FRAMEWORKS FOR
VOCATIONAL-TECHNICAL PROGRAMS
PRECISION MACHINING

SECONDARY
EXECUTIVE SUMMARY
2012

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Published by

Office of Career and Technical Education
Mississippi Department of Education
Jackson, MS 39205

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Mississippi State University
Mississippi State, MS 39762

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Foreword

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

The courses in this document reflect the statutory requirements as found in Section 37-3-49, Mississippi Code of 1972, as amended (Section 37-3-46). In addition, this curriculum reflects guidelines imposed by federal and state mandates (Laws, 1988, ch. 487, §14; Laws, 1991, ch. 423, §1; Laws, 1992, ch. 519, §4 eff. from and after July 1, 1992; Carl D. Perkins Vocational Education Act III, 1998; and No Child Left Behind Act of 2001).

Each secondary career-technical course consists of a series of instructional units which focus on a common theme. All units have been written using a common format which includes the following components:

- Unit Number and Title
- Suggested Time on Task - An estimated number of clock hours of instruction that should be required to teach the competencies and objectives of the unit. A minimum of 140 hours of instruction is required for each Carnegie unit credit. The curriculum framework should account for approximately 75-80 percent of the time in the course.
- Competencies and Suggested Objectives
  - A competency represents a general concept or performance that students are expected to master as a requirement for satisfactorily completing a unit. Students will be expected to receive instruction on all competencies.
  - The suggested objectives represent the enabling and supporting knowledge and performances that will indicate mastery of the competency at the course level.
- Suggested Teaching Strategies - This section of each unit indicates strategies that can be used to enable students to master each competency. Emphasis has been placed on strategies which reflect active learning methodologies. Teachers should feel free to modify or enhance these suggestions based on needs of their students and resources available in order to provide optimum learning experiences for their students.
- Suggested Assessment Strategies - This section indicates strategies that can be used to measure student mastery. Examples of suggested strategies could include rubrics, class participation, reflection, and journaling. Again, teachers should feel free to modify or enhance these suggested assessment strategies based on local needs and resources.
- Integrated Academic Topics, Workplace Skills, Technology Standards, and Occupational Standards - This section identifies related academic topics as required in the Subject Area Assessment Program (SATP) in Algebra I, Biology I, English II, and U. S. History from 1877, which are integrated into the content of the unit. It also identifies 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 have 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 Education Technology Standards (NETS), were strategic partners in the Partnership for 21st Century Skills.

- References - A list of suggested references is provided for each unit. The list includes some of the primary instructional resources that may be used to teach the competencies and suggested objectives. Again, these resources are suggested and the list may be modified or enhanced based on needs and abilities of students and on available resources.

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Precision Machining Executive Summary

Pathway Description

The Precision Machining pathway is designed as a secondary program for preparation to enter the field of precision machining and metal turning. The Precision Machining program includes an introduction to the basic machining metalworking processes. The purpose of the course is to prepare students to continue study in a postsecondary metals program (Precision Machining, Machine Tool Operation, and Automotive Machining) or to begin work at the entry level in a machining occupation. The machining courses found in this curriculum were written to the National Institute for Metalworking Skills (NIMS) credentialing standards.

Industry Certification

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

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

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

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

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

Assessment

Students will be assessed using the Precision Machining MS-CPAS2 test. The MS-CPAS2 blueprint can be found at http://www.rcu.msstate.edu/. If there are questions regarding assessment of this program, please contact the Manufacturing Cluster Instructional Design Specialists at the Research and Curriculum Unit at 662.325.2510.

Student Prerequisites

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

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

Applied Academic Credit (if applicable)

No applied academic credit is available for this pathway at this time.

Licensure Requirements

969 Career Pathway: Precision Machining

This endorsement licenses a person to teach the following secondary courses:

993200	2-Manufacturing Fundamentals
993400	2-Precision Machining
993202	1-Manufacturing Fundamentals I
993203	1-Manufacturing Fundamentals II
993401	1-Precision Machining I
993402	1-Precision Machining II

Minimum Requirements for this Endorsement:

1. Education

- Hold a two-year college degree (associate degree) or higher from an accredited institution of higher education.

2. Occupational Experience and Related Assessment of that Experience

-Applicants with an associate degree must have at least two years of verifiable occupational experience in the past 10 years. Experience must be appropriate to the subject to be taught.

- Applicants with a bachelor or higher degree must have at least one year of verifiable occupational experience in the past 10 years. Experience must be appropriate to the subject to be taught.

This endorsement requires the following assessment(s) of occupational expertise:

National Institute of Metalworking Skills (NIMS) Level One

OR

Other teacher occupational competency assessment approved by MDE Office of Career and Technical Education.

3. Technology Literacy and Related Assessment of that Competency

- Applicant must validate technology competency by attaining the established minimum score or higher on an assessment approved by the Mississippi Department of Education (MDE). The assessment must be directly related to technology competency required by the grade level and subject matter being taught. Approved assessments for this license are IC3, Propulse, or other specific assessment created by third-party vendors, authorized by the Local Education Agency (LEA), and approved by the MDE.

4. Teacher Education Preparation and Related Assessment(s) of that Education

- Applicant must enroll immediately in Vocational Instructor Preparation (VIP) program.

- Applicant must complete the individualized professional development plan (PDP) requirements of the VIP program prior to the expiration date of the three-year vocational license.

- Applicant must successfully complete a Certification for online learning workshop, module, or course that is approved by the Mississippi Department of Education.

- Applicant must successfully complete the Architecture and Drafting Certification workshop, module, or course that is approved by the Mississippi Department of Education.

note #1: If the applicant meets all requirements listed above, that applicant will be issued a 969 endorsement (a five-year license). If the applicant does not meet all requirements, the applicant may be issued a three-year endorsement (license), and all requirements stated above must be satisfied prior to the ending date of that license.

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

Professional Learning

The professional learning itinerary for the middle school or individual pathways can be found at http://redesign.rcu.msstate.edu. If you have specific questions about the content of each training session provided, please contact the Research and Curriculum Unit (RCU) at 662.325.2510, and ask for the Professional Learning Specialist.

Course Outlines

Option 1—Four One-Carnegie-Unit Courses

Upon completion of this option, the student will be trained to take the NIMS Level 1 Certification exams (CNC Milling and CNC Lathing certifications are dependent upon local school resources). This curriculum consists of four one-credit courses, which should be completed in the following sequence:

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

Course Description: 1. Manufacturing Machining I (Course Code: 993202)

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

Course Description: 2. Manufacturing Machining II (Course Code: 993203)

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

Course Description: 3. Precision Machining I (Course Code: 993401)

Precision Machining I (Course Code: 993204) includes a study of precision machining techniques in advanced lathe operation. This one-Carnegie-unit course should only be taken after students successfully pass Manufacturing Machining II.

Course Description: 4. Precision Machining II (Course Code: 993402)

Precision Machining II (Course Code: 993205) includes a study of precision machining techniques in advanced milling and CNC operation. This one-Carnegie-unit course should only be taken after students successfully pass Precision Machining I.

Manufacturing Machining I — Course Code: 993202

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

Manufacturing Machining II — Course Code: 993203

Unit	Unit Name	Hours
8	Orientation, Advanced Leadership, and Employability Skills	5
9	Basic Safety (Review and Reinforcement)	5
4	Lathe Theory and Operation	75
6	Grinding Theory and Operation	25
Total		110

Precision Machining I — Course Code: 993401

Unit	Unit Name	Hours
7	Orientation, Advanced Leadership, and Employability Skills	5
8	Basic Safety (Review and Reinforcement)	15
10	Advanced Lathe Operation	95
Total		115

Precision Machining II — Course Code: 993402

Unit	Unit Name	Hours
7	Orientation, Advanced Leadership, and Employability Skills	5
8	Basic Safety (Review and Reinforcement)	10
11	Advanced Milling Operation	95
12	Computerized Numerical Control	10
Total		120

Note: CNC Milling and CNC Lathing course content are dependent upon local school resources

Option 2—Two Two-Carnegie-Unit Courses

This curriculum consists of two two-Carnegie-unit courses.

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

Course Description: Manufacturing Fundamentals (Course Code: 993200)

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

Course Description: Precision Machining (Course Code: 993400)

Precision Machining includes advanced precision machining techniques in lathing, vertical milling and Computer Numerical Control (CNC). (CNC course content depth is dependent upon local school resources)

Manufacturing Fundamentals — Course Code: 993200

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

Precision Machining — Course Code: 993400

Unit	Unit Name	Hours
8	Orientation, Advanced Leadership, and Employability Skills	10
9	Basic Safety (Review and Reinforcement)	10
10	Advanced Lathe Operation	95

11	Advanced Milling Operation	95
12	Computerized Numerical Control	10
Total		220

Precision Machining Competencies and Objectives

Unit 1: Orientation, Leadership, and Basic Safety

1. Describe local program and vocational/career technical center policies and procedures. (DOK 1) SAF, MAT, HTO, PTO, BLU, MBR, COM, EMP
   a. Describe local program and vocational/career technical center policies and procedures including dress code, attendance, academic requirements, discipline, and transportation regulations. CS1, CS3, CS5, CS6, CS7, CS7, CS8, CS9, CS10, CS11, CS12, CS13, CS14, CS15, CS16, CCR1, CCR2, CCR3, CCR4, CCR5, CCR6, CCR7, CCR8, CCR10, CCW4, CCW5, CCW6, CCW7, CCW8, CCW9, CCW10, CCSL1, CCSL2, CCSL3, CCSL4, CCSL5, T1, T2, T3, T4, T6
2. Describe employment opportunities and responsibilities. (DOK 2) SAF, MAT, HTO, PTO, BLU, MBR, COM, EMP
   a. Relate employment opportunities including potential earnings, employee benefits, job availability, place of employment, working conditions, and educational requirements to students' success in a secondary or postsecondary manufacturing curriculum. CS1, CS3, CS6, CS7, CS8, CS9, CS10, CS11, CS12, CS13, CS14, CS15, CS16, CCR1, CCR2, CCR3, CCR4, CCR5, CCR6, CCR7, CCR8, CCR10, CCW4, CCW5, CCW6, CCW7, CCW8, CCW9, CCW10, CCSL1, CCSL3, CCSL5, CCL1, CCL2, CCL3, T1, T2, T3, T5, T6
   b. Describe basic employee responsibilities CS1, CS3, CS6, CS7, CS8, CS9, CS10, CS11, CS12, CS13, CS14, CS15, CS16, CCR1, CCR2, CCR3, CCR4, CCR5, CCR6, CCR7, CCR8, CCR10, CCW4, CCW5, CCW6, CCW7, CCW8, CCW9, CCW10, CCSL1, CCSL3, CCSL5, CCL1, CCL2, CCL3, T1, T2, T3, T5, T6
3. Explore leadership skills and personal development opportunities provided for students by student organizations to include SkillsUSA. (DOK 2) SAF, MAT, HTO, PTO, BLU, MBR, COM, EMP
   a. Demonstrate effective team-building and leadership skills. CS1, CS3, CS6, CS7, CS8, CS9, CS10, CS11, CS12, CS13, CS14, CS15, CS16, CCR1, CCR2, CCR3, CCR4, CCR5, CCR6, CCR7, CCR8, CCR10, CCW4, CCW5, CCW6, CCW7, CCW8, CCW9, CCW10, CCSL1, CCSL3, CCSL5, CCL1, CCL2, CCL3, T1, T2, T3, T5, T6
   b. Practice appropriate work ethics. CS1, CS3, CS6, CS7, CS8, CS9, CS10, CS11, CS12, CS13, CS14, CS15, CS16, CCR1, CCR2, CCR3, CCR4, CCR5, CCR6, CCR7, CCR8, CCR10, CCW4, CCW5, CCW6, CCW7, CCW8, CCW9, CCW10, CCSL1, CCSL3, CCSL5, CCL1, CCL2, CCL3, T1, T2, T3, T5, T6T1, T2, T3, T4, T5, T6
   c. Demonstrate the ability to follow verbal and written instructions and communicate effectively in on-the-job situations. CS1, CS3, CS6, CS7, CS8, CS9, CS10, CS11, CS12, CS13, CS14, CS15, CS16, CCR1, CCR2, CCR3, CCR4, CCR5, CCR6, CCR7, CCR8, CCR10, CCW4, CCW5, CCW6, CCW7, CCW8, CCW9, CCW10, CCSL1, CCSL3, CCSL5, CCL1, CCL2, CCL3, T1, T2, T3, T5, T6
   d. Discuss the history of the metal trade industry to include materials, terminology, and techniques. CS1, CS3, CS6, CS7, CS8, CS9, CS10, CS11, CS12, CS13, CS14,

CS15, CS16, CCR1, CCR2, CCR3, CCR4, CCR5, CCR6, CCR7, CCR8, CCR10, CCW4, CCW5, CCW6, CCW7, CCW8, CCW9, CCW10, CCSL1, CCSL3, CCSL5, CCL1, CCL2, CCL3, T1, T2, T3, T5, T6

4. Describe general safety rules for working in a shop/lab and industry. (DOK 1) SAF, HTO, PTO, MBR, COM
   a. Describe how to avoid on-site accidents. CS1, CS3, CS6, CS7, CS8, CS9, CS10, CS11, CS12, CS13, CS14, CS15, CS16, CCR1, CCR2, CCR3, CCR4, CCR5, CCR6, CCR7, CCR8, CCR10, CCW4, CCW5, CCW6, CCW7, CCW8, CCW9, CCW10, CCSL1, CCSL3, CCSL5, CCL1, CCL2, CCL3, T1, T2, T3, T5, T6
   b. Explain the relationship between housekeeping and safety. CS1, CS3, CS6, CS7, CS8, CS9, CS10, CS11, CS12, CS13, CS14, CS15, CS16, CCR1, CCR2, CCR3, CCR4, CCR5, CCR6, CCR7, CCR8, CCR10, CCW4, CCW5, CCW6, CCW7, CCW8, CCW9, CCW10, CCSL1, CCSL3, CCSL5, CCL1, CCL2, CCL3, T1, T2, T3, T5, T6
   c. Explain the importance of following all safety rules and company safety policies. CS1, CS3, CS6, CS7, CS8, CS9, CS10, CS11, CS12, CS13, CS14, CS15, CS16, CCR1, CCR2, CCR3, CCR4, CCR5, CCR6, CCR7, CCR8, CCR10, CCW4, CCW5, CCW6, CCW7, CCW8, CCW9, CCW10, CCSL1, CCSL3, CCSL5, CCL1, CCL2, CCL3, T1, T2, T3, T5, T6
   d. Explain the importance of reporting all on-the-job injuries and accidents. CS1, CS3, CS6, CS7, CS8, CS9, CS10, CS11, CS12, CS13, CS14, CS15, CS16, CCR1, CCR2, CCR3, CCR4, CCR5, CCR6, CCR7, CCR8, CCR10, CCW4, CCW5, CCW6, CCW7, CCW8, CCW9, CCW10, CCSL1, CCSL3, CCSL5, CCL1, CCL2, CCL3, T1, T2, T3, T5, T6
   e. Explain the need for evacuation policies and the importance of following them.CS1, CS3, CS6, CS7, CS8, CS9, CS10, CS11, CS12, CS13, CS14, CS15, CS16, CCR1, CCR2, CCR3, CCR4, CCR5, CCR6, CCR7, CCR8, CCR10, CCW4, CCW5, CCW6, CCW7, CCW8, CCW9, CCW10, CCSL1, CCSL3, CCSL5, CCL1, CCL2, CCL3, T1, T2, T3, T5, T6
   f. Investigate employer's substances abuse policy and how it relates to safety. CS1, CS3, CS6, CS7, CS8, CS9, CS10, CS11, CS12, CS13, CS14, CS15, CS16, CCR1, CCR2, CCR3, CCR4, CCR5, CCR6, CCR7, CCR8, CCR10, CCW4, CCW5, CCW6, CCW7, CCW8, CCW9, CCW10, CCSL1, CCSL3, CCSL5, CCL1, CCL2, CCL3, T1, T2, T3, T5, T6
   g. Demonstrate the safety procedures when working near pressurized or high temperature. CS1, CS3, CS6, CS7, CS8, CS9, CS10, CS11, CS12, CS13, CS14, CS15, CS16, CCR1, CCR2, CCR3, CCR4, CCR5, CCR6, CCR7, CCR8, CCR10, CCW4, CCW5, CCW6, CCW7, CCW8, CCW9, CCW10, CCSL1, CCSL3, CCSL5, CCL1, CCL2, CCL3, T1, T2, T3, T5, T6
5. Identify and apply safety around Manufacturing operations. (DOK 1) SAF, HTO, PTO, MBR, COM
   a. Use proper safety practices when performing Manufacturing operations. CS1, CS3, CS6, CS7, CS8, CS9, CS10, CS11, CS12, CS13, CS14, CS15, CS16, CCR1, CCR2, CCR3, CCR4, CCR5, CCR6, CCR7, CCR8, CCR10, CCW4, CCW5, CCW6, CCW7,

CCW8, CCW9, CCW10, CCSL1, CCSL3, CCSL5, CCL1, CCL2, CCL3, T1, T2, T3, T5, T6

   b. Recognize and explain personal protective equipment. CS1, CS3, CS6, CS7, CS8, CS9, CS10, CS11, CS12, CS13, CS14, CS15, CS16, CCR1, CCR2, CCR3, CCR4, CCR5, CCR6, CCR7, CCR8, CCR10, CCW4, CCW5, CCW6, CCW7, CCW8, CCW9, CCW10, CCSL1, CCSL3, CCSL5, CCL1, CCL2, CCL3, T1, T2, T3, T5, T6
   c. Inspect and care for personal protective equipment. CS1, CS3, CS6, CS7, CS8, CS9, CS10, CS11, CS12, CS13, CS14, CS15, CS16, CCR1, CCR2, CCR3, CCR4, CCR5, CCR6, CCR7, CCR8, CCR10, CCW4, CCW5, CCW6, CCW7, CCW8, CCW9, CCW10, CCSL1, CCSL3, CCSL5, CCL1, CCL2, CCL3, T1, T2, T3, T5, T6
6. Explain lifting. (DOK 3) SAF, MBR, COM
   a. Identify and explain the procedures for lifting heavy objects. CS1, CS3, CS6, CS7, CS8, CS9, CS10, CS11, CS12, CS13, CS14, CS15, CS16, CCR1, CCR2, CCR3, CCR4, CCR5, CCR6, CCR7, CCR8, CCR10, CCW4, CCW5, CCW6, CCW7, CCW8, CCW9, CCW10, CCSL1, CCSL3, CCSL5, CCL1, CCL2, CCL3, T1, T2, T3, T5, T6
7. Explain the material safety data sheet (MSDS). (DOK 2) SAF, HTO, PTO, MBR, COM
   a. Explain the function of the MSDS. CS1, CS3, CS6, CS7, CS8, CS9, CS10, CS11, CS12, CS13, CS14, CS15, CS16, CCR1, CCR2, CCR3, CCR4, CCR5, CCR6, CCR7, CCR8, CCR10, CCW4, CCW5, CCW6, CCW7, CCW8, CCW9, CCW10, CCSL1, CCSL3, CCSL5, CCL1, CCL2, CCL3, T1, T2, T3, T5, T6
   b. Interpret the requirements of the MSDS. CS1, CS3, CS6, CS7, CS8, CS9, CS10, CS11, CS12, CS13, CS14, CS15, CS16, CCR1, CCR2, CCR3, CCR4, CCR5, CCR6, CCR7, CCR8, CCR10, CCW4, CCW5, CCW6, CCW7, CCW8, CCW9, CCW10, CCSL1, CCSL3, CCSL5, CCL1, CCL2, CCL3, T1, T2, T3, T5, T6
8. Explain fires. (DOK 1) SAF, HTO, MBR, COM
   a. Explain the process by which fires start. CS1, CS3, CS6, CS7, CS8, CS9, CS10, CS11, CS12, CS13, CS14, CS15, CS16, CCR1, CCR2, CCR3, CCR4, CCR5, CCR6, CCR7, CCR8, CCR10, CCW4, CCW5, CCW6, CCW7, CCW8, CCW9, CCW10, CCSL1, CCSL3, CCSL5, CCL1, CCL2, CCL3, T1, T2, T3, T5, T6
   b. Explain fire prevention of various flammable liquids. CS1, CS3, CS6, CS7, CS8, CS9, CS10, CS11, CS12, CS13, CS14, CS15, CS16, CCR1, CCR2, CCR3, CCR4, CCR5, CCR6, CCR7, CCR8, CCR10, CCW4, CCW5, CCW6, CCW7, CCW8, CCW9, CCW10, CCSL1, CCSL3, CCSL5, CCL1, CCL2, CCL3, T1, T2, T3, T5, T6
   c. Explain the classes of fire and the types of extinguishers. CS1, CS3, CS6, CS7, CS8, CS9, CS10, CS11, CS12, CS13, CS14, CS15, CS16, CCR1, CCR2, CCR3, CCR4, CCR5, CCR6, CCR7, CCR8, CCR10, CCW4, CCW5, CCW6, CCW7, CCW8, CCW9, CCW10, CCSL1, CCSL3, CCSL5, CCL1, CCL2, CCL3, T1, T2, T3, T5, T6.
9. Explain safety in and around Manufacturing and electrical situations. (DOK 2) SAF, HTO PTO, MBR, COM
   a. Explain injuries when electrical contact occurs. CS1, CS3, CS6, CS7, CS8, CS9, CS10, CS11, CS12, CS13, CS14, CS15, CS16, CCR1, CCR2, CCR3, CCR4, CCR5, CCR6, CCR7, CCR8, CCR10, CCW4, CCW5, CCW6, CCW7, CCW8, CCW9, CCW10, CCSL1, CCSL3, CCSL5, CCL1, CCL2, CCL3, T1, T2, T3, T5, T6

b. Explain safety around Manufacturing and electrical hazards. CS1, CS3, CS6, CS7, CS8, CS9, CS10, CS11, CS12, CS13, CS14, CS15, CS16, CCR1, CCR2, CCR3, CCR4, CCR5, CCR6, CCR7, CCR8, CCR10, CCW4, CCW5, CCW6, CCW7, CCW8, CCW9, CCW10, CCSL1, CCSL3, CCSL5, CCL1, CCL2, CCL3, T1, T2, T3, T5, T6
c. Explain action to take when an electrical shock occurs. CS1, CS3, CS6, CS7, CS8, CS9, CS10, CS11, CS12, CS13, CS14, CS15, CS16, CCR1, CCR2, CCR3, CCR4, CCR5, CCR6, CCR7, CCR8, CCR10, CCW4, CCW5, CCW6, CCW7, CCW8, CCW9, CCW10, CCSL1, CCSL3, CCSL5, CCL1, CCL2, CCL3, T1, T2, T3, T5, T6

