CS3 Civic Literacy
CS4 Information and Communication Skills
CS5 Thinking and Problem-Solving Skills
CS6 Interpersonal and Self-Directional Skills

SUGGESTED REFERENCES

General Machine Tool

Fitzpatrick, M. (2005). *Machining and CNC technology.* Boston, MA: McGraw-Hill.

Kibbe, R., Neely, J., Meyer, R., & White, W. (2010). *Machine tool practices* [with workbook]. Upper Saddle River, NJ: Prentice Hall.

Krar, S., Gill, A., & Smid, P. (2005). *Technology of machine tools.* Boston, MA: McGraw-Hill.

Krar, S., Rapisarda, M., & Check, A. (1998). *Machine tool and manufacturing technology.* Albany, NY: Delmar Learning.

Oberg, E., Jones, F., Horton, H., & Ryffel, H. (2005). *Machinery's handbook.* New York, NY: Industrial Press.

Walker, J. (2004). *Machining fundamentals* [with workbook]. Tinley Park, IL: Goodheart-Willcox.

Weingartner, C., & Effner, J. (2001). *Machinist's ready reference*. Ann Arbor, MI: Prakken Publications, Inc.

Wentzell, T. (2004). *Machine design.* Albany, NY: Delmar Learning.

Journals

CNC Machining. Oxnard, CA: Haas Automation.

The Home Shop Machinist. Travers City, MI: Village Press.

Live Steam. Travers City, MI: Village Press.

The Machinist Workshop. Travers City, MI: Village Press.

Manufacturing Engineering. Dearborn, MI: Society of Manufacturing Engineers. Retrieved April 8, 2009, from http://www.sme.org/cgi-bin/find-issues.pl?&&ME&%20http%20SME&

Manufacturing News. Grapevine, TX: Southeast Manufacturing News.

Video

RMI Media Productions. (n.d.). *Machine shop series* [Videotape]. (Available from RMI Media Productions, 2807 West 47th Street, Shawnee Mission, KS 66205)

Web Site

Society of Manufacturing Engineering. Retrieved April 9, 2009, from http://www.sme.org/manufacturingengineering

Course Name: Advanced Lathe Operations

Course Abbreviation: MST 2512-3

Classification: Vocational–Technical Core (Precision Manufacturing and Machining 2-Year Certificate and Associate Degree)

Description: This course provides instruction on safety and advanced applications of the engine lathe. (2–3 sch: 1-hr lecture, 2-hr lab; 2-hr lecture, 2-hr lab)

Prerequisite: Consent of Instructor

Competencies and Suggested Objectives
1. Discuss and apply general machine shop safety. a. Identify, discuss, and test safety procedures. b. Demonstrate safety procedures.
2. Calculate and fabricate commonly used threads safely. a. Calculate dimensions and machine additional internal and external thread form types.
3. Describe and fabricate various tapers safely. a. Discuss the different types of tapers and the methods used to produce and measure them. b. Machine different types of internal and external tapers to specifications using the taper attachment and/or tailstock offset method.
4. Perform eccentric turning operations safely. a. Describe the procedure for eccentric turning. b. Manufacture eccentric parts to specifications.
5. Prepare and use a lathe to perform various operations safely. a. Install, set up, and use lathe accessories to include the following: steady rest, follower rest, and tool post grinder (when applicable).

STANDARDS

National Institute for Metalworking Skills

NIMS1 Job Planning and Management
NIMS2 Job Execution
NIMS3 Quality Control and Inspection
NIMS4 Process Adjustment and Improvement
NIMS5 General Maintenance
NIMS6 Industrial Safety and Environmental Protection

Related Academic Standards

R1 Interpret Graphic Information (forms, maps, reference sources)
R2 Words in Context (same and opposite meaning)

R3 Recall Information (details, sequence)
R4 Construct Meaning (main idea, summary/paraphrase, compare–contrast, cause–effect)
R5 Evaluate/Extend Meaning (fact/opinion, predict outcomes, point of view)
M1 Addition of Whole Numbers (no regrouping, regrouping)
M2 Subtraction of Whole Numbers (no regrouping, regrouping)
M3 Multiplication of Whole Numbers (no regrouping, regrouping)
M4 Division of Whole Numbers (no remainder, remainder)
M5 Decimals (addition, subtraction, multiplication, division)
M6 Fractions (addition, subtraction, multiplication, division)
M7 Integers (addition, subtraction, multiplication, division)
M8 Percents
M9 Algebraic Operations
A1 Numeration (ordering, place value, scientific notation)
A2 Number Theory (ratio, proportion)
A3 Data Interpretation (graph, table, chart, diagram)
A4 Pre-Algebra and Algebra (equations, inequality)
A5 Measurement (money, time, temperature, length, area, volume)
A6 Geometry (angles, Pythagorean theory)
A7 Computation in Context (whole numbers, decimals, fractions, algebraic operations)
A8 Estimation (rounding, estimation)
L1 Usage (pronoun, tense, subject–verb agreement, adjective, adverb)
L2 Sentence Formation (fragments, run-on, clarity)
L3 Paragraph Development (topic sentence, supporting sentence, sequence)
L4 Capitalization (proper noun, titles)
L5 Punctuation (comma, semicolon)
L6 Writing Conventions (quotation marks, apostrophe, parts of a letter)
S1 Vowel (short, long)
S2 Consonant (variant spelling, silent letter)
S3 Structural Unit (root, suffix)

21st Century Skills

CS1 Global Awareness
CS2 Financial, Economic, and Business Literacy
CS3 Civic Literacy
CS4 Information and Communication Skills
CS5 Thinking and Problem-Solving Skills
CS6 Interpersonal and Self-Directional Skills

SUGGESTED REFERENCES

General Machine Tool

Fitzpatrick, M. (2005). *Machining and CNC technology*. Boston, MA: McGraw-Hill.

Kibbe, R., Neely, J., Meyer, R., & White, W. (2010). *Machine tool practices* [with workbook]. Upper Saddle River, NJ: Prentice Hall.

Krar, S., Gill, A., & Smid, P. (2005). *Technology of machine tools.* Boston, MA: McGraw-Hill.

Krar, S., Rapisarda, M., & Check, A. (1998). *Machine tool and manufacturing technology.* Albany, NY: Delmar Learning.

Oberg, E., Jones, F., Horton, H., & Ryffel, H. (2005). *Machinery's handbook.* New York, NY: Industrial Press.

Walker, J. (2004). *Machining fundamentals* [with workbook]. Tinley Park, IL: Goodheart-Willcox.

Weingartner, C., & Effner, J. (2001). *Machinist's ready reference*. Ann Arbor, MI: Prakken Publications, Inc.

Wentzell, T. (2004). *Machine design.* Albany, NY: Delmar Learning.

Journals

CNC Machining. Oxnard, CA: Haas Automation.

The Home Shop Machinist. Travers City, MI: Village Press.

Live Steam. Travers City, MI: Village Press.

The Machinist Workshop. Travers City, MI: Village Press.

Manufacturing Engineering. Dearborn, MI: Society of Manufacturing Engineers. Retrieved April 8, 2009, from http://www.sme.org/cgi-bin/find-issues.pl?&&ME&%20http%20SME&

Manufacturing News. Grapevine, TX: Southeast Manufacturing News.

Video

Coastal Skills Training. (n.d.). *Intermediate lathe* [Videotape]. (Available from Coastal Skills Training, 3083 Brickhouse Center, Virginia Beach, VA 23452)

Web Site

Society of Manufacturing Engineering. Retrieved April 9, 2009, from http://www.sme.org/manufacturingengineering

Course Name: Advanced Milling Operations

Course Abbreviation: MST 2521-3

Classification: Vocational–Technical Core (Precision Manufacturing and Machining 2-Year Certificate and Associate Degree)

Description: This course provides instruction on safety and advanced applications of the vertical milling machine. (1–3 sch: 1-hr lecture; 1-hr lecture, 2-hr lab; 2-hr lecture, 2-hr lab)

Prerequisite: Consent of Instructor

Competencies and Suggested Objectives
1. Discuss and apply general machine shop safety. a. Identify, discuss, and test safety procedures. b. Demonstrate safety procedures.
2. Perform key cutting operation using a vertical mill. a. Cut a keyway to specifications. b. Cut a keyseat to specifications. c. Set up and manufacture parts correctly using an indexable dividing head. d. Discuss and demonstrate the uses of a rotary table and vertical slotting head.