Unit 2: Math, Measuring Tools, and Instruments

1. Apply the four basic math skills with whole numbers, fractions, and percentages. (DOK 1) MAT, HTO
   a. Add, subtract, multiply, and divide whole numbers, decimals, and fractions. CS1, CS2, CS3, CS5, CS6, CS7, CS8, CS9, CS10, CS11, CS12, CS13, CS14, CS15, CS16, CCR1, CCR2, CCR3, CCR4, CCR6, CCR7, CCR8, CCR9, CCR10, CCW4, CCW5, CCW6, CCW9, CCW10, CCSL1, CCSL2, CCSL3, CCSL4, CCSL5, CCSL6, CCL1, CCL2, CCL3, CCL4, CCL5, CCL6, CCM1, CCM2, CCM3, CCM4, CCM7, CCM8, CCM10, CCM11, CCM15, CCM27, CCM28, CCM29, CCM30, CCM31, CCM32, CCM33, CCM34, CCM35, CCM36, CCM37, CCM38, CCM39, CCM40, CCM43, T1, T2, T3, T4, T6
   b. Convert whole numbers to fractions, and convert fractions to whole numbers. CS1, CS2, CS3, CS5, CS6, CS7, CS8, CS9, CS10, CS11, CS12, CS13, CS14, CS15, CS16, CCR1, CCR2, CCR3, CCR4, CCR6, CCR7, CCR8, CCR9, CCR10, CCW4, CCW5, CCW6, CCW9, CCW10, CCSL1, CCSL2, CCSL3, CCSL4, CCSL5, CCSL6, CCL1, CCL2, CCL3, CCL4, CCL5, CCL6, CCM1, CCM2, CCM3, CCM4, CCM7, CCM8, CCM10, CCM11, CCM15, CCM27, CCM28, CCM29, CCM30, CCM31, CCM32, CCM33, CCM34, CCM35, CCM36, CCM37, CCM38, CCM39, CCM40, CCM43, T1, T2, T3, T4, T6
   c. Convert decimals to percents and percents to decimals.
   CS1, CS2, CS3, CS5, CS6, CS7, CS8, CS9, CS10, CS11, CS12, CS13, CS14, CS15, CS16, CCR1, CCR2, CCR3, CCR4, CCR6, CCR7, CCR8, CCR9, CCR10, CCW4, CCW5, CCW6, CCW9, CCW10, CCSL1, CCSL2, CCSL3, CCSL4, CCSL5, CCSL6, CCL1, CCL2, CCL3, CCL4, CCL5, CCL6, CCM1, CCM2, CCM3, CCM4, CCM7, CCM8, CCM10, CCM11, CCM15, CCM27, CCM28, CCM29, CCM30, CCM31, CCM32, CCM33, CCM34, CCM35, CCM36, CCM37, CCM38, CCM39, CCM40, CCM43, T1, T2, T3, T4, T6
   d. Convert fractions to decimals. CS1, CS2, CS3, CS5, CS6, CS7, CS8, CS9, CS10, CS11, CS12, CS13, CS14, CS15, CS16, CCR1, CCR2, CCR3, CCR4, CCR6, CCR7, CCR8, CCR9, CCR10, CCW4, CCW5, CCW6, CCW9, CCW10, CCSL1, CCSL2, CCSL3, CCSL4, CCSL5, CCSL6, CCL1, CCL2, CCL3, CCL4, CCL5, CCL6, CCM1, CCM2, CCM3, CCM4, CCM7, CCM8, CCM10, CCM11, CCM15, CCM27, CCM28, CCM29, CCM30, CCM31, CCM32, CCM33, CCM34, CCM35, CCM36, CCM37, CCM38, CCM39, CCM40, CCM43, T1, T2, T3, T4, T6

a. Convert fractions to percents. CS1, CS2, CS3, CS5, CS6, CS7, CS8, CS9, CS10, CS11, CS12, CS13, CS14, CS15, CS16, CCR1, CCR2, CCR3, CCR4, CCR6, CCR7, CCR8, CCR9, CCR10, CCW4, CCW5, CCW6, CCW9, CCW10, CCSL1, CCSL2, CCSL3, CCSL4, CCSL5, CCSL6, CCL1, CCL2, CCL3, CCL4, CCL5, CCL6, CCM1, CCM2, CCM3, CCM4, CCM7, CCM8, CCM10, CCM11, CCM15, CCM27, CCM28, CCM29, CCM30, CCM31, CCM32, CCM33, CCM34, CCM35, CCM36, CCM37, CCM38, CCM39, CCM40, CCM43, T1, T2, T3, T4, T6

2. Perform basic mathematical calculations related to machine shop operations. (DOK 1) MAT
   a. Convert metric measurements to English measurements.CS1, CS2, CS3, CS5, CS6, CS7, CS8, CS9, CS10, CS11, CS12, CS13, CS14, CS15, CS16, CCR1, CCR2, CCR3, CCR4, CCR6, CCR7, CCR8, CCR9, CCR10, CCW4, CCW5, CCW6, CCW9, CCW10, CCSL1, CCSL2, CCSL3, CCSL4, CCSL5, CCSL6, CCL1, CCL2, CCL3, CCL4, CCL5, CCL6, CCM1, CCM2, CCM3, CCM4, CCM7, CCM8, CCM10, CCM11, CCM15, CCM27, CCM28, CCM29, CCM30, CCM31, CCM32, CCM33, CCM34, CCM35, CCM36, CCM37, CCM38, CCM39, CCM40, CCM43, T1, T2, T3, T4, T6
   b. Solve basic angles and sides. CS1, CS2, CS3, CS5, CS6, CS7, CS8, CS9, CS10, CS11, CS12, CS13, CS14, CS15, CS16, CCR1, CCR2, CCR3, CCR4, CCR6, CCR7, CCR8, CCR9, CCR10, CCW4, CCW5, CCW6, CCW9, CCW10, CCSL1, CCSL2, CCSL3, CCSL4, CCSL5, CCSL6, CCL1, CCL2, CCL3, CCL4, CCL5, CCL6, CCM1, CCM2, CCM3, CCM4, CCM7, CCM8, CCM10, CCM11, CCM15, CCM27, CCM28, CCM29, CCM30, CCM31, CCM32, CCM33, CCM34, CCM35, CCM36, CCM37, CCM38, CCM39, CCM40, CCM43, T1, T2, T3, T4, T6
   c. Calculate the amount of material for a given project. CS1, CS2, CS3, CS5, CS6, CS7, CS8, CS9, CS10, CS11, CS12, CS13, CS14, CS15, CS16, CCR1, CCR2, CCR3, CCR4, CCR6, CCR7, CCR8, CCR9, CCR10, CCW4, CCW5, CCW6, CCW9, CCW10, CCSL1, CCSL2, CCSL3, CCSL4, CCSL5, CCSL6, CCL1, CCL2, CCL3, CCL4, CCL5, CCL6, CCM1, CCM2, CCM3, CCM4, CCM7, CCM8, CCM10, CCM11, CCM15, CCM27, CCM28, CCM29, CCM30, CCM31, CCM32, CCM33, CCM34, CCM35, CCM36, CCM37, CCM38, CCM39, CCM40, CCM43, T1, T2, T3, T4, T6
   d. Compute distances according to a drawn plan. CS1, CS2, CS3, CS5, CS6, CS7, CS8, CS9, CS10, CS11, CS12, CS13, CS14, CS15, CS16, CCR1, CCR2, CCR3, CCR4, CCR6, CCR7, CCR8, CCR9, CCR10, CCW4, CCW5, CCW6, CCW9, CCW10, CCSL1, CCSL2, CCSL3, CCSL4, CCSL5, CCSL6, CCL1, CCL2, CCL3, CCL4, CCL5, CCL6, CCM1, CCM2, CCM3, CCM4, CCM7, CCM8, CCM10, CCM11, CCM15, CCM27, CCM28, CCM29, CCM30, CCM31, CCM32, CCM33, CCM34, CCM35, CCM36, CCM37, CCM38, CCM39, CCM40, CCM43, T1, T2, T3, T4, T6
3. Identify and perform functions using various measuring tools and instruments (micrometers, dial indicators, height gauge, and digital caliper). (DOK 2) MAT, HTO
   a. Read a rule to the nearest 1/32 in. CS1, CS2, CS3, CS5, CS6, CS7, CS8, CS9, CS10, CS11, CS12, CS13, CS14, CS15, CS16, CCR1, CCR2, CCR3, CCR4, CCR6, CCR7, CCR8, CCR9, CCR10, CCW4, CCW5, CCW6, CCW9, CCW10, CCSL1, CCSL2, CCSL3, CCSL4, CCSL5, CCSL6, CCL1, CCL2, CCL3, CCL4, CCL5, CCL6,

CCM1, CCM2, CCM3, CCM4, CCM7, CCM8, CCM10, CCM11, CCM15, CCM27, CCM28, CCM29, CCM30, CCM31, CCM32, CCM33, CCM34, CCM35, CCM36, CCM37, CCM38, CCM39, CCM40, CCM43, T1, T2, T3, T4, T6

b. Lay out lines with a rule. CS1, CS2, CS3, CS5, CS6, CS7, CS8, CS9, CS10, CS11, CS12, CS13, CS14, CS15, CS16, CCR1, CCR2, CCR3, CCR4, CCR6, CCR7, CCR8, CCR9, CCR10, CCW4, CCW5, CCW6, CCW9, CCW10, CCSL1, CCSL2, CCSL3, CCSL4, CCSL5, CCSL6, CCL1, CCL2, CCL3, CCL4, CCL5, CCL6, CCM1, CCM2, CCM3, CCM4, CCM7, CCM8, CCM10, CCM11, CCM15, CCM27, CCM28, CCM29, CCM30, CCM31, CCM32, CCM33, CCM34, CCM35, CCM36, CCM37, CCM38, CCM39, CCM40, CCM43, T1, T2, T3, T4, T6

c. Describe the care and use of various rules. CS1, CS2, CS3, CS5, CS6, CS7, CS8, CS9, CS10, CS11, CS12, CS13, CS14, CS15, CS16, CCR1, CCR2, CCR3, CCR4, CCR6, CCR7, CCR8, CCR9, CCR10, CCW4, CCW5, CCW6, CCW9, CCW10, CCSL1, CCSL2, CCSL3, CCSL4, CCSL5, CCSL6, CCL1, CCL2, CCL3, CCL4, CCL5, CCL6, CCM1, CCM2, CCM3, CCM4, CCM7, CCM8, CCM10, CCM11, CCM15, CCM27, CCM28, CCM29, CCM30, CCM31, CCM32, CCM33, CCM34, CCM35, CCM36, CCM37, CCM38, CCM39, CCM40, CCM43, T1, T2, T3, T4, T6

Unit 3: Introduction to Blueprints and Hand and Power Tools

1. Read, analyze, and design a blueprint. (DOK 2) MAT, BLU, COM, L1B, LIL, 1VM, 1DP, 1SG, 1TB, 1TC, 1CM, 1CT, 2TC, 2PL, 2FA, 2CG, 2CM, 2CT
   a. Identify terms and symbols commonly used on blueprints. CS1, CS6, CS7, CS8, CS9, CS10, CS11, CS12, CS13, CS14, CS15, CS16, CCR6, CCR7, CCR8, CCR9, CCW1, CCW2, CCW3, CCW4, CCW6, CCW10, CCSL2, CCSL3, CCSL4, CCL1, CCM1, CCM2, CCM3, CCM4, CCM5, CCM8, CCM14, CCM27, CCM28, CCM29, CCM30, CCM31, CCM32, CCM33, CCM34, CCM35, CCM36, CCM37, CCM38, CCM39, CCM42, CCM43, T1, T2, T3, T4, T6
   b. Relate information on prints to real parts/models. CS1, CS6, CS7, CS8, CS9, CS10, CS11, CS12, CS13, CS14, CS15, CS16, CCR6, CCR7, CCR8, CCR9, CCW1, CCW2, CCW3, CCW4, CCW6, CCW10, CCSL2, CCSL3, CCSL4, CCL1, CCM1, CCM2, CCM3, CCM4, CCM5, CCM8, CCM14, CCM27, CCM28, CCM29, CCM30, CCM31, CCM32, CCM33, CCM34, CCM35, CCM36, CCM37, CCM38, CCM39, CCM42, CCM43, T1, T2, T3, T4, T6
   c. Interpret various symbols to locate various elements. CS1, CS6, CS7, CS8, CS9, CS10, CS11, CS12, CS13, CS14, CS15, CS16, CCR6, CCR7, CCR8, CCR9, CCW1, CCW2, CCW3, CCW4, CCW6, CCW10, CCSL2, CCSL3, CCSL4, CCL1, CCM1, CCM2, CCM3, CCM4, CCM5, CCM8, CCM14, CCM27, CCM28, CCM29, CCM30, CCM31, CCM32, CCM33, CCM34, CCM35, CCM36, CCM37, CCM38, CCM39, CCM42, CCM43, T1, T2, T3, T4, T6
   d. Interpret a plan to determine layout. CS1, CS6, CS7, CS8, CS9, CS10, CS11, CS12, CS13, CS14, CS15, CS16, CCR6, CCR7, CCR8, CCR9, CCW1, CCW2, CCW3, CCW4, CCW6, CCW10, CCSL2, CCSL3, CCSL4, CCL1, CCM1, CCM2, CCM3, CCM4, CCM5, CCM8, CCM14, CCM27, CCM28, CCM29, CCM30, CCM31,

CCM32, CCM33, CCM34, CCM35, CCM36, CCM37, CCM38, CCM39, CCM42, CCM43, T1, T2, T3, T4, T6

e. Explain basic layout of a blueprint. CS1, CS6, CS7, CS8, CS9, CS10, CS11, CS12, CS13, CS14, CS15, CS16, CCR6, CCR7, CCR8, CCR9, CCW1, CCW2, CCW3, CCW4, CCW6, CCW10, CCSL2, CCSL3, CCSL4, CCL1, CCM1, CCM2, CCM3, CCM4, CCM5, CCM8, CCM14, CCM27, CCM28, CCM29, CCM30, CCM31, CCM32, CCM33, CCM34, CCM35, CCM36, CCM37, CCM38, CCM39, CCM42, CCM43, T1, T2, T3, T4, T6
f. Describe the information in a title block.
g. Identify the lines used on blueprints.

2. Demonstrate the use and maintenance of various hand and power tools. (DOK 3) SAF, HTO, PTO, L1B, LIL, 1DP
   a. Identify and discuss the use of common hand and power tools. T1, T2, T3, T4, T6
   b. Discuss rules of safety.CS1, CS6, CS7, CS8, CS9, CS10, CS11, CS12, CS13, CS14, CS15, CS16, CCR6, CCR7, CCR8, CCR9, CCW1, CCW2, CCW3, CCW4, CCW6, CCW10, CCSL2, CCSL3, CCSL4, CCL1, CCM1, CCM2, CCM3, CCM4, CCM5, CCM8, CCM14, CCM27, CCM28, CCM29, CCM30, CCM31, CCM32, CCM33, CCM34, CCM35, CCM36, CCM37, CCM38, CCM39, CCM42, CCM43, T1, T2, T3, T4, T6
   c. Select and demonstrate the use of tools.T1, T2, T3, T4, T6
   d. Explain the procedures for maintenance. CS1, CS6, CS7, CS8, CS9, CS10, CS11, CS12, CS13, CS14, CS15, CS16, CCR6, CCR7, CCR8, CCR9, CCW1, CCW2, CCW3, CCW4, CCW6, CCW10, CCSL2, CCSL3, CCSL4, CCL1, CCM1, CCM2, CCM3, CCM4, CCM5, CCM8, CCM14, CCM27, CCM28, CCM29, CCM30, CCM31, CCM32, CCM33, CCM34, CCM35, CCM36, CCM37, CCM38, CCM39, CCM42, CCM43, T1, T2, T3, T4, T6

Unit 4: Drill Press and Band Saw Theory and Operation

1. Identify and describe the safe operation of the types of power saws. (DOK 2) SAF, MAT, BLU,HTO, PTO, COM, L1B, LIL, 1DP
   a. Identify and describe rules for safe use of power saws. CS6, CS7, CS8, CS9, CS10, CS11, CS12, CS13, CS14, CS15, CS16, CCR1, CCR2, CCR3, CCR4, CCR5, CCR6, CCR7, CCR8, CCR9, CCR10, CCW1, CCW2, CCW3, CCW4, CCW5, CCW6, CCW8, CCW9, CCSL1, CCSL2, CCSL3, CCSL4, CCSL5, CCL1, CCL2, CCL3, CCL4, CCL5, CCM1, CCM2, CCM3, CCM4, CCM7, CCM8, CCM9, CCM27, CCM30, CCM31, CCM32, CCM33, CCM34, CCM35, CCM36, CCM37, CCM38, CCM39, T1, T2, T3, T4, T6
   b. Describe factors that determine saw blade selection. CS6, CS7, CS8, CS9, CS10, CS11, CS12, CS13, CS14, CS15, CS16, CCR1, CCR2, CCR3, CCR4, CCR5, CCR6, CCR7, CCR8, CCR9, CCR10, CCW1, CCW2, CCW3, CCW4, CCW5, CCW6, CCW8, CCW9, CCSL1, CCSL2, CCSL3, CCSL4, CCSL5, CCL1, CCL2, CCL3, CCL4, CCL5, CCM1, CCM2, CCM3, CCM4, CCM7, CCM8, CCM9, CCM27, CCM30, CCM31, CCM32, CCM33, CCM34, CCM35, CCM36, CCM37, CCM38, CCM39, T1, T2, T3, T4, T6

c. Describe factors to consider in the care and cleaning of power saws. CS6, CS7, CS8, CS9, CS10, CS11, CS12, CS13, CS14, CS15, CS16, CCR1, CCR2, CCR3, CCR4, CCR5, CCR6, CCR7, CCR8, CCR9, CCR10, CCW1, CCW2, CCW3, CCW4, CCW5, CCW6, CCW8, CCW9, CCSL1, CCSL2, CCSL3, CCSL4, CCSL5, CCL1, CCL2, CCL3, CCL4, CCL5, CCM1, CCM2, CCM3, CCM4, CCM7, CCM8, CCM9, CCM27, CCM30, CCM31, CCM32, CCM33, CCM34, CCM35, CCM36, CCM37, CCM38, CCM39, T1, T2, T3, T4, T6
d. Lay out and cut stock with a band saw according to specifications. CS6, CS7, CS8, CS9, CS10, CS11, CS12, CS13, CS14, CS15, CS16, CCR1, CCR2, CCR3, CCR4, CCR5, CCR6, CCR7, CCR8, CCR9, CCR10, CCW1, CCW2, CCW3, CCW4, CCW5, CCW6, CCW8, CCW9, CCSL1, CCSL2, CCSL3, CCSL4, CCSL5, CCL1, CCL2, CCL3, CCL4, CCL5, CCM1, CCM2, CCM3, CCM4, CCM7, CCM8, CCM9, CCM27, CCM30, CCM31, CCM32, CCM33, CCM34, CCM35, CCM36, CCM37, CCM38, CCM39, T1, T2, T3, T4, T6

2. Identify and describe the types of drilling machines, including hand powered and drill press, and the rules for safe operation of each. (DOK 2) SAF, MAT, BLU, COM, HTO, PTO, 1DP
   a. Describe safety rules for the safe use of a hand power drill and drill press. CS6, CS7, CS8, CS9, CS10, CS11, CS12, CS13, CS14, CS15, CS16, CCR1, CCR2, CCR3, CCR4, CCR5, CCR6, CCR7, CCR8, CCR9, CCR10, CCW1, CCW2, CCW3, CCW4, CCW5, CCW6, CCW8, CCW9, CCSL1, CCSL2, CCSL3, CCSL4, CCSL5, CCL1, CCL2, CCL3, CCL4, CCL5, CCM1, CCM2, CCM3, CCM4, CCM7, CCM8, CCM9, CCM27, CCM30, CCM31, CCM32, CCM33, CCM34, CCM35, CCM36, CCM37, CCM38, CCM39, T1, T2, T3, T4, T6
   b. Identify work-holding and setup devices in drill press operations. CS6, CS7, CS8, CS9, CS10, CS11, CS12, CS13, CS14, CS15, CS16, CCR1, CCR2, CCR3, CCR4, CCR5, CCR6, CCR7, CCR8, CCR9, CCR10, CCW1, CCW2, CCW3, CCW4, CCW5, CCW6, CCW8, CCW9, CCSL1, CCSL2, CCSL3, CCSL4, CCSL5, CCL1, CCL2, CCL3, CCL4, CCL5, CCM1, CCM2, CCM3, CCM4, CCM7, CCM8, CCM9, CCM27, CCM30, CCM31, CCM32, CCM33, CCM34, CCM35, CCM36, CCM37, CCM38, CCM39, T1, T2, T3, T4, T6
   c. Lay out holes and drill, ream, countersink, and counter bore according to project specifications. CS6, CS7, CS8, CS9, CS10, CS11, CS12, CS13, CS14, CS15, CS16, CCR1, CCR2, CCR3, CCR4, CCR5, CCR6, CCR7, CCR8, CCR9, CCR10, CCW1, CCW2, CCW3, CCW4, CCW5, CCW6, CCW8, CCW9, CCSL1, CCSL2, CCSL3, CCSL4, CCSL5, CCL1, CCL2, CCL3, CCL4, CCL5, CCM1, CCM2, CCM3, CCM4, CCM7, CCM8, CCM9, CCM27, CCM30, CCM31, CCM32, CCM33, CCM34, CCM35, CCM36, CCM37, CCM38, CCM39, T1, T2, T3, T4, T6

Unit 5: Milling Machine Theory and Operation

1. Differentiate between the types of milling machines. (DOK 2) SAF, COM, L1B, LIL, 1VM
   a. Identify the different types of milling machines. CS1, CS2, CS3, CS4, CS5, CS6, CS7, CS8, CS9, CS10, CS11, CS12, CS13, CS14, CS15, CS16, CCR1, CCR2, CCR3,

CCR4, CCR5, CCR6, CCR7, CCR8, CCR9, CCR10, CCW1, CCW2, CCW3, CCW4, CCW5, CCW6, CCW8, CCW9, CCSL1, CCSL2, CCSL3, CCSL4, CCSL5, CCL1, CCL2, CCL3, CCL4, CCL5, CCM1, CCM2, CCM3, CCM4, CCM7, CCM8, CCM9, CCM27, CCM30, CCM31, CCM32, CCM33, CCM34, CCM35, CCM36, CCM37, CCM38, CCM39, T1, T2, T3, T4, T6

b. Explain the use and safety of each type of milling machine. CS1, CS2, CS3, CS4, CS5, CS6, CS7, CS8, CS9, CS10, CS11, CS12, CS13, CS14, CS15, CS16, CCR1, CCR2, CCR3, CCR4, CCR5, CCR6, CCR7, CCR8, CCR9, CCR10, CCW1, CCW2, CCW3, CCW4, CCW5, CCW6, CCW8, CCW9, CCSL1, CCSL2, CCSL3, CCSL4, CCSL5, CCL1, CCL2, CCL3, CCL4, CCL5, CCM1, CCM2, CCM3, CCM4, CCM7, CCM8, CCM9, CCM27, CCM30, CCM31, CCM32, CCM33, CCM34, CCM35, CCM36, CCM37, CCM38, CCM39, T1, T2, T3, T4, T6

2. Identify the parts, cutting tools, and basic maintenance of a vertical milling machine. (DOK 2) SAF, COM, L1B, LIL, 1VM

a. Identify the major parts of a horizontal and vertical mill. CS1, CS2, CS3, CS4, CS5, CS6, CS7, CS8, CS9, CS10, CS11, CS12, CS13, CS14, CS15, CS16, CCR1, CCR2, CCR3, CCR4, CCR5, CCR6, CCR7, CCR8, CCR9, CCR10, CCW1, CCW2, CCW3, CCW4, CCW5, CCW6, CCW8, CCW9, CCSL1, CCSL2, CCSL3, CCSL4, CCSL5, CCL1, CCL2, CCL3, CCL4, CCL5, CCM1, CCM2, CCM3, CCM4, CCM7, CCM8, CCM9, CCM27, CCM30, CCM31, CCM32, CCM33, CCM34, CCM35, CCM36, CCM37, CCM38, CCM39, T1, T2, T3, T4, T6

b. Identify the cutting tools used on a horizontal and vertical mill. CS1, CS2, CS3, CS4, CS5, CS6, CS7, CS8, CS9, CS10, CS11, CS12, CS13, CS14, CS15, CS16, CCR1, CCR2, CCR3, CCR4, CCR5, CCR6, CCR7, CCR8, CCR9, CCR10, CCW1, CCW2, CCW3, CCW4, CCW5, CCW6, CCW8, CCW9, CCSL1, CCSL2, CCSL3, CCSL4, CCSL5, CCL1, CCL2, CCL3, CCL4, CCL5, CCM1, CCM2, CCM3, CCM4, CCM7, CCM8, CCM9, CCM27, CCM30, CCM31, CCM32, CCM33, CCM34, CCM35, CCM36, CCM37, CCM38, CCM39, T1, T2, T3, T4, T6

c. Clean and lubricate a horizontal and vertical mill following manufacturer's specifications. T1, T2, T3, T4, T6

d. Determine the rpm and feed rate. CS1, CS2, CS3, CS4, CS5, CS6, CS7, CS8, CS9, CS10, CS11, CS12, CS13, CS14, CS15, CS16, CCR1, CCR2, CCR3, CCR4, CCR5, CCR6, CCR7, CCR8, CCR9, CCR10, CCW1, CCW2, CCW3, CCW4, CCW5, CCW6, CCW8, CCW9, CCSL1, CCSL2, CCSL3, CCSL4, CCSL5, CCL1, CCL2, CCL3, CCL4, CCL5, CCM1, CCM2, CCM3, CCM4, CCM7, CCM8, CCM9, CCM27, CCM30, CCM31, CCM32, CCM33, CCM34, CCM35, CCM36, CCM37, CCM38, CCM39, T1, T2, T3, T4, T6

3. Perform operations on a milling machine. (DOK 4) SAF, COM, L1B, LIL, 1VM

a. Perform operations on a vertical milling machine. CCM1, CCM2, CCM3, CCM4, CCM7, CCM8, CCM9, CCM27, CCM30, CCM31, CCM32, CCM33, CCM34, CCM35, CCM36, CCM37, CCM38, CCM39, T1, T2, T3, T4, T6

b. Perform an end milling operation, side milling, slotting, drilling, reaming, boring, and fly cutting, mounting cutters and cutter holders, and mounting and aligning a swivel vise; mill a key seat, a given angle, and a straight boring operation; align the head square to the table, mill operation with head tilted to 45°, and divide head operations.

CCM1, CCM2, CCM3, CCM4, CCM7, CCM8, CCM9, CCM27, CCM30, CCM31, CCM32, CCM33, CCM34, CCM35, CCM36, CCM37, CCM38, CCM39, T1, T2, T3, T4, T6

Unit 6: Lathe Theory and Operation

1. Identify the parts, rules, and care of the metal lathe. (DOK 3) SAF, MAT, HTO, PTO, BLU, COM, L1B, LIL, 1TB, 1TC
   a. Identify the four major parts of the lathe. CS1, CS2, CS3, CS4, CS5, CS6, CS7, CS8, CS9, CS10, CS11, CS12, CS13, CS14, CS15, CS16, CCR1, CCR2, CCR3, CCR4, CCR5, CCR6, CCR7, CCR8, CCR9, CCR10, CCW1, CCW2, CCW3, CCW4, CCW5, CCW6, CCW8, CCW9, CCSL1, CCSL2, CCSL3, CCSL4, CCSL5, CCL1, CCL2, CCL3, CCL4, CCL5, CCM1, CCM2, CCM3, CCM4, CCM7, CCM8, CCM9, CCM27, CCM30, CCM31, CCM32, CCM33, CCM34, CCM35, CCM36, CCM37, CCM38, CCM39, T1, T2, T3, T4, T6
   b. Set up a lathe, and determine the rpm and feed rate according to manufacturer's specifications for the basic lathe operations. CS1, CS2, CS3, CS4, CS5, CS6, CS7, CS8, CS9, CS10, CS11, CS12, CS13, CS14, CS15, CS16, CCR1, CCR2, CCR3, CCR4, CCR5, CCR6, CCR7, CCR8, CCR9, CCR10, CCW1, CCW2, CCW3, CCW4, CCW5, CCW6, CCW8, CCW9, CCSL1, CCSL2, CCSL3, CCSL4, CCSL5, CCL1, CCL2, CCL3, CCL4, CCL5, CCM1, CCM2, CCM3, CCM4, CCM7, CCM8, CCM9, CCM27, CCM30, CCM31, CCM32, CCM33, CCM34, CCM35, CCM36, CCM37, CCM38, CCM39, T1, T2, T3, T4, T6
   c. Explain the advantages and disadvantages of carbide tip cutting tools, and demonstrate how to freehand grind a high-speed steel (hss) turning tool. CS1, CS2, CS3, CS4, CS5, CS6, CS7, CS8, CS9, CS10, CS11, CS12, CS13, CS14, CS15, CS16, CCR1, CCR2, CCR3, CCR4, CCR5, CCR6, CCR7, CCR8, CCR9, CCR10, CCW1, CCW2, CCW3, CCW4, CCW5, CCW6, CCW8, CCW9, CCSL1, CCSL2, CCSL3, CCSL4, CCSL5, CCL1, CCL2, CCL3, CCL4, CCL5, CCM1, CCM2, CCM3, CCM4, CCM7, CCM8, CCM9, CCM27, CCM30, CCM31, CCM32, CCM33, CCM34, CCM35, CCM36, CCM37, CCM38, CCM39, T1, T2, T3, T4, T6
      i. Explain the turning of a piece of stock.
      ii. Describe how to chuck a piece of stock.
      iii. Describe facing, center drilling, filing, tapping, and cutoff.
2. Perform procedures for a machining operation. (DOK 3) SAF, MAT, HTO, PTO, BLU, L1B, LIL, 1TB, 1TC, 1CT
   a. . Identify terms and procedures for lathe operations. CS1, CS2, CS3, CS4, CS5, CS6, CS7, CS8, CS9, CS10, CS11, CS12, CS13, CS14, CS15, CS16, CCR1, CCR2, CCR3, CCR4, CCR5, CCR6, CCR7, CCR8, CCR9, CCR10, CCW1, CCW2, CCW3, CCW4, CCW5, CCW6, CCW8, CCW9, CCSL1, CCSL2, CCSL3, CCSL4, CCSL5, CCL1, CCL2, CCL3, CCL4, CCL5, CCM1, CCM2, CCM3, CCM4, CCM7, CCM8, CCM9, CCM27, CCM30, CCM31, CCM32, CCM33, CCM34, CCM35, CCM36, CCM37, CCM38, CCM39, T1, T2, T3, T4, T6
   b. Discuss rules of safety.
   c. Demonstrate centering a workpiece in a four-jaw chuck on the lathe. CCM1, CCM2,

CCM3, CCM4, CCM7, CCM8, CCM9, CCM27, CCM30, CCM31, CCM32, CCM33, CCM34, CCM35, CCM36, CCM37, CCM38, CCM39, T1, T2, T3, T4, T6

d. Face a part to length. CCM1, CCM2, CCM3, CCM4, CCM7, CCM8, CCM9, CCM27, CCM30, CCM31, CCM32, CCM33, CCM34, CCM35, CCM36, CCM37, CCM38, CCM39, T1, T2, T3, T4, T6
e. Perform a straight turning operation. CCM1, CCM2, CCM3, CCM4, CCM7, CCM8, CCM9, CCM27, CCM30, CCM31, CCM32, CCM33, CCM34, CCM35, CCM36, CCM37, CCM38, CCM39, T1, T2, T3, T4, T6
f. Perform a chamfer operation. CCM1, CCM2, CCM3, CCM4, CCM7, CCM8, CCM9, CCM27, CCM30, CCM31, CCM32, CCM33, CCM34, CCM35, CCM36, CCM37, CCM38, CCM39, T1, T2, T3, T4, T6
g. Perform a center drilling operation. CCM1, CCM2, CCM3, CCM4, CCM7, CCM8, CCM9, CCM27, CCM30, CCM31, CCM32, CCM33, CCM34, CCM35, CCM36, CCM37, CCM38, CCM39, T1, T2, T3, T4, T6
h. Perform a knurling operation. CCM1, CCM2, CCM3, CCM4, CCM7, CCM8, CCM9, CCM27, CCM30, CCM31, CCM32, CCM33, CCM34, CCM35, CCM36, CCM37, CCM38, CCM39, T1, T2, T3, T4, T6
i. Perform a cutoff operation. CCM1, CCM2, CCM3, CCM4, CCM7, CCM8, CCM9, CCM27, CCM30, CCM31, CCM32, CCM33, CCM34, CCM35, CCM36, CCM37, CCM38, CCM39, T1, T2, T3, T4, T6
j. Tap a blind hole. CCM1, CCM2, CCM3, CCM4, CCM7, CCM8, CCM9, CCM27, CCM30, CCM31, CCM32, CCM33, CCM34, CCM35, CCM36, CCM37, CCM38, CCM39, T1, T2, T3, T4, T6
k. Cut external and internal threads on the lathe. CCM1, CCM2, CCM3, CCM4, CCM7, CCM8, CCM9, CCM27, CCM30, CCM31, CCM32, CCM33, CCM34, CCM35, CCM36, CCM37, CCM38, CCM39, T1, T2, T3, T4, T6
l. Complete NIMS turning-chucking Level I project. CCM1, CCM2, CCM3, CCM4, CCM7, CCM8, CCM9, CCM27, CCM30, CCM31, CCM32, CCM33, CCM34, CCM35, CCM36, CCM37, CCM38, CCM39, T1, T2, T3, T4, T6
m. Complete NIMS turning between centers Level I project. CCM1, CCM2, CCM3, CCM4, CCM7, CCM8, CCM9, CCM27, CCM30, CCM31, CCM32, CCM33, CCM34, CCM35, CCM36, CCM37, CCM38, CCM39, T1, T2, T3, T4, T6
n. Install a chuck on a lathe. CCM1, CCM2, CCM3, CCM4, CCM7, CCM8, CCM9, CCM27, CCM30, CCM31, CCM32, CCM33, CCM34, CCM35, CCM36, CCM37, CCM38, CCM39, T1, T2, T3, T4, T6
o. Mount and align a part in a four-jaw chuck on a lathe to instructor's specifications. CCM1, CCM2, CCM3, CCM4, CCM7, CCM8, CCM9, CCM27, CCM30, CCM31, CCM32, CCM33, CCM34, CCM35, CCM36, CCM37, CCM38, CCM39, T1, T2, T3, T4, T6
p. Turn a taper with a compound rest and a taper attachment. CCM1, CCM2, CCM3, CCM4, CCM7, CCM8, CCM9, CCM27, CCM30, CCM31, CCM32, CCM33, CCM34, CCM35, CCM36, CCM37, CCM38, CCM39, T1, T2, T3, T4, T6
q. Perform a boring operation. CCM1, CCM2, CCM3, CCM4, CCM7, CCM8, CCM9, CCM27, CCM30, CCM31, CCM32, CCM33, CCM34, CCM35, CCM36, CCM37, CCM38, CCM39, T1, T2, T3, T4, T6

r. Perform wet and dry cuts. CCM1, CCM2, CCM3, CCM4, CCM7, CCM8, CCM9, CCM27, CCM30, CCM31, CCM32, CCM33, CCM34, CCM35, CCM36, CCM37, CCM38, CCM39, T1, T2, T3, T4, T6

Unit 7: Grinding Theory and Operation

1. Describe safety, magnetic chuck work, surface grinding operations, and reasons for truing and balancing a grinding wheel. (DOK 3) SAF, MAT, HTO, PTO, BLU, COM, L1B, LIL, 1SG, 2FA, 2CG
   a. Describe grinding safety. CS1, CS2, CS3, CS4, CS5, CS6, CS7, CS8, CS9, CS10, CS11, CS12, CS13, CS14, CS15, CS16, CCR1, CCR2, CCR3, CCR4, CCR5, CCR6, CCR7, CCR8, CCR9, CCR10, CCW1, CCW2, CCW3, CCW4, CCW5, CCW6, CCW8, CCW9, CCSL1, CCSL2, CCSL3, CCSL4, CCSL5, CCL1, CCL2, CCL3, CCL4, CCL5, CCM1, CCM2, CCM3, CCM4, CCM7, CCM8, CCM9, CCM27, CCM30, CCM31, CCM32, CCM33, CCM34, CCM35, CCM36, CCM37, CCM38, CCM39, T1, T2, T3, T4, T6
   b. Describe safety rules that apply to magnetic chuck work. CS1, CS2, CS3, CS4, CS5, CS6, CS7, CS8, CS9, CS10, CS11, CS12, CS13, CS14, CS15, CS16, CCR1, CCR2, CCR3, CCR4, CCR5, CCR6, CCR7, CCR8, CCR9, CCR10, CCW1, CCW2, CCW3, CCW4, CCW5, CCW6, CCW8, CCW9, CCSL1, CCSL2, CCSL3, CCSL4, CCSL5, CCL1, CCL2, CCL3, CCL4, CCL5, CCM1, CCM2, CCM3, CCM4, CCM7, CCM8, CCM9, CCM27, CCM30, CCM31, CCM32, CCM33, CCM34, CCM35, CCM36, CCM37, CCM38, CCM39, T1, T2, T3, T4, T6
   c. Identify surface grinding operations. CS1, CS2, CS3, CS4, CS5, CS6, CS7, CS8, CS9, CS10, CS11, CS12, CS13, CS14, CS15, CS16, CCR1, CCR2, CCR3, CCR4, CCR5, CCR6, CCR7, CCR8, CCR9, CCR10, CCW1, CCW2, CCW3, CCW4, CCW5, CCW6, CCW8, CCW9, CCSL1, CCSL2, CCSL3, CCSL4, CCSL5, CCL1, CCL2, CCL3, CCL4, CCL5, CCM1, CCM2, CCM3, CCM4, CCM7, CCM8, CCM9, CCM27, CCM30, CCM31, CCM32, CCM33, CCM34, CCM35, CCM36, CCM37, CCM38, CCM39, T1, T2, T3, T4, T6
   d. Explain reasons for truing and balancing grinding wheels. CS1, CS2, CS3, CS4, CS5, CS6, CS7, CS8, CS9, CS10, CS11, CS12, CS13, CS14, CS15, CS16, CCR1, CCR2, CCR3, CCR4, CCR5, CCR6, CCR7, CCR8, CCR9, CCR10, CCW1, CCW2, CCW3, CCW4, CCW5, CCW6, CCW8, CCW9, CCSL1, CCSL2, CCSL3, CCSL4, CCSL5, CCL1, CCL2, CCL3, CCL4, CCL5, CCM1, CCM2, CCM3, CCM4, CCM7, CCM8, CCM9, CCM27, CCM30, CCM31, CCM32, CCM33, CCM34, CCM35, CCM36, CCM37, CCM38, CCM39, T1, T2, T3, T4, T6
2. Perform maintenance operations to manufacturer's specifications and grinding operations to teacher's specifications. (DOK 4) SAF, MAT, HTO, PTO, BLU, L1B, LIL, 1SG, 2FA, 2CG
   a. Remove and replace a grinding wheel. . CCM1, CCM2, CCM3, CCM4, CCM7, CCM8, CCM9, CCM27, CCM30, CCM31, CCM32, CCM33, CCM34, CCM35, CCM36, CCM37, CCM38, CCM39, T1, T2, T3, T4, T6

b. Dress a wheel flat. CCM1, CCM2, CCM3, CCM4, CCM7, CCM8, CCM9, CCM27, CCM30, CCM31, CCM32, CCM33, CCM34, CCM35, CCM36, CCM37, CCM38, CCM39, T1, T2, T3, T4, T6
c. Grind a workpiece flat and parallel. Grind a workpiece square, to an angular surface, and to dimension. CCM1, CCM2, CCM3, CCM4, CCM7, CCM8, CCM9, CCM27, CCM30, CCM31, CCM32, CCM33, CCM34, CCM35, CCM36, CCM37, CCM38, CCM39, T1, T2, T3, T4, T6

Unit 8: Orientation, Advanced Leadership, and Employability Skills

1. Describe local program and vocational center policies and procedures. (DOK 1) SAF, MAT, HTO, PTO, BLU, MBR, COM, EMP
   a. Describe local program and vocational center policies and procedures including dress code, attendance, academic requirements, discipline, and transportation regulations. CS1, CS3, CS5, CS6, CS7, CS7, CS8, CS9, CS10, CS11, CS12, CS13, CS14, CS15, CS16, CCR1, CCR2, CCR3, CCR4, CCR5, CCR6, CCR7, CCR8, CCR10, CCW4, CCW5, CCW6, CCW7, CCW8, CCW9, CCW10, CCSL1, CCSL2, CCSL3, CCSL4, CCSL5, T1, T2, T3, T4, T6
2. Describe employment opportunities and responsibilities. (DOK 2) SAF, MAT, COM, EMP
   a. Describe employment opportunities including potential earnings, employee benefits, job availability, place of employment, working conditions, and educational requirements. CS1, CS3, CS6, CS7, CS8, CS9, CS10, CS11, CS12, CS13, CS14, CS15, CS16, CCR1, CCR2, CCR3, CCR4, CCR5, CCR6, CCR7, CCR8, CCR10, CCW4, CCW5, CCW6, CCW7, CCW8, CCW9, CCW10, CCSL1, CCSL3, CCSL5, CCL1, CCL2, CCL3, T1, T2, T3, T5, T6
   b. Describe basic employee responsibilities. CS1, CS3, CS6, CS7, CS8, CS9, CS10, CS11, CS12, CS13, CS14, CS15, CS16, CCR1, CCR2, CCR3, CCR4, CCR5, CCR6, CCR7, CCR8, CCR10, CCW4, CCW5, CCW6, CCW7, CCW8, CCW9, CCW10, CCSL1, CCSL3, CCSL5, CCL1, CCL2, CCL3, T1, T2, T3, T5, T6
   c. Design a resume, and complete a job application. CS1, CS3, CS6, CS7, CS8, CS9, CS10, CS11, CS12, CS13, CS14, CS15, CS16, CCR1, CCR2, CCR3, CCR4, CCR5, CCR6, CCR7, CCR8, CCR10, CCW4, CCW5, CCW6, CCW7, CCW8, CCW9, CCW10, CCSL1, CCSL3, CCSL5, CCL1, CCL2, CCL3, T1, T2, T3, T5, T6
3. Demonstrate the ability to follow verbal and written instructions and communicate effectively in on-the-job situations. (DOK 2) SAF, MAT, COM, EMP
   a. Perform projects through written instruction. CS1, CS3, CS6, CS7, CS8, CS9, CS10, CS11, CS12, CS13, CS14, CS15, CS16, CCR1, CCR2, CCR3, CCR4, CCR5, CCR6, CCR7, CCR8, CCR10, CCW4, CCW5, CCW6, CCW7, CCW8, CCW9, CCW10, CCSL1, CCSL3, CCSL5, CCL1, CCL2, CCL3, T1, T2, T3, T5, T6
   b. Perform projects through oral instruction. CS1, CS3, CS6, CS7, CS8, CS9, CS10, CS11, CS12, CS13, CS14, CS15, CS16, CCR1, CCR2, CCR3, CCR4, CCR5, CCR6, CCR7, CCR8, CCR10, CCW4, CCW5, CCW6, CCW7, CCW8, CCW9, CCW10, CCSL1, CCSL3, CCSL5, CCL1, CCL2, CCL3, T1, T2, T3, T5, T6

Unit 9: Basic Safety (Review and Reinforcement)

1. Describe general safety rules for working in a shop/laboratory and industry. (DOK 1) SAF, HTO, PTO, MBR, COM
   a. Describe how to avoid on-site accidents. CS1, CS3, CS6, CS7, CS8, CS9, CS10, CS11, CS12, CS13, CS14, CS15, CS16, CCR1, CCR2, CCR3, CCR4, CCR5, CCR6, CCR7, CCR8, CCR10, CCW4, CCW5, CCW6, CCW7, CCW8, CCW9, CCW10, CCSL1, CCSL3, CCSL5, CCL1, CCL2, CCL3, T1, T2, T3, T5, T6
   b. Explain the relationship between housekeeping and safety. CS1, CS3, CS6, CS7, CS8, CS9, CS10, CS11, CS12, CS13, CS14, CS15, CS16, CCR1, CCR2, CCR3, CCR4, CCR5, CCR6, CCR7, CCR8, CCR10, CCW4, CCW5, CCW6, CCW7, CCW8, CCW9, CCW10, CCSL1, CCSL3, CCSL5, CCL1, CCL2, CCL3, T1, T2, T3, T5, T6
   c. Explain the importance of following all safety rules and company safety policies. CS1, CS3, CS6, CS7, CS8, CS9, CS10, CS11, CS12, CS13, CS14, CS15, CS16, CCR1, CCR2, CCR3, CCR4, CCR5, CCR6, CCR7, CCR8, CCR10, CCW4, CCW5, CCW6, CCW7, CCW8, CCW9, CCW10, CCSL1, CCSL3, CCSL5, CCL1, CCL2, CCL3, T1, T2, T3, T5, T6
   d. Explain the importance of reporting all on-the-job injuries, accidents, and near misses. CS1, CS3, CS6, CS7, CS8, CS9, CS10, CS11, CS12, CS13, CS14, CS15, CS16, CCR1, CCR2, CCR3, CCR4, CCR5, CCR6, CCR7, CCR8, CCR10, CCW4, CCW5, CCW6, CCW7, CCW8, CCW9, CCW10, CCSL1, CCSL3, CCSL5, CCL1, CCL2, CCL3, T1, T2, T3, T5, T6
   e. Explain the need for evacuation policies and the importance of following them. CS1, CS3, CS6, CS7, CS8, CS9, CS10, CS11, CS12, CS13, CS14, CS15, CS16, CCR1, CCR2, CCR3, CCR4, CCR5, CCR6, CCR7, CCR8, CCR10, CCW4, CCW5, CCW6, CCW7, CCW8, CCW9, CCW10, CCSL1, CCSL3, CCSL5, CCL1, CCL2, CCL3, T1, T2, T3, T5, T6
   f. Explain the employer's substance-abuse policy and how it relates to safety. CS1, CS3, CS6, CS7, CS8, CS9, CS10, CS11, CS12, CS13, CS14, CS15, CS16, CCR1, CCR2, CCR3, CCR4, CCR5, CCR6, CCR7, CCR8, CCR10, CCW4, CCW5, CCW6, CCW7, CCW8, CCW9, CCW10, CCSL1, CCSL3, CCSL5, CCL1, CCL2, CCL3, T1, T2, T3, T5, T6
   g. Explain the safety procedures when working near pressurized or high temperatures. CS1, CS3, CS6, CS7, CS8, CS9, CS10, CS11, CS12, CS13, CS14, CS15, CS16, CCR1, CCR2, CCR3, CCR4, CCR5, CCR6, CCR7, CCR8, CCR10, CCW4, CCW5, CCW6, CCW7, CCW8, CCW9, CCW10, CCSL1, CCSL3, CCSL5, CCL1, CCL2, CCL3, T1, T2, T3, T5, T6
2. Identify and apply safety around manufacturing operations. (DOK 1) SAF, HTO, PTO, COM
   a. Use proper safety practices when welding or working around manufacturing operations. CS1, CS3, CS6, CS7, CS8, CS9, CS10, CS11, CS12, CS13, CS14, CS15, CS16, CCR1, CCR2, CCR3, CCR4, CCR5, CCR6, CCR7, CCR8, CCR10, CCW4, CCW5, CCW6, CCW7, CCW8, CCW9, CCW10, CCSL1, CCSL3, CCSL5, CCL1, CCL2, CCL3, T1, T2, T3, T5, T6

b. Use proper safety practices when welding in or near trenches and excavations. CS1, CS3, CS6, CS7, CS8, CS9, CS10, CS11, CS12, CS13, CS14, CS15, CS16, CCR1, CCR2, CCR3, CCR4, CCR5, CCR6, CCR7, CCR8, CCR10, CCW4, CCW5, CCW6, CCW7, CCW8, CCW9, CCW10, CCSL1, CCSL3, CCSL5, CCL1, CCL2, CCL3, T1, T2, T3, T5, T6
c. Explain the term "proximity work." CS1, CS3, CS6, CS7, CS8, CS9, CS10, CS11, CS12, CS13, CS14, CS15, CS16, CCR1, CCR2, CCR3, CCR4, CCR5, CCR6, CCR7, CCR8, CCR10, CCW4, CCW5, CCW6, CCW7, CCW8, CCW9, CCW10, CCSL1, CCSL3, CCSL5, CCL1, CCL2, CCL3, T1, T2, T3, T5, T6