STANDARDS

National Institute for Metalworking Skills

NIMS1	Job Planning and Management
NIMS2	Job Execution
NIMS3	Quality Control and Inspection
NIMS4	Process Adjustment and Improvement
NIMS5	General Maintenance
NIMS6	Industrial Safety and Environmental Protection

Related Academic Standards

R1	Interpret Graphic Information (forms, maps, reference sources)
R2	Words in Context (same and opposite meaning)
R3	Recall Information (details, sequence)
R4	Construct Meaning (main idea, summary/paraphrase, compare–contrast, cause–effect)
R5	Evaluate/Extend Meaning (fact/opinion, predict outcomes, point of view)
M1	Addition of Whole Numbers (no regrouping, regrouping)
M2	Subtraction of Whole Numbers (no regrouping, regrouping)
M3	Multiplication of Whole Numbers (no regrouping, regrouping)
M4	Division of Whole Numbers (no remainder, remainder)
M5	Decimals (addition, subtraction, multiplication, division)
M6	Fractions (addition, subtraction, multiplication, division)

M7 Integers (addition, subtraction, multiplication, division)
M8 Percents
M9 Algebraic Operations
A1 Numeration (ordering, place value, scientific notation)
A2 Number Theory (ratio, proportion)
A3 Data Interpretation (graph, table, chart, diagram)
A4 Pre-Algebra and Algebra (equations, inequality)
A5 Measurement (money, time, temperature, length, area, volume)
A6 Geometry (angles, Pythagorean theory)
A7 Computation in Context (whole numbers, decimals, fractions, algebraic operations)
A8 Estimation (rounding, estimation)
L1 Usage (pronoun, tense, subject–verb agreement, adjective, adverb)
L2 Sentence Formation (fragments, run-on, clarity)
L3 Paragraph Development (topic sentence, supporting sentence, sequence)
L4 Capitalization (proper noun, titles)
L5 Punctuation (comma, semicolon)
L6 Writing Conventions (quotation marks, apostrophe, parts of a letter)
S1 Vowel (short, long)
S2 Consonant (variant spelling, silent letter)
S3 Structural Unit (root, suffix)

21st Century Skills

CS1 Global Awareness
CS2 Financial, Economic, and Business Literacy
CS3 Civic Literacy
CS4 Information and Communication Skills
CS5 Thinking and Problem-Solving Skills
CS6 Interpersonal and Self-Directional Skills

SUGGESTED REFERENCES

General Machine Tool

Fitzpatrick, M. (2005). *Machining and CNC technology.* Boston, MA: McGraw-Hill.

Kibbe, R., Neely, J., Meyer, R., & White, W. (2010). *Machine tool practices* [with workbook]. Upper Saddle River, NJ: Prentice Hall.

Krar, S., Gill, A., & Smid, P. (2005). *Technology of machine tools.* Boston, MA: McGraw-Hill.

Krar, S., Rapisarda, M., & Check, A. (1998). *Machine tool and manufacturing technology.* Albany, NY: Delmar Learning.

Oberg, E., Jones, F., Horton, H., & Ryffel, H. (2005). *Machinery's handbook.* New York, NY: Industrial Press.

Walker, J. (2004). *Machining fundamentals* [with workbook]. Tinley Park, IL: Goodheart-Willcox.

Weingartner, C., & Effner, J. (2001). *Machinist's ready reference*. Ann Arbor, MI: Prakken Publications, Inc.

Wentzell, T. (2004). *Machine design.* Albany, NY: Delmar Learning.

Journals

CNC Machining. Oxnard, CA: Haas Automation.

The Home Shop Machinist. Travers City, MI: Village Press.

Live Steam. Travers City, MI: Village Press.

The Machinist Workshop. Travers City, MI: Village Press.

Manufacturing Engineering. Dearborn, MI: Society of Manufacturing Engineers. Retrieved April 8, 2009, from http://www.sme.org/cgi-bin/find-issues.pl?&&ME&%20http%20SME&

Manufacturing News. Grapevine, TX: Southeast Manufacturing News.

Video

RMI Media Productions. (n.d.). *Machine shop series* [Videotape]. (Available from RMI Media Productions, 2807 West 47th Street, Shawnee Mission, KS 66205)

Web Site

Society of Manufacturing Engineering. Retrieved April 9, 2009, from http://www.sme.org/manufacturingengineering

Course Name: Precision Grinding Operations

Course Abbreviation: MST 2531-2

Classification: Vocational–Technical Core (Precision Manufacturing and Machining 2-Year Certificate and Associate Degree)

Description: This course provides instruction on safety and grinding operations and applications to include tool post grinding, cylindrical grinding, and center-less grinding. (1–2 sch: 1-hr lecture; 1-hr lecture, 2-hr lab)

Prerequisite: Consent of Instructor

Competencies and Suggested Objectives
1. Discuss and apply general machine shop safety. a. Identify, discuss, and test safety procedures. b. Demonstrate safety procedures.
2. Operate grinding machinery safely. a. Describe precision grinding operations using various types of machines. b. Discuss and calculate math constants and formulas related to grinding required clearance angles and lands using the *Machinist Ready Reference* or *Machinery Handbook*. c. Perform setup and grind surfaces according to specifications. d. Set up and grind milling machine cutters.

STANDARDS

National Institute for Metalworking Skills

NIMS1	Job Planning and Management
NIMS2	Job Execution
NIMS3	Quality Control and Inspection
NIMS4	Process Adjustment and Improvement
NIMS5	General Maintenance
NIMS6	Industrial Safety and Environmental Protection

Related Academic Standards

R1	Interpret Graphic Information (forms, maps, reference sources)
R2	Words in Context (same and opposite meaning)
R3	Recall Information (details, sequence)
R4	Construct Meaning (main idea, summary/paraphrase, compare–contrast, cause–effect)
R5	Evaluate/Extend Meaning (fact/opinion, predict outcomes, point of view)
M1	Addition of Whole Numbers (no regrouping, regrouping)
M2	Subtraction of Whole Numbers (no regrouping, regrouping)
M3	Multiplication of Whole Numbers (no regrouping, regrouping)

M4 Division of Whole Numbers (no remainder, remainder)
M5 Decimals (addition, subtraction, multiplication, division)
M6 Fractions (addition, subtraction, multiplication, division)
M7 Integers (addition, subtraction, multiplication, division)
M8 Percents
M9 Algebraic Operations
A1 Numeration (ordering, place value, scientific notation)
A2 Number Theory (ratio, proportion)
A3 Data Interpretation (graph, table, chart, diagram)
A4 Pre-Algebra and Algebra (equations, inequality)
A5 Measurement (money, time, temperature, length, area, volume)
A6 Geometry (angles, Pythagorean theory)
A7 Computation in Context (whole numbers, decimals, fractions, algebraic operations)
A8 Estimation (rounding, estimation)
L1 Usage (pronoun, tense, subject–verb agreement, adjective, adverb)
L2 Sentence Formation (fragments, run-on, clarity)
L3 Paragraph Development (topic sentence, supporting sentence, sequence)
L4 Capitalization (proper noun, titles)
L5 Punctuation (comma, semicolon)
L6 Writing Conventions (quotation marks, apostrophe, parts of a letter)
S1 Vowel (short, long)
S2 Consonant (variant spelling, silent letter)
S3 Structural Unit (root, suffix)

21st Century Skills

CS1 Global Awareness
CS2 Financial, Economic, and Business Literacy
CS3 Civic Literacy
CS4 Information and Communication Skills
CS5 Thinking and Problem-Solving Skills
CS6 Interpersonal and Self-Directional Skills

SUGGESTED REFERENCES

General Machine Tool

Fitzpatrick, M. (2005). *Machining and CNC technology.* Boston, MA: McGraw-Hill.