3. Identify and explain use of various barriers and confinements. (DOK 2) SAF, HTO, PTO, MBR, COM
   a. Explain the safety requirements for working in confined areas. CS1, CS3, CS6, CS7, CS8, CS9, CS10, CS11, CS12, CS13, CS14, CS15, CS16, CCR1, CCR2, CCR3, CCR4, CCR5, CCR6, CCR7, CCR8, CCR10, CCW4, CCW5, CCW6, CCW7, CCW8, CCW9, CCW10, CCSL1, CCSL3, CCSL5, CCL1, CCL2, CCL3, T1, T2, T3, T5, T6
   b. Explain and practice lock-out/tag-out procedures. CS1, CS3, CS6, CS7, CS8, CS9, CS10, CS11, CS12, CS13, CS14, CS15, CS16, CCR1, CCR2, CCR3, CCR4, CCR5, CCR6, CCR7, CCR8, CCR10, CCW4, CCW5, CCW6, CCW7, CCW8, CCW9, CCW10, CCSL1, CCSL3, CCSL5, CCL1, CCL2, CCL3, T1, T2, T3, T5, T6
   c. Explain the different barriers and barricades and how they are used. CS1, CS3, CS6, CS7, CS8, CS9, CS10, CS11, CS12, CS13, CS14, CS15, CS16, CCR1, CCR2, CCR3, CCR4, CCR5, CCR6, CCR7, CCR8, CCR10, CCW4, CCW5, CCW6, CCW7, CCW8, CCW9, CCW10, CCSL1, CCSL3, CCSL5, CCL1, CCL2, CCL3, T1, T2, T3, T5, T6
   d. Recognize and explain personal protective equipment (PPE). CS1, CS3, CS6, CS7, CS8, CS9, CS10, CS11, CS12, CS13, CS14, CS15, CS16, CCR1, CCR2, CCR3, CCR4, CCR5, CCR6, CCR7, CCR8, CCR10, CCW4, CCW5, CCW6, CCW7, CCW8, CCW9, CCW10, CCSL1, CCSL3, CCSL5, CCL1, CCL2, CCL3, T1, T2, T3, T5, T6
   e. Inspect and care for personal protective equipment (PPE). CS1, CS3, CS6, CS7, CS8, CS9, CS10, CS11, CS12, CS13, CS14, CS15, CS16, CCR1, CCR2, CCR3, CCR4, CCR5, CCR6, CCR7, CCR8, CCR10, CCW4, CCW5, CCW6, CCW7, CCW8, CCW9, CCW10, CCSL1, CCSL3, CCSL5, CCL1, CCL2, CCL3, T1, T2, T3, T5, T6
4. Explain lifting and the use of ladders and scaffolds. (DOK 2) SAF, MAT, HTO, PTO, MBR, COM
   a. Identify and explain the procedures for lifting heavy objects. CS1, CS3, CS6, CS7, CS8, CS9, CS10, CS11, CS12, CS13, CS14, CS15, CS16, CCR1, CCR2, CCR3, CCR4, CCR5, CCR6, CCR7, CCR8, CCR10, CCW4, CCW5, CCW6, CCW7, CCW8, CCW9, CCW10, CCSL1, CCSL3, CCSL5, CCL1, CCL2, CCL3, T1, T2, T3, T5, T6
   b. Inspect and safely work with various ladders and scaffolds. CS1, CS3, CS6, CS7, CS8, CS9, CS10, CS11, CS12, CS13, CS14, CS15, CS16, CCR1, CCR2, CCR3, CCR4, CCR5, CCR6, CCR7, CCR8, CCR10, CCW4, CCW5, CCW6, CCW7,

CCW8, CCW9, CCW10, CCSL1, CCSL3, CCSL5, CCL1, CCL2, CCL3, T1, T2, T3, T5, T6

5. Explain the Material Safety Data Sheet (MSDS). (DOK 1) SAF, COM
   a. Explain the function of the MSDS. CS1, CS3, CS6, CS7, CS8, CS9, CS10, CS11, CS12, CS13, CS14, CS15, CS16, CCR1, CCR2, CCR3, CCR4, CCR5, CCR6, CCR7, CCR8, CCR10, CCW4, CCW5, CCW6, CCW7, CCW8, CCW9, CCW10, CCSL1, CCSL3, CCSL5, CCL1, CCL2, CCL3, T1, T2, T3, T5, T6
   b. Interpret the requirements of the MSDS. CS1, CS3, CS6, CS7, CS8, CS9, CS10, CS11, CS12, CS13, CS14, CS15, CS16, CCR1, CCR2, CCR3, CCR4, CCR5, CCR6, CCR7, CCR8, CCR10, CCW4, CCW5, CCW6, CCW7, CCW8, CCW9, CCW10, CCSL1, CCSL3, CCSL5, CCL1, CCL2, CCL3, T1, T2, T3, T5, T6
6. Explain fires. (DOK 2) SAF, COM
   a. Explain the process by which fires start. CS1, CS3, CS6, CS7, CS8, CS9, CS10, CS11, CS12, CS13, CS14, CS15, CS16, CCR1, CCR2, CCR3, CCR4, CCR5, CCR6, CCR7, CCR8, CCR10, CCW4, CCW5, CCW6, CCW7, CCW8, CCW9, CCW10, CCSL1, CCSL3, CCSL5, CCL1, CCL2, CCL3, T1, T2, T3, T5, T6
   b. Explain fire prevention of various flammable liquids. CS1, CS3, CS6, CS7, CS8, CS9, CS10, CS11, CS12, CS13, CS14, CS15, CS16, CCR1, CCR2, CCR3, CCR4, CCR5, CCR6, CCR7, CCR8, CCR10, CCW4, CCW5, CCW6, CCW7, CCW8, CCW9, CCW10, CCSL1, CCSL3, CCSL5, CCL1, CCL2, CCL3, T1, T2, T3, T5, T6
   c. Explain the classes of fires and the types of extinguishers. CS1, CS3, CS6, CS7, CS8, CS9, CS10, CS11, CS12, CS13, CS14, CS15, CS16, CCR1, CCR2, CCR3, CCR4, CCR5, CCR6, CCR7, CCR8, CCR10, CCW4, CCW5, CCW6, CCW7, CCW8, CCW9, CCW10, CCSL1, CCSL3, CCSL5, CCL1, CCL2, CCL3, T1, T2, T3, T5, T6
7. Explain safety in and around electrical situations. (DOK 3) SAF, HTO, PTO, MBR, COM
   a. Explain injuries when electrical contact occurs. CS1, CS3, CS6, CS7, CS8, CS9, CS10, CS11, CS12, CS13, CS14, CS15, CS16, CCR1, CCR2, CCR3, CCR4, CCR5, CCR6, CCR7, CCR8, CCR10, CCW4, CCW5, CCW6, CCW7, CCW8, CCW9, CCW10, CCSL1, CCSL3, CCSL5, CCL1, CCL2, CCL3, T1, T2, T3, T5, T6
   b. Explain safety around electrical hazards. CS1, CS3, CS6, CS7, CS8, CS9, CS10, CS11, CS12, CS13, CS14, CS15, CS16, CCR1, CCR2, CCR3, CCR4, CCR5, CCR6, CCR7, CCR8, CCR10, CCW4, CCW5, CCW6, CCW7, CCW8, CCW9, CCW10, CCSL1, CCSL3, CCSL5, CCL1, CCL2, CCL3, T1, T2, T3, T5, T6
   c. Explain actions to take when an electrical shock occurs. CS1, CS3, CS6, CS7, CS8, CS9, CS10, CS11, CS12, CS13, CS14, CS15, CS16, CCR1, CCR2, CCR3, CCR4, CCR5, CCR6, CCR7, CCR8, CCR10, CCW4, CCW5, CCW6, CCW7, CCW8, CCW9, CCW10, CCSL1, CCSL3, CCSL5, CCL1, CCL2, CCL3, T1, T2, T3, T5, T6

Unit 10: Advanced Lathe Operation

1. Describe safety precautions, methods for measuring thread-pitch diameters, and calculation of dimensions using taper formulas. (DOK 2) SAF, MAT, BLU, COM, L1B, LIL, 1TB, 1TC, 2TB, 2TC

a. Describe safety precautions. CS1, CS2, CS3, CS4, CS5, CS6, CS7, CS8, CS9, CS10, CS11, CS12, CS13, CS14, CS15, CS16, CCR1, CCR2, CCR3, CCR4, CCR5, CCR6, CCR7, CCR8, CCR9, CCR10, CCW1, CCW2, CCW3, CCW4, CCW5, CCW6, CCW8, CCW9, CCSL1, CCSL2, CCSL3, CCSL4, CCSL5, CCL1, CCL2, CCL3, CCL4, CCL5, CCM1, CCM2, CCM3, CCM4, CCM7, CCM8, CCM9, CCM27, CCM30, CCM31, CCM32, CCM33, CCM34, CCM35, CCM36, CCM37, CCM38, CCM39, T1, T2, T3, T4, T6
b. Describe methods for measuring thread-pitch diameters. CS1, CS2, CS3, CS4, CS5, CS6, CS7, CS8, CS9, CS10, CS11, CS12, CS13, CS14, CS15, CS16, CCR1, CCR2, CCR3, CCR4, CCR5, CCR6, CCR7, CCR8, CCR9, CCR10, CCW1, CCW2, CCW3, CCW4, CCW5, CCW6, CCW8, CCW9, CCSL1, CCSL2, CCSL3, CCSL4, CCSL5, CCL1, CCL2, CCL3, CCL4, CCL5, CCM1, CCM2, CCM3, CCM4, CCM7, CCM8, CCM9, CCM27, CCM30, CCM31, CCM32, CCM33, CCM34, CCM35, CCM36, CCM37, CCM38, CCM39, T1, T2, T3, T4, T6
c. Calculate dimensions using taper formulas. CS1, CS2, CS3, CS4, CS5, CS6, CS7, CS8, CS9, CS10, CS11, CS12, CS13, CS14, CS15, CS16, CCR1, CCR2, CCR3, CCR4, CCR5, CCR6, CCR7, CCR8, CCR9, CCR10, CCW1, CCW2, CCW3, CCW4, CCW5, CCW6, CCW8, CCW9, CCSL1, CCSL2, CCSL3, CCSL4, CCSL5, CCL1, CCL2, CCL3, CCL4, CCL5, CCM1, CCM2, CCM3, CCM4, CCM7, CCM8, CCM9, CCM27, CCM30, CCM31, CCM32, CCM33, CCM34, CCM35, CCM36, CCM37, CCM38, CCM39, T1, T2, T3, T4, T6

2. Perform various operations according to specifications. (DOK 2) SAF, MAT, BLU, COM, L1B, LIL, 1TB, 1TC, 2TB, 2TC
   a. Perform chamfer, recessing, knurling, drilling and recessing a hole, aligning and starting a tap using a lathe center, and cutoff. CCM1, CCM2, CCM3, CCM4, CCM7, CCM8, CCM9, CCM27, CCM30, CCM31, CCM32, CCM33, CCM34, CCM35, CCM36, CCM37, CCM38, CCM39, T1, T2, T3, T4, T6
   b. Perform turning a taper with taper attachment, turning a taper with compound, boring, cutting external threads to relief, picking up threads, and cutting internal threads. CCM1, CCM2, CCM3, CCM4, CCM7, CCM8, CCM9, CCM27, CCM30, CCM31, CCM32, CCM33, CCM34, CCM35, CCM36, CCM37, CCM38, CCM39, T1, T2, T3, T4, T6

Unit 11: Advanced Milling Operation

1. Explore vertical-milling operations. (DOK 2) SAF, MAT, HTO, PTO, BLU, COM, L1B, LIL, 1VM, 2PL
   a. Describe and apply safety rules. CS1, CS2, CS3, CS4, CS5, CS6, CS7, CS8, CS9, CS10, CS11, CS12, CS13, CS14, CS15, CS16, CCR1, CCR2, CCR3, CCR4, CCR5, CCR6, CCR7, CCR8, CCR9, CCR10, CCW1, CCW2, CCW3, CCW4, CCW5, CCW6, CCW8, CCW9, CCSL1, CCSL2, CCSL3, CCSL4, CCSL5, CCL1, CCL2, CCL3, CCL4, CCL5, CCM1, CCM2, CCM3, CCM4, CCM7, CCM8, CCM9, CCM27, CCM30, CCM31, CCM32, CCM33, CCM34, CCM35, CCM36, CCM37, CCM38, CCM39, T1, T2, T3, T4, T6

b. Identify the types of milling machines and describe the major components. CS1, CS2, CS3, CS4, CS5, CS6, CS7, CS8, CS9, CS10, CS11, CS12, CS13, CS14, CS15, CS16, CCR1, CCR2, CCR3, CCR4, CCR5, CCR6, CCR7, CCR8, CCR9, CCR10, CCW1, CCW2, CCW3, CCW4, CCW5, CCW6, CCW8, CCW9, CCSL1, CCSL2, CCSL3, CCSL4, CCSL5, CCL1, CCL2, CCL3, CCL4, CCL5, CCM1, CCM2, CCM3, CCM4, CCM7, CCM8, CCM9, CCM27, CCM30, CCM31, CCM32, CCM33, CCM34, CCM35, CCM36, CCM37, CCM38, CCM39, T1, T2, T3, T4, T6
c. Identify work-holding devices, cutting tools, tool holders, and other attachments. CS1, CS2, CS3, CS4, CS5, CS6, CS7, CS8, CS9, CS10, CS11, CS12, CS13, CS14, CS15, CS16, CCR1, CCR2, CCR3, CCR4, CCR5, CCR6, CCR7, CCR8, CCR9, CCR10, CCW1, CCW2, CCW3, CCW4, CCW5, CCW6, CCW8, CCW9, CCSL1, CCSL2, CCSL3, CCSL4, CCSL5, CCL1, CCL2, CCL3, CCL4, CCL5, CCM1, CCM2, CCM3, CCM4, CCM7, CCM8, CCM9, CCM27, CCM30, CCM31, CCM32, CCM33, CCM34, CCM35, CCM36, CCM37, CCM38, CCM39, T1, T2, T3, T4, T6
d. Describe the different types of horizontal-milling operations. CS1, CS2, CS3, CS4, CS5, CS6, CS7, CS8, CS9, CS10, CS11, CS12, CS13, CS14, CS15, CS16, CCR1, CCR2, CCR3, CCR4, CCR5, CCR6, CCR7, CCR8, CCR9, CCR10, CCW1, CCW2, CCW3, CCW4, CCW5, CCW6, CCW8, CCW9, CCSL1, CCSL2, CCSL3, CCSL4, CCSL5, CCL1, CCL2, CCL3, CCL4, CCL5, CCM1, CCM2, CCM3, CCM4, CCM7, CCM8, CCM9, CCM27, CCM30, CCM31, CCM32, CCM33, CCM34, CCM35, CCM36, CCM37, CCM38, CCM39, T1, T2, T3, T4, T6

2. Adjust speed and feed rates, clean and lubricate, mount arbors and adjust arbor support bushing, mount a cutter, mill a key-way, and perform selected horizontal operations. (DOK 2) SAF, MAT, HTO, PTO, BLU, COM, L1B, LIL, 1VM, 2PL
   a. Adjust machine speed and feed rates; clean and lubricate. T1, T2, T3, T4, T6
   b. Mount arbors and adjust arbor support bushing and mount a cutter according to specifications. CCM1, CCM2, CCM3, CCM4, CCM7, CCM8, CCM9, CCM27, CCM30, CCM31, CCM32, CCM33, CCM34, CCM35, CCM36, CCM37, CCM38, CCM39, T1, T2, T3, T4, T6
   c. Perform selected operations according to specifications. CCM1, CCM2, CCM3, CCM4, CCM7, CCM8, CCM9, CCM27, CCM30, CCM31, CCM32, CCM33, CCM34, CCM35, CCM36, CCM37, CCM38, CCM39, T1, T2, T3, T4, T6
3. Mount and remove cutters and cutter holders, align a vise using a dial indicator, and perform selected vertical milling and boring operations. (DOK 2) SAF, MAT, HTO, PTO, BLU, COM, L1B, LIL, 1VM, 2PL
   a. Mount and remove cutters and cutter holders; mount and align a vise. CCM1, CCM2, CCM3, CCM4, CCM7, CCM8, CCM9, CCM27, CCM30, CCM31, CCM32, CCM33, CCM34, CCM35, CCM36, CCM37, CCM38, CCM39, T1, T2, T3, T4, T6
   b. Perform selected milling and boring operations according to specifications. CCM1, CCM2, CCM3, CCM4, CCM7, CCM8, CCM9, CCM27, CCM30, CCM31, CCM32, CCM33, CCM34, CCM35, CCM36, CCM37, CCM38, CCM39, T1, T2, T3, T4, T6

Unit 12: Computerized Numerical Control

1. Describe computerized numerical control (CNC), including the codes and the input of a pre-written program. (DOK 2) SAF, MAT, HTO, PTO, BLU, COM, L1B, LIL, 1VM, 1TB, 1TC, 1CM, 1CT, 2CM, 2CT
   a. Describe the operations of CNC. CS1, CS2, CS3, CS4, CS5, CS6, CS7, CS8, CS9, CS10, CS11, CS12, CS13, CS14, CS15, CS16, CCR1, CCR2, CCR3, CCR4, CCR5, CCR6, CCR7, CCR8, CCR9, CCR10, CCW1, CCW2, CCW3, CCW4, CCW5, CCW6, CCW8, CCW9, CCSL1, CCSL2, CCSL3, CCSL4, CCSL5, CCL1, CCL2, CCL3, CCL4, CCL5, CCM1, CCM2, CCM3, CCM4, CCM7, CCM8, CCM9, CCM27, CCM30, CCM31, CCM32, CCM33, CCM34, CCM35, CCM36, CCM37, CCM38, CCM39, T1, T2, T3, T4, T6
   b. Describe codes used in a CNC machine. CS1, CS2, CS3, CS4, CS5, CS6, CS7, CS8, CS9, CS10, CS11, CS12, CS13, CS14, CS15, CS16, CCR1, CCR2, CCR3, CCR4, CCR5, CCR6, CCR7, CCR8, CCR9, CCR10, CCW1, CCW2, CCW3, CCW4, CCW5, CCW6, CCW8, CCW9, CCSL1, CCSL2, CCSL3, CCSL4, CCSL5, CCL1, CCL2, CCL3, CCL4, CCL5, CCM1, CCM2, CCM3, CCM4, CCM7, CCM8, CCM9, CCM27, CCM30, CCM31, CCM32, CCM33, CCM34, CCM35, CCM36, CCM37, CCM38, CCM39, T1, T2, T3, T4, T6

Precision Machining Competency Profile
Program CIP: 48.0503

Unit 1: Orientation, Leadership, and Basic Safety

_____ 1. Describe local program and vocational/career technical center policies and procedures. (DOK 1) SAF, MAT, HTO, PTO, BLU, MBR, COM, EMP

_____ 2. Describe employment opportunities and responsibilities. (DOK 2) SAF, MAT, HTO, PTO, BLU, MBR, COM, EMP

_____ 3. Explore leadership skills and personal development opportunities provided for students by student organizations to include SkillsUSA. (DOK 2) SAF, MAT, HTO, PTO, BLU, MBR, COM, EMP

_____ 4. Describe general safety rules for working in a shop/lab and industry. (DOK 1) SAF, HTO, PTO, MBR, COM

_____ 5. Identify and apply safety around manufacturing operations. (DOK 1) SAF, HTO, PTO, MBR, COM

_____ 6. Explain lifting. (DOK 3) SAF, MBR, COM

_____ 7. Explain the Material Safety Data Sheet (MSDS). (DOK 2) SAF, HTO, PTO, MBR, COM

_____ 8. Explain fires. (DOK 1) SAF, HTO, MBR, COM

_____ 9. Explain safety in and around Manufacturing and electrical situations. (DOK 2) SAF, HTO PTO, MBR, COM

Unit 2: Math, Measuring Tools, and Instruments

_____ 1. Apply the four basic math skills with whole numbers, fractions, and percentages. (DOK 1) MAT, HTO

_____ 2. Perform basic mathematical calculations related to machine shop operations. (DOK 1) MAT

_____ 3. Identify and perform functions using various measuring tools and instruments (micrometers, dial indicators, height gauge, and digital caliper). (DOK 2) MAT, HTO

Unit 3: Introduction to Blueprints and Hand and Power Tools

_____ 1. Read, analyze, and design a blueprint. (DOK 2) MAT, BLU, COM, L1B, LIL, 1VM, 1DP, 1SG, 1TB, 1TC, 1CM, 1CT, 2TC, 2PL, 2FA, 2CG, 2CM, 2CT

_____ 2. Demonstrate the use and maintenance of various hand and power tools. (DOK 3) SAF, HTO, PTO, L1B, LIL, 1DP

Unit 4: Drill Press and Band Saw Theory and Operation

_____ 1. Identify and describe the safe operation of the types of power saws. (DOK 2) SAF, MAT, BLU,HTO, PTO, COM, L1B, LIL, 1DP

_____ 2. Identify and describe the types of drilling machines, including hand powered and drill press, and the rules for safe operation of each. (DOK 2) SAF, MAT, BLU, COM, HTO, PTO, 1DP

Unit 5: Milling Machine Theory and Operation

_____ 1. Differentiate between the types of milling machines. (DOK 2) SAF, COM, L1B, LIL, 1VM

_____ 2. Identify the parts, cutting tools, and basic maintenance of a vertical milling machine. (DOK 2) SAF, COM, L1B, LIL, 1VM

_____ 3. Perform operations on a milling machine.

Unit 6: Lathe Theory and Operation

_____ 1. Identify the parts, rules, and care of the metal lathe. (DOK 3) SAF, MAT, HTO, PTO, BLU, COM, L1B, LIL, 1TB, 1TC

_____ 2. Perform procedures for a machining operation. (DOK 3) SAF, MAT, HTO, PTO, BLU, L1B, LIL, 1TB, 1TC, 1CT

Unit 7: Grinding Theory and Operation

1. Describe safety, magnetic chuck work, surface grinding operations, and reasons for truing and balancing a grinding wheel. (DOK 3) SAF, MAT, HTO, PTO, BLU, COM, L1B, LIL, 1SG, 2FA, 2CG
2. Perform maintenance operations to manufacturer's specifications and grinding operations to teacher's specifications. (DOK 4) SAF, MAT, HTO, PTO, BLU, L1B, LIL, 1SG, 2FA, 2CG

Unit 8: Orientation, Advanced Leadership, and Employability Skills

1. Describe local program and vocational center policies and procedures. (DOK 1) SAF, MAT, HTO, PTO, BLU, MBR, COM, EMP
2. Describe employment opportunities and responsibilities. (DOK 2) SAF, MAT, COM, EMP
3. Demonstrate the ability to follow verbal and written instructions and communicate effectively in on-the-job situations. (DOK 2) SAF, MAT, COM, EMP

Unit 9: Basic Safety (Review and Reinforcement)

1. Describe general safety rules for working in a shop/lab and industry. (DOK 1) SAF, HTO, PTO, MBR, COM
2. Identify and apply safety around Manufacturing operations. (DOK 1) SAF, HTO, PTO, COM
3. Identify and explain use of various barriers and confinements. (DOK 2) SAF, HTO, PTO, MBR, COM
4. Explain lifting and the use of ladders and scaffolds. (DOK 2) SAF, MAT, HTO, PTO, MBR, COM
5. Explain the material safety data sheet (MSDS). (DOK 1) SAF, COM
6. Explain fires. (DOK 2) SAF, COM
7. Explain safety in and around electrical situations. (DOK 3) SAF, HTO, PTO, MBR, COM

Unit 10: : Advanced Lathe Operation

1. Describe safety precautions, methods for measuring thread pitch diameters, and calculation of dimensions using taper formulas. (DOK 2) SAF, MAT, BLU, COM, L1B, LIL, 1TB, 1TC, 2TB, 2TC
2. Perform various operations according to specifications. (DOK 2) SAF, MAT, BLU, COM, L1B, LIL, 1TB, 1TC, 2TB, 2TC

Unit 11: Advanced Milling Operation

1. Explore vertical milling operations. (DOK 2) SAF, MAT, HTO, PTO, BLU, COM, L1B, LIL, 1VM, 2PL
2. Adjust speed and feed rates, clean and lubricate, mount arbors and adjust arbor support bushing, mount a cutter, mill a key-way, and perform selected horizontal operations. (DOK 2) SAF, MAT, HTO, PTO, BLU, COM, L1B, LIL, 1VM, 2PL
3. Mount and remove cutters and cutter holders, align a vise using a dial indicator, and perform selected vertical milling and boring operations. (DOK 2) SAF, MAT, HTO, PTO, BLU, COM, L1B, LIL, 1VM, 2PL

Unit 12: Computerized Numerical Control

1. Describe computerized numerical control (CNC), including the codes and the input of a pre-written program. (DOK 2) SAF, MAT, HTO, PTO, BLU, COM, L1B, LIL, 1VM, 1TB, 1TC, 1CM, 1CT, 2CM, 2CT

Appendix A: 21st Century Skills Standards

CSS1-21st Century Themes

CS1 Global Awareness

1. Using 21st century skills to understand and address global issues
2. 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
3. Understanding other nations and cultures, including the use of non-English languages

CS2 Financial, Economic, Business and Entrepreneurial Literacy

1. Knowing how to make appropriate personal economic choices
2. Understanding the role of the economy in society
3. Using entrepreneurial skills to enhance workplace productivity and career options

CS3 Civic Literacy

1. Participating effectively in civic life through knowing how to stay informed and understanding governmental processes
2. Exercising the rights and obligations of citizenship at local, state, national, and global levels
3. Understanding the local and global implications of civic decisions

CS4 Health Literacy

1. Obtaining, interpreting, and understanding basic health information and services and using such information and services in ways that enhance health
2. Understanding preventive physical and mental health measures, including proper diet, nutrition, exercise, risk avoidance, and stress reduction
3. Using available information to make appropriate health-related decisions
4. Establishing and monitoring personal and family health goals
5. Understanding national and international public health and safety issues

CS5 Environmental Literacy

1. Demonstrate knowledge and understanding of the environment and the circumstances and conditions affecting it, particularly as relates to air, climate, land, food, energy, water, and ecosystems
2. Demonstrate knowledge and understanding of society's impact on the natural world (e.g., population growth, population development, resource consumption rate, etc.)
3. Investigate and analyze environmental issues, and make accurate conclusions about effective solutions
4. Take individual and collective action towards addressing environmental challenges (e.g., participating in global actions, designing solutions that inspire action on environmental issues)

CSS2-Learning and Innovation Skills

CS6 Creativity and Innovation

1. Think Creatively
2. Work Creatively with Others
3. Implement Innovations

CS7 Critical Thinking and Problem Solving

1. Reason Effectively
2. Use Systems Thinking
3. Make Judgments and Decisions
4. Solve Problems

CS8 Communication and Collaboration

1. Communicate Clearly
2. Collaborate with Others

CSS3-Information, Media and Technology Skills

CS9 Information Literacy

1. Access and Evaluate Information
2. Use and Manage Information

CS10 Media Literacy

1. Analyze Media
2. Create Media Products

CS11 ICT Literacy

1. Apply Technology Effectively

CSS4-Life and Career Skills

CS12 Flexibility and Adaptability

1. Adapt to change
2. Be Flexible

CS13 Initiative and Self-Direction

1. Manage Goals and Time
2. Work Independently
3. Be Self-directed Learners

CS14 Social and Cross-Cultural Skills

1. Interact Effectively with others
2. Work Effectively in Diverse Teams

CS15 Productivity and Accountability

1. Manage Projects
2. Produce Results

CS16 Leadership and Responsibility

1. Guide and Lead Others
2. Be Responsible to Others

Appendix B: MS Academic Standards

MISSISSIPPI SCIENCE FRAMEWORK COMPETENCIES

Marine and Aquatic Science

AQ 1	Apply inquiry-based and problem-solving processes and skills to scientific investigations.
AQ 2	Develop an understanding of physical and chemical properties of water and aquatic environments.
AQ 3	Apply an understanding of the diverse organisms found in aquatic environments.
AQ 4	Draw conclusions about the relationships between human activity and aquatic organisms.

1. **Apply inquiry-based and problem-solving processes and skills to scientific investigations.**
   a. Conduct a scientific investigation demonstrating safe procedures and proper care of laboratory equipment. (DOK 2)
      - Safety rules and symbols
      - Proper use and care of the compound light microscope, slides, chemicals, etc.
      - Accuracy and precision in using graduated cylinders, balances, beakers, thermometers, and rulers

   b. Formulate questions that can be answered through research and experimental design. (DOK 3)
   c. Apply the components of scientific processes and methods in classroom and laboratory investigations (e.g., hypotheses, experimental design, observations, data analyses, interpretations, theory development). (DOK 3)
   d. Construct and analyze graphs (e.g., plotting points, labeling x-and y-axis, creating appropriate titles and legends for circle, bar, and line graphs). (DOK 2)
   e. Analyze procedures, data, and conclusions to determine the scientific validity of research. (DOK 3)
   f. Recognize and analyze alternative explanations for experimental results and to make predictions based on observations and prior knowledge. (DOK 3)
   g. Communicate and defend a scientific argument in oral, written, and graphic form. (DOK 3)

2. **Develop an understanding of physical and chemical properties of water and aquatic environments.**
   a. Analyze the physical and chemical properties of water, and justify why it is essential to living organisms. (DOK 1)
   b. Explain the causes and characteristics of tides. (DOK 1)
   c. Research, create diagrams, and summarize principles related to waves and current characteristics and formation. (DOK 2)

d. Compare and contrast the physical and chemical parameters of dissolved O2, pH, temperature, salinity, and results obtained through analysis of different water column depths/zones. (DOK 2)
e. Investigate the causes and effects of erosion and discuss conclusions. (DOK 2)
f. Describe and differentiate among the major geologic features of specific aquatic environments. (DOK 1)
   - Plate tectonics
   - Rise, slope, elevation, and depth
   - Formation of dunes, reefs, barrier/volcanic islands, and coastal/flood plains
   - Watershed formation as it relates to bodies of freshwater
g. Compare and contrast the unique abiotic and biotic characteristics of selected aquatic ecosystems. (DOK 2)
   - Barrier island, coral reef, tidal pool, and ocean
   - River, stream, lake, pond, and swamp
   - Bay, sound, estuary, and marsh

3. <u>Apply an understanding of the diverse organisms found in aquatic environments.</u>

a. Analyze and explain the diversity and interactions among aquatic life. (DOK 3)
   - Adaptations of representative organisms for their aquatic environments
   - Relationship of organisms in food chains/webs within aquatic environments
b. Research, calculate, and interpret population data. (DOK 2)
c. Research and compare reproductive processes in aquatic organisms. (DOK 2)
d. Differentiate among characteristics of planktonic, nektonic, and benthic organisms. (DOK 1)
e. Explore the taxonomy of aquatic organisms, and use dichotomous keys to differentiate among the organisms. (DOK 2)
f. Research and explain the symbiotic relationships in aquatic ecosystems. (DOK 3)

4. <u>Draw conclusions about the relationships between human activity and aquatic organisms.</u>

a. Describe the impact of natural and human activity on aquatic ecosystems, and evaluate the effectiveness of various solutions to environmental problems. (DOK 3)
   - Sources of pollution in aquatic environments and methods to reduce the effects of the pollution
   - Effectiveness of a variety of methods of environmental management and stewardship
   - Effects of urbanization on aquatic ecosystems and the effects of continued expansion
b. Research and cite evidence of the effects of natural phenomena such as hurricanes, floods, or drought on aquatic habitats and organisms. (DOK 3)
c. Discuss the advantages and disadvantages involved in applications of modern technology in aquatic science. (DOK 2)
   - Careers related to aquatic science
   - Modern technology within aquatic science (e.g., mariculture and aquaculture)
   - Contributions of aquatic technology to industry and government

Biology I

BIOI 1	Apply inquiry-based and problem-solving processes and skills to scientific investigations.
BIOI 2	Describe the biochemical basis of life, and explain how energy flows within and between the living systems.
BIOI 3	Investigate and evaluate the interaction between living organisms and their environment.
BIOI 4	Analyze and explain the structures and function of the levels of biological organization.
BIOI 5	Demonstrate an understanding of the molecular basis of heredity.
BIOI 6	Demonstrate an understanding of principles that explain the diversity of life and biological evolution.

1. **Apply inquiry-based and problem-solving processes and skills to scientific investigations.**
   a. Conduct a scientific investigation demonstrating safe procedures and proper care of laboratory equipment. (DOK 2)
      - Safety rules and symbols
      - Proper use and care of the compound light microscope, slides, chemicals, etc.
      - Accuracy and precision in using graduated cylinders, balances, beakers, thermometers, and rulers

   d. Formulate questions that can be answered through research and experimental design. (DOK 3)
   e. Apply the components of scientific processes and methods in classroom and laboratory investigations (e.g., hypotheses, experimental design, observations, data analyses, interpretations, theory development). (DOK 2)
   f. Construct and analyze graphs (e.g., plotting points, labeling x-and y-axis, creating appropriate titles and legends for circle, bar, and line graphs). (DOK 2)
   g. Analyze procedures, data, and conclusions to determine the scientific validity of research. (DOK 3)
   h. Recognize and analyze alternative explanations for experimental results and to make predictions based on observations and prior knowledge. (DOK 3)
   i. Communicate and defend a scientific argument in oral, written, and graphic form. (DOK 3)
2. **Describe the biochemical basis of life, and explain how energy flows within and between the living systems.**
   a. Explain and compare with the use of examples the types of bond formation (e.g., covalent, ionic, hydrogen, etc.) between or among atoms. (DOK 2)
      - Subatomic particles and arrangement in atoms
      - Importance of ions in biological processes

   b. Develop a logical argument defending water as an essential component of living systems (e.g., unique bonding and properties including polarity, high specific heat, surface tension, hydrogen bonding, adhesion, cohesion, and expansion upon freezing). (DOK 2)

c. Classify solutions as acidic, basic, or neutral, and relate the significance of the pH scale to an organism's survival (e.g., consequences of having different concentrations of hydrogen and hydroxide ions). (DOK 2)
d. Compare and contrast the structure, properties, and principle functions of carbohydrates, lipids, proteins, and nucleic acids in living organisms. (DOK 2)
   - Basic chemical composition of each group
   - Building components of each group (e.g., amino acids, monosaccharides, nucleotides, etc.)
   - Basic functions (e.g., energy, storage, cellular, heredity) of each group
e. Examine the life processes to conclude the role enzymes play in regulating biochemical reactions. (DOK 2)
   - Enzyme structure
   - Enzyme function, including enzyme-substrate specificity and factors that affect enzyme function (pH and temperature)
f. Describe the role of adenosine triphosphate (ATP) in making energy available to cells. (DOK 1)
   - ATP structure
   - ATP function
g. Analyze and explain the biochemical process of photosynthesis and cellular respiration, and draw conclusions about the roles of the reactant and products in each. (DOK 3)
   - Photosynthesis and respiration (reactants and products)
   - Light-dependent reactions and light independent reactions in photosynthesis, including requirements and products of each
   - Aerobic and anaerobic processes in cellular respiration, including products each and energy differences

3. <u>Investigate and evaluate the interaction between living organisms and their environment.</u>

a. Compare and contrast the characteristics of the world's major biomes (e.g., deserts, tundra, taiga, grassland, temperate forest, tropical rainforest). (DOK 2)
   - Plant and animal species
   - Climate (temperature and rainfall)
   - Adaptations of organisms
b. Provide examples to justify the interdependence among environmental elements. (DOK 2)
   - Biotic and abiotic factors in an ecosystem (e.g., water, carbon, oxygen, mold, leaves)
   - Energy flow in ecosystems (e.g., energy pyramids and photosynthetic organisms to herbivores, carnivores, and decomposers)
   - Roles of beneficial bacteria
   - Interrelationships of organisms (e.g., cooperation, predation, parasitism, commensalism, symbiosis, and mutualism)

c. Examine and evaluate the significance of natural events and human activities on major ecosystems (e.g., succession, population growth, technology, loss of genetic diversity, consumption of resources). (DOK 2)

4. <u>Analyze and explain the structures and function of the levels of biological organization.</u>

a. Differentiate among plant and animal cells and eukaryotic and prokaryotic cells. (DOK 2)
   - Functions of all major cell organelles and structures (e.g., nucleus, mitochondrion, rough ER, smooth ER, ribosomes, Golgi bodies, vesicles, lysosomes, vacuoles, microtubules, microfiliaments, chloroplast, cytoskeleton, centrioles, nucleolus, chromosomes, nuclear membrane, cell wall, cell membrane [active and passive transport], cytosol)
   - Components of mobility (e.g., cilia, flagella, pseudopodia)

b. Differentiate between types of cellular reproduction. (DOK 1)
   - Main events in the cell cycle and cell mitosis (including differences in plant and animal cell divisions)
   - Binary fission (e.g., budding, vegetative propagation, etc.)
   - Significance of meiosis in sexual reproduction
   - Significance of crossing over

c. Describe and differentiate among the organizational levels of organisms (e.g., cells, tissues, organs, systems, types of tissues.) (DOK 1)

d. Explain and describe how plant structures (vascular and nonvascular) and cellular functions are related to the survival of plants (e.g., movement of materials, plant reproduction). (DOK 1)

5. <u>Demonstrate an understanding of the molecular basis of heredity.</u>

a. Analyze and explain the molecular basis of heredity and the inheritance of traits to successive generations by using the Central Dogma of Molecular Biology. (DOK 3)
   - Structures of DNA and RNA
   - Processes of replication, transcription, and translation
   - Messenger RNA codon charts

b. Utilize Mendel's laws to evaluate the results of monohybrid Punnett squares involving complete dominance, incomplete dominance, codominance, sex linked, and multiple alleles (including outcome percentage of both genotypes and phenotypes). (DOK 2)

c. Examine inheritance patterns using current technology (e.g., pedigrees, karyotypes, gel electrophoresis). (DOK 2)

d. Discuss the characteristics and implications of both chromosomal and gene mutations. (DOK 2)
   - Significance of nondisjunction, deletion, substitutions, translocation, frame shift mutation in animals
   - Occurrence and significance of genetic disorders such as sickle cell anemia, Tay-Sachs disorder, cystic fibrosis, hemophilia, Down syndrome, color blindness

6. <u>Demonstrate an understanding of principles that explain the diversity of life and biological evolution.</u>

a. Draw conclusions about how organisms are classified into a hierarchy of groups and subgroups based on similarities that reflect their evolutionary relationships. (DOK 2)
   - Characteristics of the six kingdoms
   - Major levels in the hierarchy of taxa (e.g., kingdom, phylum/division, class, order, family, genus, and species)
   - Body plans (symmetry)
   - Methods of sexual reproduction (e.g., conjugation, fertilization, pollination)
   - Methods of asexual reproduction (e.g., budding, binary fission, regeneration, spore formation)
b. Critique data (e.g., comparative anatomy, Biogeography, molecular biology, fossil record, etc.) used by scientists (e.g., Redi, Needham, Spallanzani, Pasteur) to develop an understanding of evolutionary processes and patterns. (DOK 3)
c. Research and summarize the contributions of scientists (including Darwin, Malthus, Wallace, Lamarck, and Lyell) whose work led to the development of the theory of evolution. (DOK 2)
d. Analyze and explain the roles of natural selection, including the mechanisms of speciation (e.g., mutations, adaptations, geographic isolation) and applications of speciation (e.g., pesticide and antibiotic resistance). (DOK 3)
e. Differentiate among chemical evolution, organic evolution, and the evolutionary steps along the way to aerobic heterotrophs and photosynthetic autotrophs. (DOK 2)

Biology II

BIOII 1	Apply inquiry-based and problem-solving processes and skills to scientific investigations.
BIOII 2	Describe and contrast the structures, functions, and chemical processes of the cell.
BIOII 3	Investigate and discuss the molecular basis of heredity.
BIOII 4	Demonstrate an understanding of the factors that contribute to evolutionary theory and natural selection.
BIOII 5	Develop an understanding of organism classification.

1. **<u>Apply inquiry-based and problem-solving processes and skills to scientific investigations.</u>**
   a. Use current technologies such as CD-ROM, DVD, Internet, and on-line data search to explore current research related to a specific topic. (DOK 3)
   b. Clarify research questions and design laboratory investigations. (DOK 3)
   c. Demonstrate the use of scientific inquiry and methods to formulate, conduct, and evaluate laboratory investigations (e.g., hypotheses, experimental design, observations, data analyses, interpretations, theory development). (DOK 3)
   d. Organize data to construct graphs (e.g., plotting points, labeling x-and y-axis, creating appropriate titles and legends for circle, bar, and line graphs), draw conclusions, and make inferences. (DOK 3)
   e. Evaluate procedures, data, and conclusions to critique the scientific validity of research. (DOK 3)
   f. Formulate and revise scientific explanations and models using logic and evidence (data analysis). (DOK 3)

g. Collect, analyze, and draw conclusions from data to create a formal presentation using available technology (e.g., computers, calculators, SmartBoard, CBL's, etc.). (DOK 3)

2. **<u>Describe and contrast the structures, functions, and chemical processes of the cell.</u>**
   a. Relate the structure and function of a selectively permeable membrane to its role in diffusion and osmosis. (DOK 2)
   b. Summarize how cell regulation controls and coordinates cell growth and division. (DOK 2)
   c. Analyze and describe the function of enzymes in biochemical reactions. (DOK 2)
      - The impact of enzymatic reactions on biochemical processes
      - Factors that affect enzyme function (e.g., pH, concentration, temperature, etc.)
   d. Differentiate between photosynthesis and cellular respiration. (DOK 2)
      - Cellular sites and major pathways of anaerobic and aerobic respiration (with reactants, products, and ATP per monosaccharide)
      - Cellular respiration with respect to the sites at which they take place, the reactions involved, and the energy input and output in each stage (e.g., glycolysis, Krebs cycle, electron transport chain)
      - Pigments, absorption, reflection of light, and light-dependent and light-independent reactions of photosynthesis
      - Oxidation and reduction reactions
3. **<u>Investigate and discuss the molecular basis of heredity.</u>**
   a. Explain how the process of meiosis clarifies the mechanism underlying Mendel's conclusions about segregation and independent assortment on a molecular level. (DOK 1)
   b. Research and explain how major discoveries led to the determination of DNA structure. (DOK 2)
   c. Relate gene expression (e.g., replication, transcription, translation) to protein structure and function. (DOK 2)
      - Translation of a messenger RNA strand into a protein
      - Processing by organelles so that the protein is appropriately packaged, labeled, and eventually exported by the cell
      - Messenger RNA codon charts to determine the effects of different types of mutations on amino acid sequence and protein structure (e.g., sickle cell anemia resulting from base substitution mutation)
      - Gene expression regulated in organisms so that specific proteins are synthesized only when they are needed by the cell (e.g., allowing cell specialization)
   d. Assess the potential implications of DNA technology with respect to its impact on society. (DOK 3)
      - Modern DNA technologies (e.g., polymerase chain reaction (PCR), gene splicing, gel electrophoresis, transformation, recombinant DNA) in agriculture, medicine, and forensics
   e. Develop a logical argument defending or refuting bioethical issues arising from applications of genetic technology (e.g., the human genome project, cloning, gene therapy, stem cell research). (DOK 3)

4. **<u>Demonstrate an understanding of the factors that contribute to evolutionary theory and natural selection.</u>**
   a. Explain the history of life on earth, and infer how geological changes provide opportunities and constraints for biological evolution. (DOK 2)
      - Main periods of the geologic timetable of earth's history
        - Roles of catastrophic and gradualistic processes in shaping planet Earth
   b. Provide support for the argument based upon evidence from anatomy, embryology, biochemistry, and paleontology that organisms descended with modification from common ancestry. (DOK 2)
   c. Identify and provide supporting evidence for the evolutionary relationships among various organisms using phylogenetic trees and cladograms. (DOK 2)
   d. Formulate a scientific explanation based on fossil records of ancient life-forms, and describe how new species could originate as a result of geological isolation and reproductive isolation. (DOK 2)
   e. Compare and contrast the basic types of selection (e.g., disruptive, stabilizing, directional, etc.). (DOK 2)
   f. Cite examples to justify behaviors that have evolved through natural selection (e.g., migration, parental care, use of tools, etc.). (DOK 1)
   g. Research and explain the contributions of 19th century scientists (e.g., Malthus, Wallace, Lyell, and Darwin) on the formulation of ideas about evolution. (DOK 2)
   h. Develop a logical argument describing ways in which the influences of 20th century science have impacted the development of ideas about evolution (e.g., synthetic theory of evolution, molecular biology). (DOK 3)
   i. Analyze changes in an ecosystem resulting from natural causes (succession), changes in climate, human activity (pollution and recycling), or introduction of nonnative species. (DOK 2)
5. **<u>Develop an understanding of organism classification.</u>**
   a. Classify organisms according to traditional Linnaean classification characteristics (e.g., cell structure, biochemistry, anatomy, fossil record, methods of reproduction) and the cladistic approach. (DOK 2)
   b. Categorize organisms according to the characteristics that distinguish them as Bacteria, Archaea, or Eucarya. (DOK 1)
      - Bacteria, fungi, and protists
      - Characteristics of invertebrates (e.g., habitat, reproduction, body plan, locomotion) as related to phyla (e.g., Porifera, Cnidarians, Nematoda, Annelida, Platyhelmenthes, and Arthropoda) and classes (e.g., Insecta, Crustacea, Arachnida, Mollusca, Echinodermata)
      - Characteristics of vertebrates (e.g., habitat, reproduction, body plan, locomotion) as related to classes (e.g., Agnatha, Chondrichthyes, Osteichthyes, Amphibia, Reptilia, Aves, Mammalia)
      - Nomenclature of various types of plants (e.g., Bryophyta, Tracheophyta, Gymnospermae, Angiospermae, Monocotyledonae, Dicotyledonae, vascular plants, nonvascular plants)

Botany

BO 1	Apply inquiry-based and problem-solving processes and skills to scientific investigations.
BO 2	Distinguish among the characteristics of botanical organization, structure, and function.
BO 3	Demonstrate an understanding of plant reproduction.
BO 4	Draw conclusions about the factors that affect the adaptation and survival of plants.
BO 5	Relate an understanding of plant genetics to its uses in modern living.

1. **Apply inquiry-based and problem-solving processes and skills to scientific investigations.**
    a. Conduct a scientific investigation demonstrating safe procedures and proper care of laboratory equipment. (DOK 2)
        - Safety rules and symbols
        - Proper use and care of the compound light microscope, slides, chemicals, etc.
        - Accuracy and precision in using graduated cylinders, balances, beakers, thermometers, and rulers
    b. Formulate questions that can be answered through research and experimental design. (DOK 3)
    c. Apply the components of scientific processes and methods in classroom and laboratory investigations (e.g., hypotheses, experimental design, observations, data analyses, interpretations, theory development). (DOK 3)
    d. Construct and analyze graphs (e.g., plotting points, labeling x-and y-axis, creating appropriate titles and legends for circle, bar, and line graphs). (DOK 2)
    e. Analyze procedures, data, and conclusions to determine the scientific validity of research. (DOK 3)
    f. Recognize and analyze alternative explanations for experimental results and to make predictions based on observations and prior knowledge. (DOK 3)
    g. Communicate and defend a scientific argument in oral, written, and graphic form. (DOK 3)
2. **Distinguish among the characteristics of botanical organization, structure, and function.**
    a. Relate plant cell structures to their functions (e.g., major organelles, cell wall components, photosynthetic chemical reactions, plant pigments, plant tissues, roots, stems, leaves, flowers). (DOK 1)
    b. Differentiate the characteristics found in various plant divisions. (DOK 2)
        - Differences and similarities of nonvascular plants
        - Characteristics of seed-bearing and non-seed bearing vascular plants relative to taxonomy
        - Major vegetative structures and their modifications in angiosperms and gymnosperms
    c. Compare and contrast leaf modifications of gymnosperms and angiosperms (e.g., needles, overlapping scales, simple leaves, compound leaves, evergreen trees, and deciduous trees). (DOK 2)

d. Apply the modern classification scheme utilized in naming plants to identify plant specimens. (DOK 2)
    - Classification scheme used in botany
    - Classification of native Mississippi plants
e. Use inquiry to investigate and discuss the physical and chemical processes of plants. (DOK 3)
    - Relationships among photosynthesis, cellular respiration, and translocation
    - Importance of soil type and soil profiles to plant survival
    - Mechanism of water movement in plants
    - Effects of environmental conditions for plant survival
    - Tropic responses of a plant organ to a given stimulus

3. <u>Demonstrate an understanding of plant reproduction.</u>

a. Compare and contrast reproductive structures (e.g., cones, flowers). (DOK 2)
b. Differentiate among the vegetative organs of monocots, herbaceous dicots, and woody dicots. (DOK 1)
c. Differentiate between the structures and processes of sexual and asexual reproduction in plants. (DOK 1)
    - Reproductive structures, their modifications, and the mechanisms involved in plant reproduction
    - Functions of flower parts, seeds, cones
    - Spore production in bryophytes and ferns
d. Explain and provide examples of the concept of alternation of generations and its examples. (DOK 2)
e. Categorize types of fruits and methods of seed distribution in plants. (DOK 1)
f. Research and compare various methods of plant propagation. (DOK 2)

4. <u>Draw conclusions about the factors that affect the adaptation and survival of plants.</u>

a. List and assess several adaptations of plants to survive in a given biome. (DOK 2)
b. Design and conduct an experiment to determine the effects of environmental factors on photosynthesis. (DOK 3)
c. Explain how natural selection and the evolutionary consequences (e.g., adaptation or extinction) support scientific explanations for similarities of ancient life-forms in the fossil record and molecular similarities present in living organisms. (DOK 2)
d. Research factors that might influence or alter plant stability, and propose actions that may reduce the negative impacts of human activity. (DOK 2)

5. <u>Relate an understanding of plant genetics to its uses in modern living.</u>

a. Research, prepare, and present a position relating to issues surrounding the current botanical trends involving biotechnology. (DOK 3)
b. Apply an understanding of the principles of plant genetics to analyze monohybrid and dihybrid crosses, and predict the potential effects the crosses might have on agronomy and agriculture. (DOK 3)
c. Discuss the effects of genetic engineering of plants on society. (DOK 2)
d. Describe the chemical compounds extracted from plants, their economical importance, and the impact on humans. (DOK 3)
    - Plant extracts, their function, and origin

- Impact of the timber industry on local and national economy

Chemistry I

CHI 1	Apply inquiry-based and problem-solving processes and skills to scientific investigations.
CHI 2	Demonstrate an understanding of the atomic model of matter by explaining atomic structure and chemical bonding.
CHI 3	Develop an understanding of the periodic table.
CHI 4.	Analyze the relationship between microscopic and macroscopic models of matter.
CHI 5	Compare factors associated with acid/base and oxidation/reduction reactions.