Kibbe, R., Neely, J., Meyer, R., & White, W. (2010). *Machine tool practices* [with workbook]. Upper Saddle River, NJ: Prentice Hall.

Krar, S., Gill, A., & Smid, P. (2005). *Technology of machine tools.* Boston, MA: McGraw-Hill.

Krar, S., Rapisarda, M., & Check, A. (1998). *Machine tool and manufacturing technology.* Albany, NY: Delmar Learning.

Oberg, E., Jones, F., Horton, H., & Ryffel, H. (2005). *Machinery's handbook.* New York, NY: Industrial Press.

Walker, J. (2004). *Machining fundamentals* [with workbook]. Tinley Park, IL: Goodheart-Willcox.

Weingartner, C., & Effner, J. (2001). *Machinist's ready reference*. Ann Arbor, MI: Prakken Publications, Inc.

Wentzell, T. (2004). *Machine design.* Albany, NY: Delmar Learning.

Journals

CNC Machining. Oxnard, CA: Haas Automation.

The Home Shop Machinist. Travers City, MI: Village Press.

Live Steam. Travers City, MI: Village Press.

The Machinist Workshop. Travers City, MI: Village Press.

Manufacturing Engineering. Dearborn, MI: Society of Manufacturing Engineers. Retrieved April 8, 2009, from http://www.sme.org/cgi-bin/find-issues.pl?&&ME&%20http%20SME&

Manufacturing News. Grapevine, TX: Southeast Manufacturing News.

Web Site

Society of Manufacturing Engineering. Retrieved April 9, 2009, from http://www.sme.org/manufacturingengineering

Course Name: Gear Types and Manufacturing

Course Abbreviation: MST 2541-2

Classification: Vocational–Technical Core (Precision Manufacturing and Machining 2-Year Certificate and Associate Degree)

Description: This course provides instruction on safety and vertical or horizontal milling operations, formulas, and procedures required to manufacture various types of gears and their applications. (1–2 sch: 1-hr lecture; 1-hr lecture, 2-hr lab)

Prerequisite: Consent of Instructor

Competencies and Suggested Objectives
1. Discuss and apply general machine shop safety. a. Identify, discuss, and test safety procedures. b. Demonstrate safety procedures.
2. Discuss and operate indexing safely. a. Identify the various types of gears including spur, helical, bevel, and herringbone. b. Calculate needed gear tooth elements and sizes using the *Machinist Ready Reference* or *Machinery Handbook*. c. Manufacture parts to specifications using direct, simple, and angular indexing.

STANDARDS

National Institute for Metalworking Skills

NIMS1	Job Planning and Management
NIMS2	Job Execution
NIMS3	Quality Control and Inspection
NIMS4	Process Adjustment and Improvement
NIMS5	General Maintenance
NIMS6	Industrial Safety and Environmental Protection

Related Academic Standards

R1	Interpret Graphic Information (forms, maps, reference sources)
R2	Words in Context (same and opposite meaning)
R3	Recall Information (details, sequence)
R4	Construct Meaning (main idea, summary/paraphrase, compare–contrast, cause–effect)
R5	Evaluate/Extend Meaning (fact/opinion, predict outcomes, point of view)
M1	Addition of Whole Numbers (no regrouping, regrouping)
M2	Subtraction of Whole Numbers (no regrouping, regrouping)
M3	Multiplication of Whole Numbers (no regrouping, regrouping)
M4	Division of Whole Numbers (no remainder, remainder)
M5	Decimals (addition, subtraction, multiplication, division)

M6 Fractions (addition, subtraction, multiplication, division)
M7 Integers (addition, subtraction, multiplication, division)
M8 Percents
M9 Algebraic Operations
A1 Numeration (ordering, place value, scientific notation)
A2 Number Theory (ratio, proportion)
A3 Data Interpretation (graph, table, chart, diagram)
A4 Pre-Algebra and Algebra (equations, inequality)
A5 Measurement (money, time, temperature, length, area, volume)
A6 Geometry (angles, Pythagorean theory)
A7 Computation in Context (whole numbers, decimals, fractions, algebraic operations)
A8 Estimation (rounding, estimation)
L1 Usage (pronoun, tense, subject–verb agreement, adjective, adverb)
L2 Sentence Formation (fragments, run-on, clarity)
L3 Paragraph Development (topic sentence, supporting sentence, sequence)
L4 Capitalization (proper noun, titles)
L5 Punctuation (comma, semicolon)
L6 Writing Conventions (quotation marks, apostrophe, parts of a letter)
S1 Vowel (short, long)
S2 Consonant (variant spelling, silent letter)
S3 Structural Unit (root, suffix)

21st Century Skills

CS1 Global Awareness
CS2 Financial, Economic, and Business Literacy
CS3 Civic Literacy
CS4 Information and Communication Skills
CS5 Thinking and Problem-Solving Skills
CS6 Interpersonal and Self-Directional Skills

SUGGESTED REFERENCES

General Machine Tool

Fitzpatrick, M. (2005). *Machining and CNC technology.* Boston, MA: McGraw-Hill.

Kibbe, R., Neely, J., Meyer, R., & White, W. (2010). *Machine tool practices* [with workbook]. Upper Saddle River, NJ: Prentice Hall.

Krar, S., Gill, A., & Smid, P. (2005). *Technology of machine tools.* Boston, MA: McGraw-Hill.

Krar, S., Rapisarda, M., & Check, A. (1998). *Machine tool and manufacturing technology.* Albany, NY: Delmar Learning.

Oberg, E., Jones, F., Horton, H., & Ryffel, H. (2005). *Machinery's handbook.* New York, NY: Industrial Press.

Walker, J. (2004). *Machining fundamentals* [with workbook]. Tinley Park, IL: Goodheart-Willcox.

Weingartner, C., & Effner, J. (2001). *Machinist's ready reference*. Ann Arbor, MI: Prakken Publications, Inc.

Wentzell, T. (2004). *Machine design.* Albany, NY: Delmar Learning.

Journals

CNC Machining. Oxnard, CA: Haas Automation.

The Home Shop Machinist. Travers City, MI: Village Press.

Live Steam. Travers City, MI: Village Press.

The Machinist Workshop. Travers City, MI: Village Press.

Manufacturing Engineering. Dearborn, MI: Society of Manufacturing Engineers. Retrieved April 8, 2009, from http://www.sme.org/cgi-bin/find-issues.pl?&&ME&%20http%20SME&

Manufacturing News. Grapevine, TX: Southeast Manufacturing News.

Web Site

Society of Manufacturing Engineering. Retrieved April 9, 2009, from http://www.sme.org/manufacturingengineering

Course Name: Advanced Machining Technologies

Course Abbreviation: MST 2551-2

Classification: Vocational–Technical Core (Precision Manufacturing and Machining 2-Year Certificate and Associate Degree)

Description: This course provides instruction on safety and operation and applications of new machining technologies that apply to precision manufacturing in global markets. Laser technology, EDM wire and Die sink, and plasma and water jets are now commonly used in machining and forming shapes in utilizing exotic space age materials. (1–2 sch: 1-hr lecture; 1-hr lecture, 2-hr lab)

Prerequisite: Consent of Instructor

Competencies and Suggested Objectives
1. Discuss and apply general machine shop safety. a. Identify, discuss, and test safety procedures. b. Demonstrate safety procedures.
2. Discuss electrical discharge machine (EDM) technology. a. Identify the uses of the EDM. b. Discuss the various types and applications of EDM. c. Discuss the advantages and disadvantages of EDM. d. Manufacture a part to specifications.
3. Discuss emerging technologies in Machine Tool Technology. a. Discuss various types and applications of laser cutting equipment. b. Discuss types and applications of CNC plasma cutting equipment. c. Identify and discuss types and applications of water jet cutting. d. Manufacture a part to specifications.