1. **Apply inquiry-based and problem-solving processes and skills to scientific investigations.**
    a. Use current technologies such as CD-ROM, DVD, Internet, and online data search to explore current research related to a specific topic. (DOK 3)
    b. Clarify research questions and design laboratory investigations. (DOK 3)
    c. Demonstrate the use of scientific inquiry and methods to formulate, conduct, and evaluate laboratory investigations (e.g., hypotheses, experimental design, observations, data analyses, interpretations, theory development). (DOK 3)
    d. Organize data to construct graphs (e.g., plotting points, labeling x-and y-axis, creating appropriate titles and legends for circle, bar, and line graphs), draw conclusions, and make inferences. (DOK 3)
    e. Evaluate procedures, data, and conclusions to critique the scientific validity of research. (DOK 3)
    f. Formulate and revise scientific explanations and models using logic and evidence (data analysis). (DOK 3)
    g. Collect, analyze, and draw conclusions from data to create a formal presentation using available technology (e.g., computers, calculators, SmartBoard, CBL's, etc.). (DOK 3)
2. **Demonstrate an understanding of the atomic model of matter by explaining atomic structure and chemical bonding.**
    a. Describe and classify matter based on physical and chemical properties and interactions between molecules or atoms. (DOK 1)
        - Physical properties (e.g., melting points, densities, boiling points) of a variety of substances
        - Substances and mixtures
        - Three states of matter in terms of internal energy, molecular motion, and the phase transitions between them
    b. Research and explain crucial contributions and critical experiments of Dalton, Thomson, Rutherford, Bohr, de Broglie, and Schrődinger, and describe how each discovery contributed to the current model of atomic and nuclear structure. (DOK 2)
    c. Develop a model of atomic and nuclear structure based on theory and knowledge of fundamental particles. (DOK 2)
        - Properties and interactions of the three fundamental particles of the atom

- Laws of conservation of mass, constant composition, definite proportions, and multiple proportions

d. Write appropriate equations for nuclear decay reactions, describe how the nucleus changes during these reactions, and compare the resulting radiation with regard to penetrating ability. (DOK 1)
   - Three major types of radioactive decay (e.g., alpha, beta, gamma) and the properties of the emissions (e.g., composition, mass, charge, penetrating power)
   - The concept of half-life for a radioactive isotope (e.g., carbon-14 dating) based on the principle that the decay of any individual atom is a random process

e. Compare the properties of compounds according to their type of bonding. (DOK 1)
   - Covalent, ionic, and metallic bonding
   - Polar and nonpolar covalent bonding
   - Valence electrons and bonding atoms

f. Compare different types of intermolecular forces, and explain the relationship between intermolecular forces, boiling points, and vapor pressure when comparing differences in properties of pure substances. (DOK 1)

g. Develop a three-dimensional model of molecular structure. (DOK 2)
   - Lewis dot structures for simple molecules and ionic compounds
   - Valence shell electron pair repulsion theory (VSEPR)

3. <u>Develop an understanding of the periodic table.</u>

a. Calculate the number of protons, neutrons, and electrons in individual isotopes using atomic numbers and mass numbers, write electron configurations of elements and ions following the Aufbau principle, and balance equations representing nuclear reactions. (DOK 1)

b. Analyze patterns and trends in the organization of elements in the periodic table, and compare their relationship to position in the periodic table. (DOK 2)
   - Atomic number, atomic mass, mass number, and number of protons, electrons, and neutrons in isotopes of elements
   - Average atomic mass calculations
   - Chemical characteristics of each region
   - Periodic properties (e.g., metal/nonmetal/metalloid behavior, electrical/heat conductivity, electronegativity, electron affinity, ionization energy, atomic/covalent/ionic radius)

c. Classify chemical reactions by type. (DOK 2)
   - Single displacement, double displacement, synthesis (combination), decomposition, disproportionation, combustion, or precipitation
   - Products (given reactants) or reactants (given products) for each reaction type
   - Solubility rules for precipitation reactions and the activity series for single and double displacement reactions

d. Use stoichiometry to calculate the amount of reactants consumed and products formed. (DOK 3)
   - Difference between chemical reactions and chemical equations
   - Formulas and calculations of the molecular (molar) masses
   - Empirical formula given the percent composition of elements

- Molecular formula given the empirical formula and molar mass

4. **<u>Analyze the relationship between microscopic and macroscopic models of matter.</u>**
    a. Calculate the number of protons, neutrons, and electrons in individual isotopes using atomic numbers and mass numbers, write electron configurations of elements and ions following the Aufbau principle, and balance equations representing nuclear reactions. (DOK 1)
    b. Analyze patterns and trends in the organization of elements in the periodic table, and compare their relationship to position in the periodic table. (DOK 2)
        - Atomic number, atomic mass, mass number, and number of protons, electrons, and neutrons in isotopes of elements
        - Average atomic mass calculations
        - Chemical characteristics of each region
        - Periodic properties (e.g., metal/nonmetal/metalloid behavior, electrical/heat conductivity, electronegativity, electron affinity, ionization energy, atomic/covalent/ionic radius)
    c. Classify chemical reactions by type. (DOK 2)
        - Single displacement, double displacement, synthesis (combination), decomposition, disproportionation, combustion, or precipitation
        - Products (given reactants) or reactants (given products) for each reaction type
        - Solubility rules for precipitation reactions and the activity series for single and double displacement reactions
    d. Use stoichiometry to calculate the amount of reactants consumed and products formed. (DOK 3)
        - Difference between chemical reactions and chemical equations
        - Formulas and calculations of the molecular (molar) masses
        - Empirical formula given the percent composition of elements
        - Molecular formula given the empirical formula and molar mass

5. **<u>Compare factors associated with acid/base and oxidation/reduction reactions.</u>**
    a. Analyze and explain acid/base reactions. (DOK 2)
        - Properties of acids and bases, including how they affect indicators and the relative pH of the solution
        - Formation of acidic and basic solutions
        - Definition of pH in terms of the hydronium ion concentration and the hydroxide ion concentration
        - The pH or pOH from the hydrogen ion or hydroxide ion concentrations of solution
        - How a buffer works and examples of buffer solutions
    b. Classify species in aqueous solutions according to the Arrhenius and Bronsted-Lowry definitions respectively, and predict products for aqueous neutralization reactions. (DOK 2)
    c. Analyze a reduction/oxidation reaction (REDOX) to assign oxidation numbers (states) to reaction species, and identify the species oxidized and reduced, the oxidizing agent, and reducing agent. (DOK 2)

Organic Chemistry

ORGC 1 Apply inquiry-based and problem-solving processes and skills to scientific investigations.

ORGC 2 Demonstrate an understanding of the properties, structure, and function of organic compounds.

ORGC 3 Discuss the versatility of polymers and the diverse application of organic chemicals.

1. **Apply inquiry-based and problem-solving processes and skills to scientific investigations.**
    a. Conduct a scientific investigation demonstrating safe procedures and proper care of laboratory equipment. (DOK 2)
        - Safety rules and symbols
        - Proper use and care of the compound light microscope, slides, chemicals, etc.
        - Accuracy and precision in using graduated cylinders, balances, beakers, thermometers, and rulers
    b. Formulate questions that can be answered through research and experimental design. (DOK 3)
    c. Apply the components of scientific processes and methods in classroom and laboratory investigations (e.g., hypotheses, experimental design, observations, data analyses, interpretations, theory development). (DOK 3)
    d. Organize data to construct graphs (e.g., plotting points, labeling x-and y-axis, creating appropriate titles and legends for circle, bar, and line graphs), draw conclusions, and make inferences. (DOK 3)
    e. Analyze procedures, data, and conclusions to determine the scientific validity of research. (DOK 3)
    f. Recognize and analyze alternative explanations for experimental results, and make predictions based on observations and prior knowledge. (DOK 3)
    g. Communicate and defend a scientific argument in oral, written, and graphic form. (DOK 3)
2. **Demonstrate an understanding of the properties, structure, and function of organic compounds.**
    a. Apply International Union of Pure and Applied Chemistry (IUPAC) nomenclature, and differentiate the structure of aliphatic, aromatic, and cyclic hydrocarbon compounds. (DOK 1)
        - Structures of hydrocarbon compounds
        - Isomerism in hydrocarbon compounds
    b. Relate structure to physical and chemical properties of hydrocarbon. (DOK 1)
    c. Apply principles of geometry and hybridization to organic molecules. (DOK 2)
        - Lewis structures for organic molecules
        - Bond angles
        - Hybridization (as it applies to organic molecules)
    d. Write, complete, and classify common reactions for aliphatic, aromatic, and cyclic hydrocarbons. (DOK 1)

e. Construct, solve, and explain equations representing combustion reactions, substitution reactions, dehydrogenation reactions, and addition reactions. (DOK 2)
f. Classify functional groups (e.g., alcohols, ethers, aldehydes, ketones, carboxylic acids, esters, amines, amides, and nitrides) by their structure and properties. (DOK 2)
   - Structural formulas from functional group names and vice versa
   - Chemical and physical properties of compounds containing functional groups
   - Equations representing the transformation of one functional group into another

3. <u>Discuss the versatility of polymers and the diverse application of organic chemicals.</u>

a. Describe and classify the synthesis, properties, and uses of polymers. (DOK 2)
   - Common polymers
   - Synthesis of polymers from monomers by addition or condensation
   - Condensations of plastics according to their commercial types
   - Elasticity and other polymer properties
b. Develop a logical argument supporting the use of organic chemicals and their application in industry, drug manufacture, and biological chemistry. (DOK 1)
   - Common uses of polymers and organic compounds in medicine, drugs, and personal care products
   - Compounds that have the property to dye materials
   - Petrochemical production
   - Biologically active compounds in terms of functional group substrate interaction
c. Research and summarize the diversity, applications, and economics of industrial chemicals (solvents, coatings, surfactants, etc.). (DOK 3)

Earth and Space Science

E1	Apply inquiry-based and problem-solving processes and skills to scientific investigations.
E2	Develop an understanding of the history and evolution of the universe and earth.
E3	Discuss factors that are used to explain the geological history of earth.
E4	Demonstrate an understanding of earth systems relating to weather and climate.
E5	Apply an understanding of ecological factors to explain relationships between earth systems.

1. <u>Apply inquiry-based and problem-solving processes and skills to scientific investigations.</u>

a. Conduct a scientific investigation demonstrating safe procedures and proper care of laboratory equipment. (DOK 2)
   - Safety rules and symbols
   - Proper use and care of the compound light microscope, slides, chemicals, etc.
   - Accuracy and precision in using graduated cylinders, balances, beakers, thermometers, and rulers.
b. Formulate questions that can be answered through research and experimental design. (DOK 3)

c. Apply the components of scientific processes and methods in classroom and laboratory investigations (e.g., hypotheses, experimental design, observations, data analyses, interpretations, theory development). (DOK 3)
d. Construct and analyze graphs (e.g., plotting points, labeling x-and y-axis, creating appropriate titles and legends for circle, bar, and line graphs). (DOK 2)
e. Analyze procedures, data, and conclusions to determine the scientific validity of research. (DOK 3)
f. Recognize and analyze alternative explanations for experimental results and to make predictions based on observations and prior knowledge. (DOK 3)
g. Communicate and defend a scientific argument in oral, written, and graphic form. (DOK 3)

2. <u>Develop an understanding of the history and evolution of the universe and earth.</u>

a. Summarize the origin and evolution of the universe. (DOK 2)
   - Big bang theory
   - Microwave background radiation
   - The Hubble constant
   - Evidence of the existence of dark matter and dark energy in the universe and the history of the universe
b. Differentiate methods used to measure space distances, including astronomical unit, light-year, stellar parallax, Cepheid variables, and the red shift. (DOK 1)
c. Interpret how gravitational attraction played a role in the formation of the planetary bodies and how the fusion of hydrogen and other processes in "ordinary" stars and supernovae lead to the formation of all other elements. (DOK 2)
d. Summarize the early evolution of the earth, including the formation of Earth's solid layers (e.g., core, mantle, and crust), the distribution of major elements, the origin of internal heat sources, and the initiation of plate tectonics. (DOK 2)

- How the decay of radioactive isotopes is used to determine the age of rocks, earth, and the solar system
- How Earth acquired its initial oceans and atmosphere

3. <u>Discuss factors which are used to explain the geological history of earth.</u>

a. Develop an understanding of how plate tectonics create certain geological features, materials, and hazards. (DOK 1)
   - Plate tectonic boundaries (e.g., divergent, convergent, and transform)
   - Modern and ancient geological features to each kind of plate tectonic boundary
   - Production of particular groups of igneous and metamorphic rocks and mineral resources
   - Sedimentary basins created and destroyed through time
b. Compare and contrast types of mineral deposits/groups (e.g., oxides, carbonates, halides, sulfides, sulfates, silicates, phosphates). (DOK 2)
c. Categorize minerals and rocks by determining their physical and/or chemical characteristics. (DOK 2)
d. Justify the causes of certain geological hazards (e.g., earthquakes, volcanoes, tsunamis) to their effects on specific plate tectonic locations. (DOK 2)

e. Interpret and explain how rock relationships and fossils are used to reconstruct the geologic history of the earth. (DOK 2)
f. Apply principles of relative age (e.g., superposition, original horizontality, crosscutting relations, and original lateral continuity) to support an opinion related to earth's geological history. (DOK 3)
    - Types of unconformity (e.g., disconformity, angular unconformity, nonconformity)
    - Geological timetable
g. Apply the principle of uniformitarianism to relate sedimentary rock associations and their fossils to the environments in which the rocks were deposited. (DOK 2)
h. Compare and contrast the relative and absolute dating methods (e.g., the principle of fossil succession, radiometric dating, and paleomagnetism) for determining the age of the earth. (DOK 1)

4. <u>Demonstrate an understanding of earth systems relating to weather and climate.</u>

a. Explain the interaction of earth systems that affect weather and climate. (DOK 1)
    - Latitudinal variations in solar heating
    - The effects of Coriolis forces on ocean currents, cyclones, anticyclones, ocean currents, topography, and air masses (e.g., warm fronts, cold fronts, stationary fronts, and occluded fronts).
b. Interpret the patterns in temperature and precipitation that produce the climate regions on earth, and relate them to the hazards associated with extreme weather events and climate change (e.g., hurricanes, tornadoes, El Niño/La Niña, global warming). (DOK 2)
c. Justify how changes in global climate and variation in earth/sun relationships contribute to natural and anthropogenic (human-caused) modification of atmospheric composition. (DOK 2)
d. Summarize how past and present actions of ice, wind, and water contributed to the types and distributions of erosional and depositional features in landscapes. (DOK 1)
e. Research and explain how external forces affect earth's topography. (DOK 2)
    - How surface water and groundwater act as the major agents of physical and chemical weathering
    - How soil results from weathering and biological processes
    - Processes and hazards associated with both sudden and gradual mass wasting

5. <u>Apply an understanding of ecological factors to explain relationships between earth systems.</u>

a. Draw conclusions about how life on earth shapes earth systems and responds to the interaction of earth systems (lithosphere, hydrosphere, atmosphere, and biosphere). (DOK 3)
    - Nature and distribution of life on earth, including humans, to the chemistry and availability of water
    - Distribution of biomes (e.g., terrestrial, freshwater, and marine) to climate regions through time
    - Geochemical and ecological processes (e.g., rock, hydrologic, carbon, nitrogen) that interact through time to cycle matter and energy and how human activity

alters the rates of these processes (e.g., fossil fuel formation and combustion, damming and channeling of rivers)

b. Interpret the record of shared ancestry (fossils), evolution, and extinction as related to natural selection. (DOK 2)
c. Identify the cause and effect relationships of the evolutionary innovations that most profoundly shaped earth systems. (DOK 1)
    - Photosynthesis and the atmosphere
    - Multicellular animals and marine environments
    - Land plants and terrestrial environments
d. Cite evidence about how dramatic changes in earth's atmosphere influenced the evolution of life. (DOK 1)

Environmental Science

ES 1 Apply inquiry-based and problem-solving processes and skills to scientific investigations.

ES 2 Develop an understanding of the relationship of ecological factors that affect an ecosystem.

ES 3 Discuss the impact of human activities on the environment, conservation activities, and efforts to maintain and restore ecosystems.

1. **Apply inquiry-based and problem-solving processes and skills to scientific investigations.**
    a. Conduct a scientific investigation demonstrating safe procedures and proper care of laboratory equipment. (DOK 2)
        - Safety rules and symbols
        - Proper use and care of the compound light microscope, slides, chemicals, etc.
        - Accuracy and precision in using graduated cylinders, balances, beakers, thermometers, and rulers
    b. Formulate questions that can be answered through research and experimental design. (DOK 3)
    c. Apply the components of scientific processes and methods in classroom and laboratory investigations (e.g., hypotheses, experimental design, observations, data analyses, interpretations, theory development). (DOK 3)
    d. Construct and analyze graphs (e.g., plotting points, labeling x-and y-axis, creating appropriate titles and legends for circle, bar, and line graphs). (DOK 2)
    e. Analyze procedures, data, and conclusions to determine the scientific validity of research. (DOK 3)
    f. Recognize and analyze alternative explanations for experimental results and to make predictions based on observations and prior knowledge. (DOK 3)
    g. Communicate and defend a scientific argument in oral, written, and graphic form. (DOK3)
2. **Develop an understanding of the relationship of ecological factors that affect an ecosystem.**

a. Compare ways in which the three layers of the biosphere change over time and their influence on an ecosystem's ability to support life. (DOK 2)
b. Explain the flow of matter and energy in ecosystems. (DOK 2)
    - Interactions between biotic and abiotic factors
    - Indigenous plants and animals and their roles in various ecosystems
    - Biogeochemical cycles within the environment
c. Predict the impact of the introduction, removal, and reintroduction of an organism on an ecosystem. (DOK 3)
d. Develop a logical argument explaining the relationships and changes within an ecosystem. (DOK 2)
    - How a species adapts to its niche
    - Process of primary and secondary succession and its effects on a population
    - How changes in the environment might affect organisms
e. Explain the causes and effects of changes in population dynamics (e.g., natural selection, exponential growth, predator/prey relationships) to carrying capacity and limiting factors. (DOK 2)
f. Research and explain how habitat destruction leads to the loss of biodiversity. (DOK 2)
g. Compare and contrast the major biomes of the world's ecosystems, including location, climate, adaptations and diversity. (DOK 1)

3. <u>Discuss the impact of human activities on the environment, conservation activities, and efforts to maintain and restore ecosystems.</u>

a. Summarize the effects of human activities on resources in the local environments. (DOK 2)
    - Sources, uses, quality, and conservation of water
    - Renewable and nonrenewable resources
    - Effects of pollution (e.g., water, noise, air, etc.) on the ecosystem
b. Research and evaluate the impacts of human activity and technology on the lithosphere, hydrosphere, and atmosphere, and develop a logical argument to support how communities restore ecosystems. (DOK 3)
c. Research and evaluate the use of renewable and nonrenewable resources, and critique efforts to conserve natural resources and reduce global warming in the United States including (but not limited) to Mississippi. (DOK 3)

Genetics

G 1	Apply inquiry-based and problem-solving processes and skills to scientific investigations.
G 2	Analyze the structure and function of the cell and cellular organelles.
G 3	Apply the principles of heredity to demonstrate genetic understandings.

1. <u>Use critical thinking and scientific problem solving in designing and performing biological research and experimentation. (L, P, E)</u>

a. Use current technologies such as CD-ROM, DVD, Internet, and online data search to explore current research related to a specific topic. (DOK 3)
b. Clarify research questions and design laboratory investigations. (DOK 3)

c. Demonstrate the use of scientific inquiry and methods to formulate, conduct, and evaluate laboratory investigations (e.g., hypotheses, experimental design, observations, data analyses, interpretations, theory development). (DOK 3)
d. Organize data to construct graphs (e.g., plotting points, labeling x-and y-axis, creating appropriate titles and legends for pie, bar, and line graphs) to draw conclusions and make inferences. (DOK 3)
e. Evaluate procedures, data, and conclusions to critique the scientific validity of research. (DOK 3)
f. Formulate and revise scientific explanations and models using logic and evidence (data analysis). (DOK 3)
g. Collect, analyze, and draw conclusions from data to create a formal presentation using available technology (e.g., computers, calculators, SmartBoard, CBL's, etc.). (DOK 3)

2. <u>Review the structure and function of the cell as it applies to genetics. (L)</u>

a. Cite evidence to illustrate how the structure and function of cells are involved in the maintenance of life. (DOK 2)
b. Describe how organic components are integral to biochemical processes. (DOK 2)
c. Differentiate among the processes by which plants and animals reproduce. (DOK 1)
    - Cell cycle and mitosis
    - Meiosis, spermatogenesis, and oogenesis
d. Explain the significance of the discovery of nucleic acids. (DOK 1)
e. Analyze and explain the structure and function of DNA and RNA in replication, transcription, translation and DNA repair. (DOK 2)
f. Cite examples to compare the consequences of the different types of mutations. (DOK 1)
g. Draw conclusions about the importance and potential impacts of the process of gene transfer used in biotechnology. (DOK 3)

3. <u>Analyze the structure and function of DNA and RNA molecules. (L, P)</u>

a. Cite evidence that supports the significance of Mendel's concept of "particulate inheritance" to explain the understanding of heredity. (DOK 1)
b. Apply classical genetics principles to solve basic genetic problems. (DOK 2)
    - Genes and alleles, dominance, recessiveness, the laws of segregation, and independent assortment
    - Inheritance of autosomal and sex-linked traits
    - Inheritance of traits influenced by multiple alleles and traits with polygenetic inheritance
    - Chromosomal theory of inheritance
c. Apply population genetic concepts to summarize variability of multicellular organisms. (DOK 2)
    - Genetic variability
    - Hardy-Weinberg formula
    - Migration and genetic drift
    - Natural selection in humans
d. Distinguish and explain the applications of various tools and techniques used in DNA manipulation. (DOK 1)

- Steps in genetic engineering experiments
- Use of restriction enzymes
- Role of vectors in genetic research
- Use of transformation techniques

e. Research and present a justifiable explanation the practical uses of biotechnology (e.g., chromosome mapping, karyotyping, and pedigrees). (DOK 2)
f. Develop and present a scientifically-based logical argument for or against moral and ethical issues related to genetic engineering. (DOK 3)
g. Research genomics (human and other organisms), and predict benefits and medical advances that may result from the use of genome projects. (DOK 2)

Geology

GE1	Apply inquiry-based and problem-solving processes and skills to scientific investigations.
GE2	Develop an understanding of plate tectonics and geochemical and ecological processes that affect earth.

1. **Apply inquiry-based and problem-solving processes and skills to scientific investigations.**
   a. Conduct a scientific investigation demonstrating safe procedures and proper care of laboratory equipment. (DOK 2)
      - Safety rules and symbols
      - Proper use and care of the compound light microscope, slides, chemicals, etc.
      - Accuracy and precision in using graduated cylinders, balances, beakers, thermometers, and rulers

   b. Formulate questions that can be answered through research and experimental design. (DOK 3)
   c. Apply the components of scientific processes and methods in classroom and laboratory investigations (e.g., hypotheses, experimental design, observations, data analyses, interpretations, theory development). (DOK 3)
   d. Construct and analyze graphs (e.g., plotting points, labeling x-and y-axis, creating appropriate titles and legends for circle, bar, and line graphs). (DOK 2)
   e. Analyze procedures, data, and conclusions to determine the scientific validity of research. (DOK 3)
   f. Recognize and analyze alternative explanations for experimental results and to make predictions based on observations and prior knowledge. (DOK 3)
   g. Communicate and defend a scientific argument in oral, written, and graphic form. (DOK 3)
2. **Develop an understanding of plate tectonics and geochemical and ecological processes that affect earth.**
   a. Differentiate the components of the earth's atmosphere and lithosphere. (DOK 1)
   b. Research and summarize explanations of how earth acquired its initial atmosphere and oceans. (DOK 2)

c. Compare the causes and effects of internal and external components that shape earth's topography. (DOK 2)
   - Physical weathering (e.g., atmospheric, glacial, etc.)
   - Chemical weathering agents (e.g., acid precipitation, carbon dioxide, oxygen, water, etc.)
d. Develop an understanding of how plate tectonics create certain geologic features, materials, and hazards. (DOK 2)
   - Types of crustal movements and the resulting landforms (e.g., seafloor spreading, paleomagnetic measurements, and orogenesis)
   - Processes that create earthquakes and volcanoes
   - Asthenosphere
e. Summarize the theories of plate development and continental drift, and describe the causes and effects involved in each. (DOK 2)
f. Develop a logical argument to explain how geochemical and ecological processes (e.g., rock, hydrologic, carbon, nitrogen) interact through time to cycle matter and energy and how human activity alters the rates of these processes (e.g., fossil fuel formation and combustion, damming, and channeling of rivers). (DOK 2)
g. Interpret how the earth's geological time scale relates to geological history, landforms, and life-forms. (DOK 2)
h. Research and describe different techniques for determining relative and absolute age of the earth (e.g., index of fossil layers, superposition, radiometric dating, etc.). (DOK 1)
i. Summarize the geological activity of the New Madrid fault line, and compare and contrast it to geological activity in other parts of the world. (DOK 2)
j. Identify and differentiate the major geological features in Mississippi (e.g., Delta, Coastal Areas, etc.). (DOK 1)
k. Evaluate an emergency preparedness plan for natural disasters associated with crustal movement. (DOK 3)

Physical Science

PS 1	Apply inquiry-based and problem-solving processes and skills to scientific investigations.
PS 2	Describe and explain how forces affect motion.
PS 3	Demonstrate an understanding of general properties and characteristics of waves.
PS 4	Develop an understanding of the atom.
PS 5	Investigate and apply principles of physical and chemical changes in matter.

1. Apply inquiry-based and problem-solving processes and skills to scientific investigations.

a. Use appropriate laboratory safety symbols and procedures to design and conduct a scientific investigation. (DOK 2)
   - Safety symbols and safety rules in all laboratory activities
   - Proper use and care of the compound light microscope

- Accuracy and precision in using graduated cylinders, balances, beakers, thermometers, and rulers

b. Identify questions that can be answered through scientific investigations. (DOK 3)
c. Identify and apply components of scientific methods in classroom investigations. (DOK 3)
    - Predicting, gathering data, drawing conclusions
    - Recording outcomes and organizing data from a variety of sources (e.g., scientific articles, magazines, student experiments, etc.)
    - Critically analyzing current investigations/problems using periodicals and scientific scenarios
d. Interpret and generate graphs (e.g., plotting points, labeling x-and y-axis, creating appropriate titles and legends for circle, bar, and line graphs). (DOK 2)
e. Analyze procedures and data to draw conclusions about the validity of research. (DOK 3)
f. Formulate and revise scientific explanations and models using logic and evidence (data analysis). (DOK 3)
g. Communicate effectively to present and explain scientific results, using appropriate terminology and graphics. (DOK 3)

2. <u>Describe and explain how forces affect motion.</u>

a. Demonstrate and explain the basic principles of Newton's three laws of motion including calculations of acceleration, force, and momentum. (DOK 2)
    - Inertia and distance-time graphs to determine average speed
    - Net force (accounting for gravity, friction, and air resistance) and the resulting motion of objects
    - Effects of the gravitational force on objects on Earth and effects on planetary and lunar motion
    - Simple harmonic motion (oscillation)
b. Explain the connection between force, work, and energy. (DOK 2)
    - Force exerted over a distance (results in work done)
    - Force-distance graph (to determine work)
    - Network on an object that contributes to change in kinetic energy (work-to-energy theorem)
c. Describe (with supporting details and diagrams) how the kinetic energy of an object can be converted into potential energy (the energy of position) and how energy is transferred or transformed (conservation of energy). (DOK 2)
d. Draw and assess conclusions about charges and electric current. (DOK 2)
    - Static/current electricity and direct current/alternating current
    - Elements in an electric circuit that are in series or parallel
    - Conductors and insulators
    - Relationship between current flowing through a resistor and voltage flowing across a resistor
e. Cite evidence and explain the application of electric currents and magnetic fields as they relate to their use in everyday living (e.g., the application of fields in motors and generators and the concept of electric current using Ohm's law). (DOK 2)

3. **<u>Demonstrate an understanding of general properties and characteristics of waves.</u>**
    a. Differentiate among transverse, longitudinal, and surface waves as they propagate through a medium (e.g., string, air, water, steel beam). (DOK 1)
    b. Compare properties of waves (e.g., superposition, interference, refraction, reflection, diffraction, Doppler effect), and explain the connection among the quantities (e.g., wavelength, frequency, period, amplitude, and velocity). (DOK 2)
    c. Classify the electromagnetic spectrum's regions according to frequency and/or wavelength, and draw conclusions about their impact on life. (DOK 2)
        - The emission of light by electrons when moving from higher to lower levels
        - Energy (photons as quanta of light)
        - Additive and subtractive properties of colors
        - Relationship of visible light to the color spectrum
    d. Explain how sound intensity is measured and its relationship to the decibel scale. (DOK 1)
4. **<u>Develop an understanding of the atom.</u>**
    a. Cite evidence to summarize the atomic theory. (DOK 1)
        - Models for atoms
        - Hund's rule and Aufbau process to specify the electron configuration of elements
        - Building blocks of matter (e.g., proton, neutron, and electron) and elementary particles (e.g., positron, mesons, neutrinos, etc.)
        - Atomic orbitals (s, p, d, f) and their basic shapes
    b. Explain the difference between chemical and physical changes, and demonstrate how these changes can be used to separate mixtures and compounds into their components. (DOK 2)
    c. Research the history of the periodic table of the elements, and summarize the contributions that led to the atomic theory. (DOK 2)
        - Contributions of scientists (e.g., John Dalton, J.J. Thomson, Ernest Rutherford, Newton, Einstein, Neils, Bohr, Louis de Broglie, Erwin Schrödinger, etc.)
        - Technology (e.g., X-rays, cathode-ray tubes, spectroscopes)
        - Experiments (e.g., gold-foil, cathode-ray, etc.)
    d. Utilize the periodic table to predict and explain patterns and draw conclusions about the structure, properties, and organization of matter. (DOK 2)
        - Atomic composition and valence electron configuration (e.g., atomic number, mass number of protons, neutrons, electrons, isotopes, and ions)
        - Periodic trends using the periodic table (e.g., valence, reactivity, atomic radius)
        - Average atomic mass from isotopic abundance
        - Solids, liquids, and gases
        - Periodic properties of elements (e.g., metal/nonmetal/metalloid behavior, electrical/heat conductivity, electronegativity, electron affinity, ionization energy, atomic/covalent/ionic radius) and how they relate to position in the periodic table
5. **<u>Investigate and apply principles of physical and chemical changes in matter.</u>**
    a. Write chemical formulas for compounds comprising monatomic and polyatomic ions. (DOK 1)
    b. Balance chemical equations. (DOK 2)

c. Classify types of chemical reactions (e, g., composition, decomposition, single displacement, double displacement, combustion, acid/base reactions). (DOK 2)

Physics I

PHYI 1	Apply inquiry-based and problem-solving processes and skills to scientific investigations.
PHYI 2	Develop an understanding of concepts related to forces and motion.
PHYI 3	Develop an understanding of concepts related to work and energy.
PHYI 4	Discuss the characteristics and properties of light and sound.
PHYI 5	Apply an understanding of magnetism, electric fields, and electricity.
PHYI 6	Analyze and explain concepts of nuclear physics.

1. **Investigate and apply principles of physical and chemical changes in matter.**
   a. Use current technologies such as CD-ROM, DVD, Internet, and online data search to explore current research related to a specific topic. (DOK 3)
   b. Clarify research questions, and design laboratory investigations. (DOK 3)
   c. Demonstrate the use of scientific inquiry and methods to formulate, conduct, and evaluate laboratory investigations (e.g., hypotheses, experimental design, observations, data analyses, interpretations, theory development). (DOK 3)
   d. Organize data to construct graphs (e.g., plotting points, labeling x-and y-axis, creating appropriate titles and legends for circle, bar, and line graphs), draw conclusions, and make inferences. (DOK 3)
   e. Evaluate procedures, data, and conclusions to critique the scientific validity of research. (DOK 3)
   f. Formulate and revise scientific explanations and models using logic and evidence (data analysis). (DOK 3)
   g. Collect, analyze, and draw conclusions from data to create a formal presentation using available technology (e.g., computers, calculators, SmartBoard, CBL's, etc.). (DOK 3)
2. **Develop an understanding of concepts related to forces and motion.**
   a. Use inquiry to investigate and develop an understanding of the kinematics and dynamics of physical bodies. (DOK 3)
      - Vector and scalar quantities
      - Vector problems (solved mathematically and graphically)
      - Vector techniques and free-body diagrams to determine the net force on a body when several forces are acting on it
      - Relations among mass, inertia, and weight
   b. Analyze, describe, and solve problems by creating and utilizing graphs of one-dimensional motion (e.g., position, distance, displacement, time, speed, velocity, acceleration, the special case of free fall). (DOK 2)
   c. Analyze real-world applications to draw conclusions about Newton's three laws of motion. (DOK 2)
   d. Apply the effects of the universal gravitation law to graph and interpret the force between two masses, acceleration due to gravity, and planetary motion. (DOK 2)
      - Situations where g is constant (falling bodies)

- Concept of centripetal acceleration undergoing uniform circular motion
- Kepler's third law
- Oscillatory motion and the mechanics of waves

3. **<u>Develop an understanding of concepts related to work and energy.</u>**
    a. Explain and apply the conservation of energy and momentum. (DOK 2)
        - Concept of work and applications
        - Concept of kinetic energy, using the elementary work-energy theorem
        - Concept of conservation of energy with simple examples
        - Concepts of energy, work, and power (qualitatively and quantitatively)
        - Principles of impulse in inelastic and elastic collisions
    b. Analyze real-world applications to draw conclusions about mechanical potential energy (the energy of configuration). (DOK 3)
    c. Apply the principles of impulse, and compare conservation of momentum and conservation of kinetic energy in perfectly inelastic and elastic collisions. (DOK 1)
    d. Investigate and summarize the principles of thermodynamics. (DOK 2)
        - How heat energy is transferred from higher temperature to lower temperature until equilibrium is reached
        - Temperature and thermal energy as related to molecular motion and states of matter
        - Problems involving specific heat and heat capacity
        - First and second laws of thermodynamics as related to heat engines, refrigerators, and thermal efficiency
    e. Develop the kinetic theory of ideal gases and explain the concept of Carnot efficiency. (DOK 2)
4. **<u>Discuss the characteristics and properties of light and sound.</u>**
    a. Describe and model the characteristics and properties of mechanical waves. (DOK 2)
        - Simple harmonic motion
        - Relationships among wave characteristics such as velocity, period, frequency, amplitude, phase, and wavelength
        - Energy of a wave in terms of amplitude and frequency.
        - Standing waves and waves in specific media (e.g., stretched string, water surface, air, etc.)
    b. Differentiate and explain the Doppler effect as it relates to a moving source and to a moving observer. (DOK 1)
    c. Explain the laws of reflection and refraction, and apply Snell's law to describe the relationship between the angles of incidence and refraction. (DOK 2)
    d. Use ray tracing and the thin lens equation to solve real-world problems involving object distance from lenses. (DOK 2)
    e. Investigate and draw conclusions about the characteristics and properties of electromagnetic waves. (DOK 2)
5. **<u>Apply an understanding of magnetism, electric fields, and electricity.</u>**
    a. Analyze and explain the relationship between electricity and magnetism. (DOK 2)
        - Characteristics of static charge and how a static charge is generated

- Electric field, electric potential, current, voltage, and resistance as related to Ohm's law
- Magnetic poles, magnetic flux and field, Ampère's law and Faraday's law
- Coulomb's law

b. Use schematic diagrams to analyze the current flow in series and parallel electric circuits, given the component resistances and the imposed electric potential. (DOK 2)

c. Analyze and explain the relationship between magnetic fields and electrical current by induction, generators, and electric motors. (DOK 2)

6. <u>Analyze and explain concepts of nuclear physics.</u>

a. Analyze and explain the principles of nuclear physics. (DOK 1)
- The mass number and atomic number of the nucleus of an isotope of a given chemical element
- The conservation of mass and the conservation of charge
- Nuclear decay

b. Defend the wave-particle duality model of light, using observational evidence. (DOK 3)
- Quantum energy and emission spectra
- Photoelectric and Compton effects

<u>Spatial Information Science</u>

SP 1 Apply inquiry-based and problem-solving processes and skills to scientific investigations.

SP 2 Develop an understanding of geographic information systems.

1. <u>Demonstrate the basic concepts of global positioning systems (GPS). (E)</u>

a. Use current technologies such as CD-ROM, DVD, Internet, and online data search to explore current research related to a specific topic. (DOK 3)

b. Clarify research questions, and design laboratory investigations. (DOK 3)

c. Demonstrate the use of scientific inquiry and methods to formulate, conduct, and evaluate laboratory investigations (e.g., hypotheses, experimental design, observations, data analyses, interpretations, and theory development). (DOK 3)

d. Organize data to construct graphs (e.g., plotting points, labeling x-and y-axis, creating appropriate titles and legends for circle, bar, and line graphs), draw conclusions, and make inferences). (DOK 3)

e. Evaluate procedures, data, and conclusions to critique the scientific validity of research. (DOK 3)

f. Formulate and revise scientific explanations and models using logic and evidence (data analysis). (DOK 3)

g. Collect, analyze, and draw conclusions from data to create a formal presentation using available technology (e.g., computers, calculators, SmartBoard, CBLs, etc.). (DOK 3)

2. <u>Demonstrate the basic concepts of remote sensing. (E, P)</u>

a. Describe the characteristics of the electromagnetic spectrum.

b. Using images and graphs, interpret the absorption/reflection spectrum.

c. Distinguish between passive vs. active sensor systems.
d. Analyze the effects of changes in spatial, temporal, and spectral resolution.
e. Analyze the effects on images due to changes in scale.
f. Identify the types of sensor platforms.

Zoology

ZO 1	Apply inquiry-based and problem-solving processes and skills to scientific investigations.
ZO 2	Develop an understanding of levels of organization and animal classification.
ZO 3	Differentiate among animal life cycles, behaviors, adaptations, and relationships.
ZO 4	Demonstrate an understanding of the principles of animal genetic diversity and evolution.

1. **Apply inquiry-based and problem-solving processes and skills to scientific investigations.**
   a. Conduct a scientific investigation demonstrating safe procedures and proper care of laboratory equipment. (DOK 2)
      - Safety rules and symbols
      - Proper use and care of the compound light microscope, slides, chemicals, etc.
      - Accuracy and precision in using graduated cylinders, balances, beakers, thermometers, and rulers
   b. Formulate questions that can be answered through research and experimental design. (DOK 3)
   c. Apply the components of scientific processes and methods in classroom and laboratory investigations (e.g., hypotheses, experimental design, observations, data analyses, interpretations, theory development). (DOK 3)
   d. Construct and analyze graphs (e.g., plotting points, labeling x-and y-axis, creating appropriate titles and legends for circle, bar, and line graphs). (DOK 2)
   e. Analyze procedures, data, and conclusions to determine the scientific validity of research. (DOK 3)
   f. Recognize and analyze alternative explanations for experimental results and to make predictions based on observations and prior knowledge. (DOK 3)
   g. Communicate and defend a scientific argument in oral, written, and graphic form. (DOK 3)
2. **Develop an understanding of levels of organization and animal classification.**
   a. Explain how organisms are classified, and identify characteristics of major groups. (DOK 1)
      - Levels of organization of structures in animals (e.g., cells, tissues, organs, and systems)
      - Characteristics used to classify organisms (e.g., cell structure, biochemistry, anatomy, fossil record, and methods of reproduction)
   b. Identify and describe characteristics of the major phyla. (DOK 1)
      - Symmetry and body plan
      - Germ layers and embryonic development

- Organ systems (e.g., digestive, circulatory, excretory, and reproductive)
- Locomotion and coordination

c. Distinguish viruses from bacteria and protists, and give examples. (DOK 1)

d. Differentiate among the characteristics of bacteria, archaea, and eucarya. (DOK 1)
   - Phylogenic sequencing of the major phyla
   - Invertebrate characteristics (e.g., habitat, reproduction, body plan, locomotion) of the following phyla: Porifera, Cnidarians, Nematoda, Annelida, Platyhelmenthes, Arthropoda, Insecta, Crustacea, Arachnida, Mollusca [Bivalvia and Gastropoda], and Echinodermata)
   - Vertebrate characteristics (e.g., habitat, reproduction, body plan, locomotion) of the following classes: Agnatha, Chondrichthyes, Osteichthyes, Amphibia, Reptilia, Aves, and Mammalia

3. <u>Differentiate among animal life cycles, behaviors, adaptations, and relationships.</u>

a. Describe life cycles, alternation of generations, and metamorphosis of various animals, and evaluate the advantages and disadvantages of asexual and sexual reproduction. (DOK 1)

b. Describe and explain concepts of animal behavior, and differentiate between learned and innate behavior. (DOK 1)
   - Division of labor within a group of animals
   - Communication within animals groups
   - Degree of parental care given in animal groups

c. Evaluate the unique protective adaptations of animals as they relate to survival. (DOK 2)

d. Compare and contrast ecological relationships, and make predictions about the survival of populations under given circumstances. (DOK 3)
   - Terrestrial and aquatic ecosystems
   - Herbivores, carnivores, omnivores, decomposers and other feeding relationships
   - Symbiotic relationships such as mutualism, commensalisms, and parasitism

e. Contrast food chains and food webs. (DOK 2)

4. <u>Demonstrate an understanding of the principles of animal genetic diversity and evolution.</u>

a. Categorize and explain sources of genetic variation on the cellular level (e.g., mutations, crossing over, and nondisjunction) and the population level (e.g., nonrandom mating, migration, etc.). (DOK 2)
   - Relationship between natural selection and evolution
   - Mutations, crossing over, nondisjunction
   - Nonrandom mating, migration, etc.
   - Effects of genetic drift on evolution

b. Develop a logical argument defending or refuting issues related to genetic engineering of animals. (DOK 3)

Appendix C: ACT College Readiness Standards

English

E1 Topic Development in Terms of Purpose and Focus

- Identify the basic purpose or role of a specified phrase or sentence.
- Delete a clause or sentence because it is obviously irrelevant to the essay.
- Identify the central idea or main topic of a straightforward piece of writing.
- Determine relevancy when presented with a variety of sentence-level details.
- Identify the focus of a simple essay, applying that knowledge to add a sentence that sharpens that focus or to determine if an essay has met a specified goal.
- Delete material primarily because it disturbs the flow and development of the paragraph.
- Add a sentence to accomplish a fairly straightforward purpose such as illustrating a given statement.
- Apply an awareness of the focus and purpose of a fairly involved essay to determine the rhetorical effect and suitability of an existing phrase or sentence or to determine the need to delete plausible but irrelevant material.
- Add a sentence to accomplish a subtle rhetorical purpose such as to emphasize, to add supporting detail, or to express meaning through connotation.
- Determine whether a complex essay has accomplished a specific purpose.
- Add a phrase or sentence to accomplish a complex purpose, often expressed in terms of the main focus of the essay.

E2 Organization, Unity, and Coherence

- Use conjunctive adverbs or phrases to show time relationship in simple narrative essays (e.g., *then, this time*, etc.).
- Select the most logical place to add a sentence in a paragraph.
- Use conjunctive adverbs or phrases to express straightforward logical relationships (e.g., *first, afterward, in response*).
- Decide the most logical place to add a sentence in an essay.
- Add a sentence that introduces a simple paragraph.
- Determine the need for conjunctive adverbs or phrases to create subtle logical connections between sentences (e.g., *therefore, however, in addition*).
- Rearrange the sentences in a fairly uncomplicated paragraph for the sake of logic.
- Add a sentence to introduce or conclude the essay or to provide a transition between paragraphs when the essay is fairly straightforward.
- Make sophisticated distinctions concerning the logical use of conjunctive adverbs or phrases, particularly when signaling a shift between paragraphs.
- Rearrange sentences to improve the logic and coherence of a complex paragraph.
- Add a sentence to introduce or conclude a fairly complex paragraph.
- Consider the need for introductory sentences or transitions, basing decisions on a thorough understanding of both the logic and rhetorical effect of the paragraph and essay.

E3 Word Choice in Terms of Style, Tone, Clarity, and Economy

- Revise sentences to correct awkward and confusing arrangements of sentence elements.
- Revise vague nouns and pronouns that create obvious logic problems.
- Delete obviously synonymous and wordy material in a sentence.
- Revise expressions that deviate from the style of an essay.
- Delete redundant material when information is repeated in different parts of speech (e.g., *alarmingly startled*).
- Use the word or phrase most consistent with the style and tone of a fairly straightforward essay.
- Determine the clearest and most logical conjunction to link clauses.
- Revise a phrase that is redundant in terms of the meaning and logic of the entire sentence.
- Identify and correct ambiguous pronoun references.
- Use the word or phrase most appropriate in terms of the content of the sentence and tone of the essay.
- Correct redundant material that involves sophisticated vocabulary and sounds acceptable as conversational English (e.g., *an aesthetic viewpoint* versus *the outlook of an aesthetic viewpoint*).
- Correct vague and wordy or clumsy and confusing writing containing sophisticated language.
- Delete redundant material that involves subtle concepts or that is redundant in terms of the paragraph as a whole.

E4 Sentence Structure and Formation

- Use conjunctions or punctuation to join simple clauses.
- Revise shifts in verb tense between simple clauses in a sentence or between simple adjoining sentences.
- Determine the need for punctuation and conjunctions to avoid awkward sounding sentence fragments and fused sentences.
- Decide the appropriate verb tense and voice by considering the meaning of the entire sentence.
- Recognize and correct marked disturbances of sentence flow and structure (e.g., participial phrase fragments, missing or incorrect relative pronouns, dangling or misplaced modifiers).
- Revise to avoid faulty placement of phrases and faulty coordination and subordination of clauses in sentences with subtle structural problems.
- Maintain consistent verb tense and pronoun person on the basis of the preceding clause or sentence.
- Use sentence-combining techniques, effectively avoiding problematic comma splices, run-on sentences, and sentence fragments, especially in sentences containing compound subjects or verbs.
- Maintain a consistent and logical use of verb tense and pronoun person on the basis of information in the paragraph or essay as a whole.

- Work comfortably with long sentences and complex clausal relationships within sentences, avoiding weak conjunctions between independent clauses and maintaining parallel structure between clauses.

E5 Conventions of Usage

- Solve such basic grammatical problems as how to form the past and past participle of irregular but commonly used verbs and how to form comparative and superlative adjectives.
- Solve such grammatical problems as whether to use an adverb or adjective form, how to ensure straightforward subject–verb and pronoun–antecedent agreement, and which preposition to use in simple contexts.
- Recognize and use the appropriate word in frequently confused pairs such as *there* and *their*, *past* and *passed*, and *led* and *lead*.
- Use idiomatically appropriate prepositions, especially in combination with verbs (e.g., *long for, appeal to*).
- Ensure that a verb agrees with its subject when there is some text between the two.
- Ensure that a pronoun agrees with its antecedent when the two occur in separate clauses or sentences.
- Identify the correct past and past participle forms of irregular and infrequently used verbs, and form present–perfect verbs by using *have* rather than *of*.
- Correctly use reflexive pronouns, the possessive pronouns *its* and *your*, and the relative pronouns *who* and *whom*.
- Ensure that a verb agrees with its subject in unusual situations (e.g., when the subject–verb order is inverted or when the subject is an indefinite pronoun).
- Provide idiomatically and contextually appropriate prepositions following verbs in situations involving sophisticated language or ideas.
- Ensure that a verb agrees with its subject when a phrase or clause between the two suggests a different number for the verb.

E6 Conventions of Punctuation

- Delete commas that create basic sense problems (e.g., between verb and direct object).
- Provide appropriate punctuation in straightforward situations (e.g., items in a series).
- Delete commas that disturb the sentence flow (e.g., between modifier and modified element).
- Use commas to set off simple parenthetical phrases.
- Delete unnecessary commas when an incorrect reading of the sentence suggests a pause that should be punctuated (e.g., between verb and direct object clause).
- Use punctuation to set off complex parenthetical phrases.
- Recognize and delete unnecessary commas based on a careful reading of a complicated sentence (e.g., between the elements of a compound subject or compound verb joined by *and*).
- Use apostrophes to indicate simple possessive nouns.
- Recognize inappropriate uses of colons and semicolons.