STANDARDS

National Institute for Metalworking Skills

NIMS1	Job Planning and Management
NIMS5	General Maintenance
NIMS6	Industrial Safety and Environmental Protection
NIMS7	Career Management and Employment Relations

Related Academic Standards

R1	Interpret Graphic Information (forms, maps, reference sources)
R2	Words in Context (same and opposite meaning)
R3	Recall Information (details, sequence)
R4	Construct Meaning (main idea, summary/paraphrase, compare–contrast, cause–effect)

R5 Evaluate/Extend Meaning (fact/opinion, predict outcomes, point of view)
M1 Addition of Whole Numbers (no regrouping, regrouping)
M2 Subtraction of Whole Numbers (no regrouping, regrouping)
M3 Multiplication of Whole Numbers (no regrouping, regrouping)
M4 Division of Whole Numbers (no remainder, remainder)
M5 Decimals (addition, subtraction, multiplication, division)
M6 Fractions (addition, subtraction, multiplication, division)
M7 Integers (addition, subtraction, multiplication, division)
M8 Percents
M9 Algebraic Operations
A1 Numeration (ordering, place value, scientific notation)
A2 Number Theory (ratio, proportion)
A3 Data Interpretation (graph, table, chart, diagram)
A4 Pre-Algebra and Algebra (equations, inequality)
A5 Measurement (money, time, temperature, length, area, volume)
A6 Geometry (angles, Pythagorean theory)
A7 Computation in Context (whole numbers, decimals, fractions, algebraic operations)
A8 Estimation (rounding, estimation)
L1 Usage (pronoun, tense, subject–verb agreement, adjective, adverb)
L2 Sentence Formation (fragments, run-on, clarity)
L3 Paragraph Development (topic sentence, supporting sentence, sequence)
L4 Capitalization (proper noun, titles)
L5 Punctuation (comma, semicolon)
L6 Writing Conventions (quotation marks, apostrophe, parts of a letter)
S1 Vowel (short, long)
S2 Consonant (variant spelling, silent letter)
S3 Structural Unit (root, suffix)

21st Century Skills

CS1 Global Awareness
CS2 Financial, Economic, and Business Literacy
CS3 Civic Literacy
CS4 Information and Communication Skills
CS5 Thinking and Problem-Solving Skills
CS6 Interpersonal and Self-Directional Skills

SUGGESTED REFERENCES

General Machine Tool

Fitzpatrick, M. (2005). *Machining and CNC technology.* Boston, MA: McGraw-Hill.

Kibbe, R., Neely, J., Meyer, R., & White, W. (2010). *Machine tool practices* [with workbook]. Upper Saddle River, NJ: Prentice Hall.

Krar, S., Gill, A., & Smid, P. (2005). *Technology of machine tools.* Boston, MA: McGraw-Hill.

Krar, S., Rapisarda, M., & Check, A. (1998). *Machine tool and manufacturing technology.* Albany, NY: Delmar Learning.

Oberg, E., Jones, F., Horton, H., & Ryffel, H. (2005). *Machinery's handbook.* New York, NY: Industrial Press.

Walker, J. (2004). *Machining fundamentals* [with workbook]. Tinley Park, IL: Goodheart-Willcox.

Weingartner, C., & Effner, J. (2001). *Machinist's ready reference*. Ann Arbor, MI: Prakken Publications, Inc.

Wentzell, T. (2004). *Machine design.* Albany, NY: Delmar Learning.

Journals

CNC Machining. Oxnard, CA: Haas Automation.

The Home Shop Machinist. Travers City, MI: Village Press.

Live Steam. Travers City, MI: Village Press.

The Machinist Workshop. Travers City, MI: Village Press.

Manufacturing Engineering. Dearborn, MI: Society of Manufacturing Engineers. Retrieved April 8, 2009, from http://www.sme.org/cgi-bin/find-issues.pl?&&ME&%20http%20SME&

Manufacturing News. Grapevine, TX: Southeast Manufacturing News.

Web Site

Society of Manufacturing Engineering. Retrieved April 9, 2009, from http://www.sme.org/manufacturingengineering

Related Vocational–Technical Courses

Course Name: Safety and Fundamentals of Die Fabrication

Course Abbreviation: TDT 1113

Classification: Vocational–Technical Core

Description: Fundamentals of tool and die fabrication procedures including an orientation to metallurgy and instruction of die fabrication (3 sch: 1-hr lecture, 4-hr lab)

Prerequisite: None

Competencies and Suggested Objectives
1. Describe general safety rules for working in a shop/lab and industry. a. Describe how to avoid on-site accidents. b. Explain the relationship between housekeeping and safety. c. Explain the importance of following all safety rules and company safety policies. d. Explain the importance of reporting all on-the-job injuries and accidents. e. Explain the need for evacuation policies and the importance of following them. f. Explain the employer's substances abuse policy and how it relates to safety. g. Explain the safety procedures when working near pressurized or high temperature.
2. Identify and apply safety around machine tool operations. a. Use proper safety practices when performing machine tool operations. b. Recognize and explain personal protective equipment. c. Inspect and care for personal protective equipment.
3. Explain lifting. a. Identify and explain the procedures for lifting heavy objects.
4. Explain the Material Safety Data Sheet (MSDS). a. Explain the function of the MSDS. b. Interpret the requirements of the MSDS.
5. Explain fires. a. Explain the process by which fires start. b. Explain fire prevention of various flammable liquids. c. Explain the classes of fire and the types of extinguishers.
6. Explain safety in and around tool and die situations. a. Explain injuries when electrical contact occurs. b. Explain safety around tool and die hazards. c. Explain action to take when an electrical shock occurs.
7. Identify the basic parts of an elementary die and metals used in fabrication of dies. a. Define the role of die sets in industry. b. Identify and describe the use of different metals used in die fabrication. c. Describe the basic parts of an elementary die.
8. Describe the use and maintenance of carbide and diamond tipped tools in die making equipment.

a. Distinguish between fixed and replaceable cutting tips. b. Describe design requirements for carbide and diamond tipped tools.
9. Describe the three cortical stages of shearing action on metals. a. Determine cutting clearances between die and punch for different types of materials (brass, aluminum, steel, etc.). b. Describe factors that affect the life of a die. c. Explain and demonstrate processes of slug and scrap elimination.
10. Safely fabricate, harden, temper, and test steel die components to a specified Rockwell hardness. a. Describe procedures for heat treatment of die components. b. Safely finish hardened die components.

STANDARDS

National Institute for Metalworking Skills

NIMS1	Job Planning and Management
NIMS2	Job Execution
NIMS3	Quality Control and Inspection
NIMS4	Process Adjustment and Improvement
NIMS5	General Maintenance
NIMS6	Industrial Safety and Environmental Protection
NIMS7	Career Management and Employment Relations

Related Academic Standards

R1	Interpret Graphic Information (forms, maps, reference sources)
R2	Words in Context (same and opposite meaning)
R3	Recall Information (details, sequence)
R4	Construct Meaning (main idea, summary/paraphrase, compare–contrast, cause–effect)
R5	Evaluate/Extend Meaning (fact/opinion, predict outcomes, point of view)
M1	Addition of Whole Numbers (no regrouping, regrouping)
M2	Subtraction of Whole Numbers (no regrouping, regrouping)
M3	Multiplication of Whole Numbers (no regrouping, regrouping)
M4	Division of Whole Numbers (no remainder, remainder)
M5	Decimals (addition, subtraction, multiplication, division)
M6	Fractions (addition, subtraction, multiplication, division)
M7	Integers (addition, subtraction, multiplication, division)
M8	Percents
M9	Algebraic Operations
A1	Numeration (ordering, place value, scientific notation)
A2	Number Theory (ratio, proportion)
A3	Data Interpretation (graph, table, chart, diagram)
A4	Pre-Algebra and Algebra (equations, inequality)
A5	Measurement (money, time, temperature, length, area, volume)

A6 Geometry (angles, Pythagorean theory)
A7 Computation in Context (whole numbers, decimals, fractions, algebraic operations)
A8 Estimation (rounding, estimation)
L1 Usage (pronoun, tense, subject–verb agreement, adjective, adverb)
L2 Sentence Formation (fragments, run-on, clarity)
L3 Paragraph Development (topic sentence, supporting sentence, sequence)
L4 Capitalization (proper noun, titles)
L5 Punctuation (comma, semicolon)
L6 Writing Conventions (quotation marks, apostrophe, parts of a letter)
S1 Vowel (short, long)
S2 Consonant (variant spelling, silent letter)
S3 Structural Unit (root, suffix)

21st Century Skills

CS1 Global Awareness
CS2 Financial, Economic, and Business Literacy
CS3 Civic Literacy
CS4 Information and Communication Skills
CS5 Thinking and Problem-Solving Skills
CS6 Interpersonal and Self-Directional Skills

SUGGESTED REFERENCES

General Machine Tool

Boljanovic, V., & Paquin, J. (2005). *Die design fundamentals.* New York, NY: Industrial Press.

Krar, S., Gill, A., & Smid, P. (2005). *Technology of machine tools.* Boston, MA: McGraw-Hill.

Oberg, E., Jones, F., Horton, H., & Ryffel, H. (2008). *Machinery's handbook.* New York, NY: Industrial Press.

Ostergarrd, D. (1989). *Basic diemaking.* Ft. Washington, MD: National Tooling and Machining Association.

Journals

American Tool Die and Stamping. Novi, MI: Eagle Publications.

CNC Machining. Oxnard, CA: Haas Automation.

EDM Today Magazine. Pompton Plaines, NJ: EDM Publications.

The Home Shop Machinist. Travers City, MI: Village Press.

The Machinist Workshop. Travers City, MI: Village Press.

Manufacturing Engineering. Dearborn, MI: Society of Manufacturing Engineers. Retrieved February 26, 2009, from http://www.sme.org/cgi-bin/find-issues.pl?&&ME&%20http%20SME&

Manufacturing News. Grapevine, TX: Southeast Manufacturing News.

Videos

RMI Media Productions. (n.d.). *Machine shop series* [Videotape]. (Available from RMI Media Productions, 2807 West 47th Street, Shawnee Mission, KS 66205)

Web Sites

American Tool Die and Stamping. Retrieved February 26, 2009, from http://www.ameritooldie.com/

CNC Machining. Retrieved February 26, 2009, from http://www.haascnc.com

EDM Today Magazine. Retrieved February 26, 2009, from http://www.edmtodaymagazine.com/

Society of Manufacturing Engineering. Retrieved February 26, 2009, from http://www.sme.org/manufacturingengineering

Course Name: Die Repair

Course Abbreviation: TDT 1123

Classification: Vocational–Technical Elective

Description: Repair and maintenance of industrial dies, including practice using industrial dies (3 sch: 1-hr lecture, 4-hr lab)

Prerequisite: None

Competencies and Suggested Objectives
1. Discuss and apply general tool and die shop safety. a. Identify, discuss, and test safety procedures. b. Demonstrate safety procedures.
2. Determine safe and proper handling of a die. a. Determine safe and proper handling and support procedures based on weight and size. b. Identify and describe the different types of failures that can occur in dies. c. Analyze and determine causes of failure of an open die.
3. Disassemble, repair, and reassemble die for tryout. a. Disassemble and correct failure. b. Check clearances, realign, and re-dowel. c. Recondition a die set to hold the repaired die. d. Set up die in punch press for tryout.

STANDARDS

National Institute for Metalworking Skills

NIMS1	Job Planning and Management
NIMS2	Job Execution
NIMS3	Quality Control and Inspection
NIMS4	Process Adjustment and Improvement
NIMS5	General Maintenance
NIMS6	Industrial Safety and Environmental Protection
NIMS7	Career Management and Employment Relations

Related Academic Standards

R1	Interpret Graphic Information (forms, maps, reference sources)
R2	Words in Context (same and opposite meaning)
R3	Recall Information (details, sequence)
R4	Construct Meaning (main idea, summary/paraphrase, compare–contrast, cause–effect)
R5	Evaluate/Extend Meaning (fact/opinion, predict outcomes, point of view)
M1	Addition of Whole Numbers (no regrouping, regrouping)

M2 Subtraction of Whole Numbers (no regrouping, regrouping)
M3 Multiplication of Whole Numbers (no regrouping, regrouping)
M4 Division of Whole Numbers (no remainder, remainder)
M5 Decimals (addition, subtraction, multiplication, division)
M6 Fractions (addition, subtraction, multiplication, division)
M7 Integers (addition, subtraction, multiplication, division)
M8 Percents
M9 Algebraic Operations
A1 Numeration (ordering, place value, scientific notation)
A2 Number Theory (ratio, proportion)
A3 Data Interpretation (graph, table, chart, diagram)
A4 Pre-Algebra and Algebra (equations, inequality)
A5 Measurement (money, time, temperature, length, area, volume)
A6 Geometry (angles, Pythagorean theory)
A7 Computation in Context (whole numbers, decimals, fractions, algebraic operations)
A8 Estimation (rounding, estimation)
L1 Usage (pronoun, tense, subject–verb agreement, adjective, adverb)
L2 Sentence Formation (fragments, run-on, clarity)
L3 Paragraph Development (topic sentence, supporting sentence, sequence)
L4 Capitalization (proper noun, titles)
L5 Punctuation (comma, semicolon)
L6 Writing Conventions (quotation marks, apostrophe, parts of a letter)
S1 Vowel (short, long)
S2 Consonant (variant spelling, silent letter)
S3 Structural Unit (root, suffix)

21st Century Skills

CS1 Global Awareness
CS2 Financial, Economic, and Business Literacy
CS3 Civic Literacy
CS4 Information and Communication Skills
CS5 Thinking and Problem-Solving Skills
CS6 Interpersonal and Self-Directional Skills

SUGGESTED REFERENCES

General Machine Tool

Krar, S., Gill, A., & Smid, P. (2005). *Technology of machine tools.* Boston, MA: McGraw-Hill.

Oberg, E., Jones, F., Horton, H., & Ryffel, H. (2008). *Machinery's handbook.* New York, NY: Industrial Press.

Ostergarrd, D. (1989). *Basic diemaking.* Ft. Washington, MD: National Tooling and Machining Association.

Ostergarrd, D. (1993). *Advanced diemaking.* Ft. Washington, MD: National Tooling and Machining Association.

Journals

American Tool Die and Stamping. Novi, MI: Eagle Publications.

CNC Machining. Oxnard, CA: Haas Automation.

EDM Today Magazine. Pompton Plaines, NJ: EDM Publications.

The Home Shop Machinist. Travers City, MI: Village Press.

The Machinist Workshop. Travers City, MI: Village Press.

Manufacturing Engineering. Dearborn, MI: Society of Manufacturing Engineers. Retrieved February 26, 2009, from http://www.sme.org/cgi-bin/find-issues.pl?&&ME&%20http%20SME&

Manufacturing News. Grapevine, TX: Southeast Manufacturing News.

Videos

RMI Media Productions. (n.d.). *Machine shop series* [Videotape]. (Available from RMI Media Productions, 2807 West 47th Street, Shawnee Mission, KS 66205)

Web Sites

American Tool Die and Stamping. Retrieved February 26, 2009, from http://www.ameritooldie.com/

CNC Machining. Retrieved February 26, 2009, from http://www.haascnc.com

Society of Manufacturing Engineering. Retrieved February 26, 2009, from http://www.sme.org/manufacturingengineering

Course Name: Die Design I

Course Abbreviation: TDT 1133

Classification: Vocational–Technical Core (Tool and Die Technology Associate Degree)

Description: Basic design of industrial dies that includes instruction and practice in calculations and processes of die design (3 sch: 2-hr lecture, 2-hr lab)

Prerequisite: None

Competencies and Suggested Objectives
1. Discuss and apply general tool and die shop safety. a. Identify, discuss, and test safety procedures. b. Demonstrate safety procedures.
2. Describe the basic types of die designs and characteristics. a. Describe the basic types of die designs and the advantages and disadvantages of each. b. Identify and describe the use of the different types of die sets used for mounting dies. c. Describe the characteristics of the different types of industrial dies.
3. Sketch a die showing its components and strip layout. a. Sketch a die showing its components. b. Do a strip layout, and calculate the advance for a progressive die.
4. Make required calculations for die fabrications. a. Describe the procedures for calculations. b. Calculate cutting clearances, shut height, bend allowance, developed length, offset displacement, blanking tonnage, stripping pressures, spring pressure, and number of springs.
5. Select, describe, and determine procedures obtaining die-to-press relationship. a. Describe and demonstrate procedures for obtaining correct die-to-press relationship. b. Select a die set to fit a given punch press.

STANDARDS

National Institute for Metalworking Skills

NIMS1	Job Planning and Management
NIMS2	Job Execution
NIMS3	Quality Control and Inspection
NIMS4	Process Adjustment and Improvement
NIMS5	General Maintenance
NIMS6	Industrial Safety and Environmental Protection
NIMS7	Career Management and Employment Relations

Related Academic Standards

R1 Interpret Graphic Information (forms, maps, reference sources)
R2 Words in Context (same and opposite meaning)
R3 Recall Information (details, sequence)
R4 Construct Meaning (main idea, summary/paraphrase, compare–contrast, cause–effect)
R5 Evaluate/Extend Meaning (fact/opinion, predict outcomes, point of view)
M1 Addition of Whole Numbers (no regrouping, regrouping)
M2 Subtraction of Whole Numbers (no regrouping, regrouping)
M3 Multiplication of Whole Numbers (no regrouping, regrouping)
M4 Division of Whole Numbers (no remainder, remainder)
M5 Decimals (addition, subtraction, multiplication, division)
M6 Fractions (addition, subtraction, multiplication, division)
M7 Integers (addition, subtraction, multiplication, division)
M8 Percents
M9 Algebraic Operations
A1 Numeration (ordering, place value, scientific notation)
A2 Number Theory (ratio, proportion)
A3 Data Interpretation (graph, table, chart, diagram)
A4 Pre-Algebra and Algebra (equations, inequality)
A5 Measurement (money, time, temperature, length, area, volume)
A6 Geometry (angles, Pythagorean theory)
A7 Computation in Context (whole numbers, decimals, fractions, algebraic operations)
A8 Estimation (rounding, estimation)
L1 Usage (pronoun, tense, subject–verb agreement, adjective, adverb)
L2 Sentence Formation (fragments, run-on, clarity)
L3 Paragraph Development (topic sentence, supporting sentence, sequence)
L4 Capitalization (proper noun, titles)
L5 Punctuation (comma, semicolon)
L6 Writing Conventions (quotation marks, apostrophe, parts of a letter)
S1 Vowel (short, long)
S2 Consonant (variant spelling, silent letter)
S3 Structural Unit (root, suffix)

21st Century Skills

CS1 Global Awareness
CS2 Financial, Economic, and Business Literacy
CS3 Civic Literacy
CS4 Information and Communication Skills
CS5 Thinking and Problem-Solving Skills
CS6 Interpersonal and Self-Directional Skills

SUGGESTED REFERENCES

General Machine Tool

Boljanovic, V., & Paquin, J. (2005). *Die design fundamentals.* New York, NY: Industrial Press. ISBN 9780831131197.

Ostergarrd, D. (1989). *Basic diemaking.* Ft. Washington, MD: National Tooling and Machining Association.

Ostergarrd, D. (1993). *Advanced diemaking.* Ft. Washington, MD: National Tooling and Machining Association.

Journals

American Tool Die and Stamping. Novi, MI: Eagle Publications.

CNC Machining. Oxnard, CA: Haas Automation.

EDM Today Magazine. Pompton Plaines, NJ: EDM Publications.

The Home Shop Machinist. Travers City, MI: Village Press.

The Machinist Workshop. Travers City, MI: Village Press.

Manufacturing Engineering. Dearborn, MI: Society of Manufacturing Engineers. Retrieved February 26, 2009, from http://www.sme.org/cgi-bin/find-issues.pl?&&ME&%20http%20SME&

Manufacturing News. Grapevine, TX: Southeast Manufacturing News.

Videos

RMI Media Productions. (n.d.). *Machine shop series* [Videotape]. (Available from RMI Media Productions, 2807 West 47th Street, Shawnee Mission, KS 66205)

Web Sites

American Tool Die and Stamping. Retrieved February 26, 2009, from http://www.ameritooldie.com/

CNC Machining. Retrieved February 26, 2009, from http://www.haascnc.com

Society of Manufacturing Engineering. Retrieved February 26, 2009, from http://www.sme.org/manufacturingengineering

Course Name: Jigs, Fixtures, and Tools

Course Abbreviation: TDT 2183

Classification: Vocational–Technical Elective

Description: Specialized skills associated with the design and fabrication of work holding devices including jigs, fixtures, and other tools (3 sch: 1-hr lecture, 4-hr lab)

Prerequisite: None

Competencies and Suggested Objectives
1. Discuss and apply general tool and die shop safety. a. Identify, discuss, and test safety procedures. b. Demonstrate safety procedures.
2. Describe and design basic jig and fixture components. a. Identify and describe clamps, drill bushings, gauges, and feet. b. Design drill jigs to meet part specifications. c. Design a work holding fixture to meet job specifications.
3. Fabricate, heat treat, and test drill jig and work holding fixture. a. Safely fabricate and try out a drill jig. b. Safely fabricate and try out a work holding fixture. c. Safely heat treat components and test to specified hardness.

STANDARDS

National Institute for Metalworking Skills

NIMS1	Job Planning and Management
NIMS2	Job Execution
NIMS3	Quality Control and Inspection
NIMS4	Process Adjustment and Improvement
NIMS5	General Maintenance
NIMS6	Industrial Safety and Environmental Protection
NIMS7	Career Management and Employment Relations

Related Academic Standards

R1	Interpret Graphic Information (forms, maps, reference sources)
R2	Words in Context (same and opposite meaning)
R3	Recall Information (details, sequence)
R4	Construct Meaning (main idea, summary/paraphrase, compare–contrast, cause–effect)
R5	Evaluate/Extend Meaning (fact/opinion, predict outcomes, point of view)
M1	Addition of Whole Numbers (no regrouping, regrouping)
M2	Subtraction of Whole Numbers (no regrouping, regrouping)

M3 Multiplication of Whole Numbers (no regrouping, regrouping)
M4 Division of Whole Numbers (no remainder, remainder)
M5 Decimals (addition, subtraction, multiplication, division)
M6 Fractions (addition, subtraction, multiplication, division)
M7 Integers (addition, subtraction, multiplication, division)
M8 Percents
M9 Algebraic Operations
A1 Numeration (ordering, place value, scientific notation)
A2 Number Theory (ratio, proportion)
A3 Data Interpretation (graph, table, chart, diagram)
A4 Pre-Algebra and Algebra (equations, inequality)
A5 Measurement (money, time, temperature, length, area, volume)
A6 Geometry (angles, Pythagorean theory)
A7 Computation in Context (whole numbers, decimals, fractions, algebraic operations)
A8 Estimation (rounding, estimation)
L1 Usage (pronoun, tense, subject–verb agreement, adjective, adverb)
L2 Sentence Formation (fragments, run-on, clarity)
L3 Paragraph Development (topic sentence, supporting sentence, sequence)
L4 Capitalization (proper noun, titles)
L5 Punctuation (comma, semicolon)
L6 Writing Conventions (quotation marks, apostrophe, parts of a letter)
S1 Vowel (short, long)
S2 Consonant (variant spelling, silent letter)
S3 Structural Unit (root, suffix)

21st Century Skills

CS1 Global Awareness
CS2 Financial, Economic, and Business Literacy
CS3 Civic Literacy
CS4 Information and Communication Skills
CS5 Thinking and Problem-Solving Skills
CS6 Interpersonal and Self-Directional Skills

SUGGESTED REFERENCES

General Machine Tool

Hoffman, E. (2004). *Jig and fixture design*. Albany, NY: Delmar Learning.

Journals

American Tool Die and Stamping. Novi, MI: Eagle Publications.

CNC Machining. Oxnard, CA: Haas Automation.

EDM Today Magazine. Pompton Plaines, NJ: EDM Publications.

The Home Shop Machinist. Travers City, MI: Village Press.

The Machinist Workshop. Travers City, MI: Village Press.

Manufacturing Engineering. Dearborn, MI: Society of Manufacturing Engineers. Retrieved February 20, 2009, from http://www.sme.org/cgi-bin/find-issues.pl?&&ME&%20http%20SME&

Manufacturing News. Grapevine, TX: Southeast Manufacturing News.

Web Sites

American Tool Die and Stamping. Retrieved February 26, 2009, from http://www.ameritooldie.com/

CNC Machining. Retrieved February 26, 2009, from http://www.haascnc.com

Society of Manufacturing Engineering. Retrieved February 26, 2009, from http://www.sme.org/manufacturingengineering

Course Name: Work-Based Learning I, II, III, IV, V, and VI

Course Abbreviation: WBL 191(1-3), WBL 192(1-3), WBL 193(1-3), WBL 291(1-3), WBL 292(1-3), and WBL 293(1-3)

Classification: Free Elective

Description: A structured work-site learning experience in which the student, program area teacher, work-based learning coordinator, and worksite supervisor/mentor develop and implement an educational training agreement. Designed to integrate the student's academic and technical skills into a work environment. Includes regular meetings and seminars with school personnel for supplemental instruction and progress reviews (1–3 sch: 3–9 hours externship)

Prerequisite: Concurrent enrollment in vocational–technical program area courses

Competencies and Suggested Objectives
1. Apply technical skills and related academic knowledge needed to be a viable member of the workforce. a. Apply technical skills needed to be a viable member of the workforce. b. Apply skills developed in other related courses in a work-based setting. c. Perform tasks detailed in an educational training agreement at the work setting.
2. Apply general workplace skills to include positive work habits and responsibilities necessary for successful employment. a. Demonstrate proactive human relationship skills in the work setting to include conflict resolution, team participation, leadership, negotiation, and customer/client service. b. Demonstrate time, materials, and resource management skills. c. Demonstrate critical-thinking skills such as problem solving, decision making, and reasoning. d. Demonstrate acquiring, evaluating, organizing, maintaining, interpreting, and communicating information. e. Demonstrate positive work habits and acceptance of responsibilities necessary for successful employment.

STANDARDS

Specific standards for this course will depend upon the nature of the problem under investigation.

SUGGESTED REFERENCES

Specific references for this course will depend upon the nature of the problem under investigation.

Recommended Tools and Equipment

CAPITALIZED ITEMS

1. Lathes with accessories including digital readout (15)
   13 in. or 14 in. (9)
   15 in. x 60 in. (2)
   15 in. x 48 in. (2)
   17 in. x 72 in. (2)
2. Vertical mills: 9 in. x 42 in. bed with accessories including digital readout (8)
3. Horizontal mill (1)
4. Surface grinder, automatic with magnetic chuck and accessories (3)
5. Vertical band saw with butt welder – 20 in. (1)
6. Horizontal band saw – 10 in. (1)
7. Drill press – 20 in. minimum (with accessories) (3)
8. Radial drill press – 36 in. (1)
9. Hydraulic press – 50 T (1)
10. CNC lathe (2)
11. CNC vertical mill (2)
12. CNC Machining Center (1)
13. Pedestal grinders (10 in. and 12 in.) (4)
14. Air compressor (1)
15. Dividing head, wide range (2)
16. Rotary table (2)
17. Sets of drills (taper shank) (2)
18. Set of taper shank reamer (1)
19. Computers with software (CAM) (15)
20. Printers (5)
21. Tool post grinder (2)
22. Height gauge (electronic and conventional) (1)
23. Surface plate – 24 in. x 36 in. (1)
24. Boring head and boring bar set for vertical mill (5)
25. Cutting torch set with cart (1)
26. Welding machine with accessories (1)
27. Arbor press (5 T) (1)
28. Safety glass cabinet with safety glasses (1)
29. High speed steel drill and counter drill x 60 degrees – 5-piece set - #1 - #6 (1)
30. High speed steel: 6 flute countersink 82 degrees – 8 piece set ⅛ in. -1 in. (1)
31. Hand reamers set: ⅛ in. - ½ in. by 1/64th (1)
32. Tap and die set: high speed steel – 1/4 - 20 through 9/16 – 18 (1)
33. Metric screw pitch gauge, Acme screw pitch gauge, 60 degrees – V-sharp screw pitch gage (1 each)
34. Keyway broach set ⅛ in. through ⅜ in. (1)
35. Horizontal milling cutter set per machine specifications (1)
36. Boring head with C. T. boring bar set per machine specifications for horizontal mill (1)
37. Radius angle dresser for surface grinder and diamonds (1)

38. Heat treating furnace (1)
39. Tempering furnace (1)
40. Easy track mill with tooling (1)

NON-CAPITALIZED ITEMS

1. Work benches (6)
2. 14.Vises (6 in.) (6)
3. Drill set (3 in 1 set) 1/16 in. - ½ in. by 64th, A-Z, and #1 - #60 (4)
4. Set end mill high speed steel 1/8 in. - 3/4 in. by 1/16 – 2 flute – center cut (double end) (4)
5. Single end ball end mill (1/8 in. through 3/4 in. by 1/8 in.) (1)
6. Abrasive shop roll – 1 ft wide x 100 grit, 180 grit, 220 grit (1 each) (1)
7. Buffing wheel and buffing compound (1)
8. Bench grinders (6 in.) (2)
9. Surface grinder wheels to machine specifications (10)
10. Bench grinder wheels (6)
11. Wheel dressing stick (1)
12. Grinder wheel dresser (1)
13. Cluster diamond and holder for surface grinder and diamonds (1)
14. Set of gage telescopic 5/16 in. - 6 in. – 6 piece (3)
15. Set small hole: ⅛ in. - ½ in. – 4 piece set (3)
16. Dial indicators with magnetic based and 1 in. travel (10)
17. Angle plates (6 in. x 6 in. and 3 in. x 3 in.) (2)
18. “V” block set (2)
19. Sine bar – 5 in. sine chuck (1)
20. Set steel parallel (10 pieces) ⅛ in. (2)
21. Combination square set (4 pieces) 4R graduation with 12 in. blades (10)
22. Scales 6 in. 4R graduation (20)
23. Drill point gauge (15)
24. Radius gauge set (4)
25. Acme thread gauge set (10)
26. Center gauges (10)
27. Spring calipers: inside, outside, and hermaphrodite – 3 in. x 6 in. (2)
28. Dividers – 3 in. and 6 in. (2)
29. Edge finders (electronic and conventional) (3)
30. Metal scribes (10)
31. Set, punch center, 8 piece (3)
32. Punch drive pin, 8 piece set (4 in. long) (3)
33. Combination wrench set (1)
34. Set (21 pieces) ½ in. drive socket set (1)
35. Set of pliers (1 set slip point, 1 set needlenose, 1 set vise grip) (1)
36. Set, pipe wrench (8 in., 10 in., 12 in.) (1)
37. Set, adjustable wrench (6 in., 10 in., 12 in.) (1)
38. 25 ft power lock tape (1)
39. Screwdriver set (6 pieces) (2)

40. 12 ft power lock tape (6)
41. Demagnetizer for surface grinder files (12 ft power lock tape 12 files with handles and file cards) (1)
42. Dead blow hammers (6)
43. Ball peen hammers (6)
44. Pistol pump oilers (6)
45. Grease gun (1)
46. Sets, Allen wrenches (2 metric and 2 English) (2)
47. C–clamps - 6 in. (6)
48. Set, steel stamp (numbers and letters) (1)
49. Electrical engraver (1)
50. Retractable air hoses and reels (3)
51. 4 in. disk grinder (1)
52. Air pressure regulator (1)
53. Drill motors (⅜ in.) (1)
54. Drill motor (½ in.) (1)
55. Shop vacuum (wet and dry) (1)
56. Wheel dolly (4 wheels) heavy duty (1)
57. Hack saws with blades (6)
58. Trammel points (1)
59. Quenching tank (1)
60. Set Woodruff key seat cutter (1)
61. Refractometer (1)
62. Micrometers: 10 @ 0 in. - 1 in.; 5 @ 1 in. - 2 in.; 2 @ 2 in. - 3 in.; and 2 @ 3 in. - 4 in. (19)
63. Depth micrometers: 2 @ 0 in. - 6 in. (2)
64. Vernier calipers: 6 in. (2)
65. Dial calipers: 6 in. (6)
66. Digital caliper: 6 in. (1)
67. Sets – test indicators and surface gauges (2)
68. Gage block set (rectangular) (1)
69. Precision grinding vise – 4 in. (2)
70. Precision square set (4 pieces) (1)
71. Level precision – 12 in. (1)
72. Compound angle vise (2)
73.

RECOMMENDED INSTRUCTIONAL AIDS

1. Scientific calculator (1)
2. Teacher computer with operating software with multimedia kit (1)
3. Teacher printer
4. VCR/DVD player (1)
5. Data projector/screen (1)
6. Digital visual presenter (1)

7. Digital camera
8. Scanner

Assessment

Blueprint

This program is assessed using the MS-CPAS. The following blueprint summary contains the competencies that are measured when assessing this program. Competencies are grouped into *clusters*, and a weight is given to each cluster to determine the number of items needed from each cluster. The numbers of C1s and C2s (item difficulty levels) are also indicated on the blueprint.

Visit http://info.rcu.msstate.edu/services/curriculum.asp to download the appropriate blueprint for this curriculum.

Appendix A: National Institute for Metalworking Skills [1]

NIMS1	Job Planning and Management
NIMS2	Job Execution
NIMS3	Quality Control and Inspection
NIMS4	Process Adjustment and Improvement
NIMS5	General Maintenance
NIMS6	Industrial Safety and Environmental Protection
NIMS7	Career Management and Employment Relations

[1] NIMS (*National institute for metalworking skills).* Reproduced with permission of the National Institute for Metalworking Skills, copyright © 2001, NIMS (National Institute for Metalworking Skills), 3251 Old Lee Highway, Suite 205, Fairfax, VA 22030. Permission does not constitute an endorsement by NIMS. Retrieved October 6, 2004, from http://www.nims-skills.org

Appendix B: Related Academic Standards[2]

Reading

R1 Interpret Graphic Information (forms, maps, reference sources)
R2 Words in Context (same and opposite meaning)
R3 Recall Information (details, sequence)
R4 Construct Meaning (main idea, summary/paraphrase, compare–contrast, cause–effect)
R5 Evaluate/Extend Meaning (fact/opinion, predict outcomes, point of view)

Mathematics Computation

M1 Addition of Whole Numbers (no regrouping, regrouping)
M2 Subtraction of Whole Numbers (no regrouping, regrouping)
M3 Multiplication of Whole Numbers (no regrouping, regrouping)
M4 Division of Whole Numbers (no remainder, remainder)
M5 Decimals (addition, subtraction, multiplication, division)
M6 Fractions (addition, subtraction, multiplication, division)
M7 Integers (addition, subtraction, multiplication, division)
M8 Percents
M9 Algebraic Operations

Applied Mathematics

A1 Numeration (ordering, place value, scientific notation)
A2 Number Theory (ratio, proportion)
A3 Data Interpretation (graph, table, chart, diagram)
A4 Pre-Algebra and Algebra (equations, inequality)
A5 Measurement (money, time, temperature, length, area, volume)
A6 Geometry (angles, Pythagorean theory)
A7 Computation in Context (whole numbers, decimals, fractions, algebraic operations)
A8 Estimation (rounding, estimation)

Language

L1 Usage (pronoun, tense, subject–verb agreement, adjective, adverb)
L2 Sentence Formation (fragments, run-on, clarity)
L3 Paragraph Development (topic sentence, supporting sentence, sequence)
L4 Capitalization (proper noun, titles)
L5 Punctuation (comma, semicolon)
L6 Writing Conventions (quotation marks, apostrophe, parts of a letter)

Spelling

S1 Vowel (short, long)
S2 Consonant (variant spelling, silent letter)
S3 Structural Unit (root, suffix)

[2] CTB/McGraw-Hill LLC. (1994). *Tests of adult basic education, forms 7 and 8.* Monterey, CA: Author.

Appendix C: 21st Century Skills[3]

CS1 Global Awareness

- Using 21st century skills to understand and address global issues
- Learning from and working collaboratively with individuals representing diverse cultures, religions, and lifestyles in a spirit of mutual respect and open dialogue in personal, work, and community contexts
- Promoting the study of non-English language as a tool for understanding other nations and cultures

CS2 Financial, Economic, and Business Literacy

- Knowing how to make appropriate personal economic choices
- Understanding the role of the economy and the role of business in the economy
- Applying appropriate 21st century skills to function as a productive contributor within an organizational setting
- Integrating oneself within and adapting continually to our nation's evolving economic and business environment

CS3 Civic Literacy

- Being an informed citizen to participate effectively in government
- Exercising the rights and obligations of citizenship at local, state, national, and global levels
- Understanding the local and global implications of civic decisions
- Applying 21st century skills to make intelligent choices as a citizen

CS4 Information and Communication Skills

- Information and media literacy skills: Analyzing, accessing, managing, integrating, evaluating, and creating information in a variety of forms and media; understanding the role of media in society
- Communication skills: Understanding, managing, and creating effective oral, written, and multimedia communication in a variety of forms and contexts

CS5 Thinking and Problem-Solving Skills

- Critical thinking and systems thinking: Exercising sound reasoning in understanding and making complex choices, understanding the interconnections among systems
- Problem identification, formulation, and solution: Ability to frame, analyze, and solve problems
- Creativity and intellectual curiosity: Developing, implementing, and communicating new ideas to others, staying open and responsive to new and diverse perspectives

CS6 Interpersonal and Self-Directional Skills

- Interpersonal and collaborative skills: Demonstrating teamwork and leadership, adapting to varied roles and responsibilities, working productively with others, exercising empathy, respecting diverse perspectives
- Self-direction: Monitoring one's own understanding and learning needs, locating appropriate resources, transferring learning from one domain to another
- Accountability and adaptability: Exercising personal responsibility and flexibility in personal, workplace, and community contexts; setting and meeting high standards and goals for one's self and others; tolerating ambiguity

[3] *21st century skills.* (n.d.). Washington, DC: Partnership for 21st Century Skills.

- Social responsibility: Acting responsibly with the interests of the larger community in mind; demonstrating ethical behavior in personal, workplace, and community contexts