- Use commas to set off a nonessential/nonrestrictive appositive or clause.
- Deal with multiple punctuation problems (e.g., compound sentences containing unnecessary commas and phrases that may or may not be parenthetical).
- Use an apostrophe to show possession, especially with irregular plural nouns.
- Use a semicolon to indicate a relationship between closely related independent clauses.
- Use a colon to introduce an example or an elaboration.

Math

M1 Basic Operations and Applications

- Perform one-operation computation with whole numbers and decimals.
- Solve problems in one or two steps using whole numbers.
- Perform common conversions (e.g., inches to feet or hours to minutes).
- Solve routine one-step arithmetic problems (using whole numbers, fractions, and decimals) such as single-step percent.
- Solve some routine two-step arithmetic problems.
- Solve routine two-step or three-step arithmetic problems involving concepts such as rate and proportion, tax added, percentage off, and computing with a given average.
- Solve multistep arithmetic problems that involve planning or converting units of measure (e.g., feet per second to miles per hour).
- Solve word problems containing several rates, proportions, or percentages.
- Solve complex arithmetic problems involving percent of increase or decrease and problems requiring integration of several concepts from pre-algebra and/or pre-geometry (e.g., comparing percentages or averages, using several ratios, and finding ratios in geometry settings).

M2 Probability, Statistics, and Data Analysis

- Calculate the average of a list of positive whole numbers.
- Perform a single computation using information from a table or chart.
- Calculate the average of a list of numbers.
- Calculate the average, given the number of data values and the sum of the data values.
- Read tables and graphs.
- Perform computations on data from tables and graphs.
- Use the relationship between the probability of an event and the probability of its complement.
- Calculate the missing data value, given the average and all data values but one.
- Translate from one representation of data to another (e.g., a bar graph to a circle graph).
- Determine the probability of a simple event.
- Exhibit knowledge of simple counting techniques.*
- Calculate the average, given the frequency counts of all the data values.
- Manipulate data from tables and graphs.
- Compute straightforward probabilities for common situations.
- Use Venn diagrams in counting.*
- Calculate or use a weighted average.

- Interpret and use information from figures, tables, and graphs.
- Apply counting techniques.
- Compute a probability when the event and/or sample space is not given or obvious.
- Distinguish between mean, median, and mode for a list of numbers.
- Analyze and draw conclusions based on information from figures, tables, and graphs.
- Exhibit knowledge of conditional and joint probability.

M3 Numbers: Concepts and Properties

- Recognize equivalent fractions and fractions in lowest terms.
- Recognize one-digit factors of a number.
- Identify a digit's place value.
- Exhibit knowledge of elementary number concepts including rounding, the ordering of decimals, pattern identification, absolute value, primes, and greatest common factor.
- Find and use the least common multiple.
- Order fractions.
- Work with numerical factors.
- Work with scientific notation.
- Work with squares and square roots of numbers.
- Work problems involving positive integer exponents.*
- Work with cubes and cube roots of numbers.*
- Determine when an expression is undefined.*
- Exhibit some knowledge of the complex numbers.†
- Apply number properties involving prime factorization.
- Apply number properties involving even and odd numbers and factors and multiples.
- Apply number properties involving positive and negative numbers.
- Apply rules of exponents.
- Multiply two complex numbers.†
- Draw conclusions based on number concepts, algebraic properties, and/or relationships between expressions and numbers.
- Exhibit knowledge of logarithms and geometric sequences.
- Apply properties of complex numbers.

M4 Expressions, Equations, and Inequalities

- Exhibit knowledge of basic expressions (e.g., identify an expression for a total as $b + g$).
- Solve equations in the form $x + a = b$, where a and b are whole numbers or decimals.
- Substitute whole numbers for unknown quantities to evaluate expressions.
- Solve one-step equations having integer or decimal answers.
- Combine like terms (e.g., $2x + 5x$).
- Evaluate algebraic expressions by substituting integers for unknown quantities.
- Add and subtract simple algebraic expressions.
- Solve routine first-degree equations.
- Perform straightforward word-to-symbol translations.
- Multiply two binomials.*

- Solve real-world problems using first-degree equations.
- Write expressions, equations, or inequalities with a single variable for common pre-algebra settings (e.g., rate and distance problems and problems that can be solved by using proportions).
- Identify solutions to simple quadratic equations.
- Add, subtract, and multiply polynomials.*
- Factor simple quadratics (e.g., the difference of squares and perfect square trinomials).*
- Solve first-degree inequalities that do not require reversing the inequality sign.*
- Manipulate expressions and equations.
- Write expressions, equations, and inequalities for common algebra settings.
- Solve linear inequalities that require reversing the inequality sign.
- Solve absolute value equations.
- Solve quadratic equations.
- Find solutions to systems of linear equations.
- Write expressions that require planning and/or manipulating to accurately model a situation.
- Write equations and inequalities that require planning, manipulating, and/or solving.
- Solve simple absolute value inequalities.

M5 Graphical Representations

- Identify the location of a point with a positive coordinate on the number line.
- Locate points on the number line and in the first quadrant.
- Locate points in the coordinate plane.
- Comprehend the concept of length on the number line.*
- Exhibit knowledge of slope.*
- Identify the graph of a linear inequality on the number line.*
- Determine the slope of a line from points or equations.*
- Match linear graphs with their equations.*
- Find the midpoint of a line segment.*
- Interpret and use information from graphs in the coordinate plane.
- Match number line graphs with solution sets of linear inequalities.
- Use the distance formula.
- Use properties of parallel and perpendicular lines to determine an equation of a line or coordinates of a point.
- Recognize special characteristics of parabolas and circles (e.g., the vertex of a parabola and the center or radius of a circle).†
- Match number line graphs with solution sets of simple quadratic inequalities.
- Identify characteristics of graphs based on a set of conditions or on a general equation such as y = ax2 + c.
- Solve problems integrating multiple algebraic and/or geometric concepts.
- Analyze and draw conclusions based on information from graphs in the coordinate plane.

M6 Properties of Plane Figures

- Exhibit some knowledge of the angles associated with parallel lines.
- Find the measure of an angle using properties of parallel lines.
- Exhibit knowledge of basic angle properties and special sums of angle measures (e.g., 90°, 180°, and 360°).
- Use several angle properties to find an unknown angle measure.
- Recognize Pythagorean triples.*
- Use properties of isosceles triangles.*
- Apply properties of 30°-60°-90°, 45°-45°-90°, similar, and congruent triangles.
- Use the Pythagorean theorem.
- Draw conclusions based on a set of conditions.
- Solve multistep geometry problems that involve integrating concepts, planning, visualization, and/or making connections with other content areas.
- Use relationships among angles, arcs, and distances in a circle.

M7Measurement

- Estimate or calculate the length of a line segment based on other lengths given on a geometric figure.
- Compute the perimeter of polygons when all side lengths are given.
- Compute the area of rectangles when whole number dimensions are given.
- Compute the area and perimeter of triangles and rectangles in simple problems.
- Use geometric formulas when all necessary information is given.
- Compute the area of triangles and rectangles when one or more additional simple steps are required.
- Compute the area and circumference of circles after identifying necessary information.
- Compute the perimeter of simple composite geometric figures with unknown side lengths.*
- Use relationships involving area, perimeter, and volume of geometric figures to compute another measure.
- Use scale factors to determine the magnitude of a size change.
- Compute the area of composite geometric figures when planning or visualization is required.

M8Functions

- Evaluate quadratic functions, expressed in function notation, at integer values.
- Evaluate polynomial functions, expressed in function notation, at integer values.†
- Express the sine, cosine, and tangent of an angle in a right triangle as a ratio of given side lengths.†
- Evaluate composite functions at integer values.†
- Apply basic trigonometric ratios to solve right-triangle problems.†
- Write an expression for the composite of two simple functions.†
- Use trigonometric concepts and basic identities to solve problems.†
- Exhibit knowledge of unit circle trigonometry.†
- Match graphs of basic trigonometric functions with their equations.

Notes

- Students who score in the 1–12 range are most likely beginning to develop the knowledge and skills assessed in the other ranges.
- Standards followed by an asterisk (*) apply to the PLAN and ACT Mathematics tests only.
- Standards followed by a dagger (†) apply to the ACT Mathematics test only.

Reading

R1 Main Ideas and Author's Approach

- Recognize a clear intent of an author or narrator in uncomplicated literary narratives.
- Identify a clear main idea or purpose of straightforward paragraphs in uncomplicated literary narratives.
- Infer the main idea or purpose of straightforward paragraphs in uncomplicated literary narratives.
- Understand the overall approach taken by an author or narrator (e.g., point of view, kinds of evidence used) in uncomplicated passages.
- Identify a clear main idea or purpose of any paragraph or paragraphs in uncomplicated passages.
- Infer the main idea or purpose of straightforward paragraphs in more challenging passages.
- Summarize basic events and ideas in more challenging passages.
- Understand the overall approach taken by an author or narrator (e.g., point of view, kinds of evidence used) in more challenging passages.
- Infer the main idea or purpose of more challenging passages or their paragraphs.
- Summarize events and ideas in virtually any passage.
- Understand the overall approach taken by an author or narrator (e.g., point of view, kinds of evidence used) in virtually any passage.
- Identify clear main ideas or purposes of complex passages or their paragraphs.

R2 Supporting Details

- Locate basic facts (e.g., names, dates, events) clearly stated in a passage.
- Locate simple details at the sentence and paragraph level in uncomplicated passages.
- Recognize a clear function of a part of an uncomplicated passage.
- Locate important details in uncomplicated passages.
- Make simple inferences about how details are used in passages.
- Locate important details in more challenging passages.
- Locate and interpret minor or subtly stated details in uncomplicated passages.
- Discern which details, though they may appear in different sections throughout a passage, support important points in more challenging passages.
- Locate and interpret minor or subtly stated details in more challenging passages.
- Use details from different sections of some complex informational passages to support a specific point or argument.

- Locate and interpret details in complex passages.
- Understand the function of a part of a passage when the function is subtle or complex.

R3 Sequential, Comparative, and Cause–Effect Relationships

- Determine when (e.g., first, last, before, after) or if an event occurred in uncomplicated passages.
- Recognize clear cause–effect relationships described within a single sentence in a passage.
- Identify relationships between main characters in uncomplicated literary narratives.
- Recognize clear cause–effect relationships within a single paragraph in uncomplicated literary narratives.
- Order simple sequences of events in uncomplicated literary narratives.
- Identify clear relationships between people, ideas, and so forth in uncomplicated passages.
- Identify clear cause–effect relationships in uncomplicated passages.
- Order sequences of events in uncomplicated passages.
- Understand relationships between people, ideas, and so forth in uncomplicated passages.
- Identify clear relationships between characters, ideas, and so forth in more challenging literary narratives.
- Understand implied or subtly stated cause–effect relationships in uncomplicated passages.
- Identify clear cause–effect relationships in more challenging passages.
- Order sequences of events in more challenging passages.
- Understand the dynamics between people, ideas, and so forth in more challenging passages.
- Understand implied or subtly stated cause–effect relationships in more challenging passages.
- Order sequences of events in complex passages.
- Understand the subtleties in relationships between people, ideas, and so forth in virtually any passage.
- Understand implied, subtle, or complex cause–effect relationships in virtually any passage.

R4 Meaning of Words

- Understand the implication of a familiar word or phrase and of simple descriptive language.
- Use context to understand basic figurative language.
- Use context to determine the appropriate meaning of some figurative and nonfigurative words, phrases, and statements in uncomplicated passages.
- Use context to determine the appropriate meaning of virtually any word, phrase, or statement in uncomplicated passages.
- Use context to determine the appropriate meaning of some figurative and nonfigurative words, phrases, and statements in more challenging passages.

- Determine the appropriate meaning of words, phrases, or statements from figurative or somewhat technical contexts.
- Determine, even when the language is richly figurative and the vocabulary is difficult, the appropriate meaning of context-dependent words, phrases, or statements in virtually any passage.

R5 Generalizations and Conclusions

- Draw simple generalizations and conclusions about the main characters in uncomplicated literary narratives.
- Draw simple generalizations and conclusions about people, ideas, and so forth in uncomplicated passages.
- Draw generalizations and conclusions about people, ideas, and so forth in uncomplicated passages.
- Draw simple generalizations and conclusions using details that support the main points of more challenging passages.
- Draw subtle generalizations and conclusions about characters, ideas, and so forth in uncomplicated literary narratives.
- Draw generalizations and conclusions about people, ideas, and so forth in more challenging passages.
- Use information from one or more sections of a more challenging passage to draw generalizations and conclusions about people, ideas, and so forth.
- Draw complex or subtle generalizations and conclusions about people, ideas, and so forth, often by synthesizing information from different portions of the passage.
- Understand and generalize about portions of a complex literary narrative.

Science

S1 Interpretation of Data

- Select a single piece of data (numerical or non-numerical) from a simple data presentation (e.g., a table or graph with two or three variables, a food web diagram).
- Identify basic features of a table, graph, or diagram (e.g., headings, units of measurement, axis labels).
- Select two or more pieces of data from a simple data presentation.
- Understand basic scientific terminology.
- Find basic information in a brief body of text.
- Determine how the value of one variable changes as the value of another variable changes in a simple data presentation.
- Select data from a complex data presentation (e.g., a table or graph with more than three variables, a phase diagram).
- Compare or combine data from a simple data presentation (e.g., order or sum data from a table).
- Translate information into a table, graph, or diagram.
- Compare or combine data from two or more simple data presentations (e.g., categorize data from a table using a scale from another table).

- Compare or combine data from a complex data presentation.
- Interpolate between data points in a table or graph.
- Determine how the value of one variable changes as the value of another variable changes in a complex data presentation.
- Identify and/or use a simple (e.g., linear) mathematical relationship between data.
- Analyze given information when presented with new, simple information.
- Compare or combine data from a simple data presentation with data from a complex data presentation.
- Identify and/or use a complex (e.g., nonlinear) mathematical relationship between data.
- Extrapolate from data points in a table or graph.
- Compare or combine data from two or more complex data presentations.
- Analyze given information when presented with new, complex information.

S2 Scientific Investigation

- Understand the methods and tools used in a simple experiment.
- Understand the methods and tools used in a moderately complex experiment.
- Understand a simple experimental design.
- Identify a control in an experiment.
- Identify similarities and differences between experiments.
- Understand the methods and tools used in a complex experiment.
- Understand a complex experimental design.
- Predict the results of an additional trial or measurement in an experiment.
- Determine the experimental conditions that would produce specified results.
- Determine the hypothesis for an experiment.
- Identify an alternate method for testing a hypothesis.
- Understand precision and accuracy issues.
- Predict how modifying the design or methods of an experiment will affect results.
- Identify an additional trial or experiment that could be performed to enhance or evaluate experimental results.

S3 Evaluation of Models, Inferences, and Experimental Results

- Select a simple hypothesis, prediction, or conclusion that is supported by a data presentation or a model.
- Identify key issues or assumptions in a model.
- Select a simple hypothesis, prediction, or conclusion that is supported by two or more data presentations or models.
- Determine whether given information supports or contradicts a simple hypothesis or conclusion and why.
- Identify strengths and weaknesses in one or more models.
- Identify similarities and differences between models.
- Determine which model(s) is/are supported or weakened by new information.
- Select a data presentation or a model that supports or contradicts a hypothesis, prediction, or conclusion.

- Select a complex hypothesis, prediction, or conclusion that is supported by a data presentation or model.
- Determine whether new information supports or weakens a model and why.
- Use new information to make a prediction based on a model.
- Select a complex hypothesis, prediction, or conclusion that is supported by two or more data presentations or models.
- Determine whether given information supports or contradicts a complex hypothesis or conclusion and why.

Writing

W1 Expressing Judgments

- Show a little understanding of the persuasive purpose of the task, but neglect to take or to maintain a position on the issue in the prompt.
- Show limited recognition of the complexity of the issue in the prompt.
- Show a basic understanding of the persuasive purpose of the task by taking a position on the issue in the prompt but may not maintain that position.
- Show a little recognition of the complexity of the issue in the prompt by acknowledging, but only briefly describing, a counterargument to the writer's position.
- Show understanding of the persuasive purpose of the task by taking a position on the issue in the prompt.
- Show some recognition of the complexity of the issue in the prompt by doing the following:
    - Acknowledging counterarguments to the writer's position
    - Providing some response to counterarguments to the writer's position
- Show clear understanding of the persuasive purpose of the task by taking a position on the specific issue in the prompt and offering a broad context for discussion.
- Show recognition of the complexity of the issue in the prompt by doing the following:
    - Partially evaluating implications and/or complications of the issue
    - Posing and partially responding to counterarguments to the writer's position
- Show clear understanding of the persuasive purpose of the task by taking a position on the specific issue in the prompt and offering a critical context for discussion.
- Show understanding of the complexity of the issue in the prompt by doing the following:
    - Examining different perspectives
    - Evaluating implications or complications of the issue
    - Posing and fully discussing counterarguments to the writer's position

W2 Focusing on the Topic

- Maintain a focus on the general topic in the prompt through most of the essay.
- Maintain a focus on the general topic in the prompt throughout the essay.
- Maintain a focus on the general topic in the prompt throughout the essay, and attempt a focus on the specific issue in the prompt.
- Present a thesis that establishes focus on the topic.
- Maintain a focus on discussion of the specific topic and issue in the prompt throughout the essay.

- Present a thesis that establishes a focus on the writer's position on the issue.
- Maintain a clear focus on discussion of the specific topic and issue in the prompt throughout the essay.
- Present a critical thesis that clearly establishes the focus on the writer's position on the issue.

W3 Developing a Position

- Offer a little development, with one or two ideas; if examples are given, they are general and may not be clearly relevant; resort often to merely repeating ideas.
- Show little or no movement between general and specific ideas and examples.
- Offer limited development of ideas using a few general examples; resort sometimes to merely repeating ideas.
- Show little movement between general and specific ideas and examples.
- Develop ideas by using some specific reasons, details, and examples.
- Show some movement between general and specific ideas and examples.
- Develop most ideas fully, using some specific and relevant reasons, details, and examples.
- Show clear movement between general and specific ideas and examples.
- Develop several ideas fully, using specific and relevant reasons, details, and examples.
- Show effective movement between general and specific ideas and examples.

W4 Organizing Ideas

- Provide a discernible organization with some logical grouping of ideas in parts of the essay.
- Use a few simple and obvious transitions.
- Present a discernible, though minimally developed, introduction and conclusion.
- Provide a simple organization with logical grouping of ideas in parts of the essay.
- Use some simple and obvious transitional words, though they may at times be inappropriate or misleading.
- Present a discernible, though underdeveloped, introduction and conclusion.
- Provide an adequate but simple organization with logical grouping of ideas in parts of the essay but with little evidence of logical progression of ideas.
- Use some simple and obvious, but appropriate, transitional words and phrases.
- Present a discernible introduction and conclusion with a little development.
- Provide unity and coherence throughout the essay, sometimes with a logical progression of ideas.
- Use relevant, though at times simple and obvious, transitional words and phrases to convey logical relationships between ideas.
- Present a somewhat developed introduction and conclusion.
- Provide unity and coherence throughout the essay, often with a logical progression of ideas.
- Use relevant transitional words, phrases, and sentences to convey logical relationships between ideas.

- Present a well-developed introduction and conclusion.

W5 Using Language

- Show limited control of language by doing the following:
    - Correctly employing some of the conventions of standard English grammar, usage, and mechanics but with distracting errors that sometimes significantly impede understanding
    - Using simple vocabulary
    - Using simple sentence structure
    - Correctly employing some of the conventions of standard English grammar, usage, and mechanics but with distracting errors that sometimes impede understanding
    - Using simple but appropriate vocabulary
    - Using a little sentence variety, though most sentences are simple in structure
    - Correctly employing many of the conventions of standard English grammar, usage, and mechanics but with some distracting errors that may occasionally impede understanding
    - Using appropriate vocabulary
    - Using some varied kinds of sentence structures to vary pace
    - Correctly employing most conventions of standard English grammar, usage, and mechanics with a few distracting errors but none that impede understanding
    - Using some precise and varied vocabulary
    - Using several kinds of sentence structures to vary pace and to support meaning
    - Correctly employing most conventions of standard English grammar, usage, and mechanics with just a few, if any, errors
    - Using precise and varied vocabulary
    - Using a variety of kinds of sentence structures to vary pace and to support meaning

Appendix D: Pathway Content Standards

CONTREN Crosswalk for Precision Machining

	Units	Unit 1	Unit 2	Unit 3	Unit 4	Unit 5	Unit 6	Unit 7	Unit 8	Unit 9	Unit 10
CONTREN Core											
SAF		X			X	X	X	X	X	X	X
MAT		X	X	X	X	X	X	X	X		X
HTO		X	X		X	X	X	X	X	X	X
PTO		X			X	X	X	X	X	X	X
BLU		X		X	X	X	X	X	X		X
MBR		X							X	X	
COM		X			X	X	X	X	X	X	X
EMP		X							X		

	Units	Unit 11	Unit 12			
CONTREN Core						
SAF		X	X			
MAT		X	X			
HTO		X	X			
PTO		X	X			
BLU		X	X			
MBR						
COM		X	X			
EMP						

NIMS Crosswalk for Precision Machining

	Units	Unit 1	Unit 2	Unit 3	Unit 4	Unit 5	Unit 6	Unit 7	Unit 8	Unit 9	Unit 10
NIMS LEVEL ONE											
L1B			X	X	X	X	X	X			X
LIL			X	X	X	X	X	X			X
1VM			X	X		X					
1DP			X	X	X						
1SG			X	X				X			
1TB			X	X			X				X
1TC			X	X			X				X
1CM			X	X							
1CT			X	X							
2TB			X	X							X
2TC			X	X							X
2PL			X	X							
2FA			X	X				X			
2CG			X	X				X			
2CM			X	X							

2CT			X	X							

	Units	Unit 11	Unit 12								
NIMS LEVEL ONE											
L1B		X	X								
LIL		X	X								
1VM		X	X								
1DP											
1SG											
1TB			X								
1TC			X								
1CM			X								
1CT			X								
2TB											
2TC											
2PL		X									
2FA											
2CG											
2CM			X								
2CT			X								

CONTREN CORE

SAF - Basic Safety

- Explain the role that safety plays in the construction crafts.
- Describe the meaning of jobsite safety.
- Describe the characteristics of a competent person and a qualified person.
- Explain the appropriate safety precautions to take around common jobsite hazards.
- Demonstrate the use and care of appropriate personal protective equipment (PPE).
- Properly don and remove personal protective equipment (safety goggles, hard hat, and personal fall protection).
- Follow the safety procedures required for lifting heavy objects.
- Describe safe behavior on and around ladders and scaffolds.
- Explain the importance of Hazard Communications (HazCom) and material safety data sheets (MSDSs).
- Describe fire prevention and firefighting techniques.

- Define safe work procedures to use around electrical hazards.

MAT - Introduction to Construction Math

- Add, subtract, multiply, and divide whole numbers, with and without a calculator.
- Use a standard ruler and a metric ruler to measure.
- Add, subtract, multiply, and divide fractions.
- Add, subtract, multiply, and divide decimals, with and without a calculator.
- Convert decimals to percentages and percentages to decimals.
- Convert fractions to decimals and decimals to fractions.
- Explain what the metric system is and how it is important in the construction trade.
- Recognize and use metric units of length, weight, volume, and temperature.
- Recognize some of the basic shapes used in the construction industry, and apply basic geometry to measure them.

HTO - Introduction to Hand Tools

- Recognize and identify some of the basic hand tools used in the construction trade.
- Use hand tools safely.
- Describe the basic procedures for taking care of hand tools.

PTO - Introduction to Power Tools

- Identify power tools commonly used in the construction trades.
- Use power tools safely.
- Explain how to maintain power tools properly.

BLU - Introduction to Blueprints

- Recognize and identify basic blueprint terms, components, and symbols.
- Relate information on blueprints to actual locations on the print.
- Recognize different classifications of drawings.

- Interpret and use drawing dimensions.

MBR - Basic Rigging

- Identify and describe the use of slings and common rigging hardware.
- Describe basic inspection techniques and rejection criteria used for slings and hardware.
- Describe basic hitch configurations and their proper connections.
- Describe basic load-handling safety practices.
- Demonstrate proper use of American National Standards Institute (ANSI) hand signals.

COM - Basic Communication Skills

- Demonstrate the ability to interpret information and instructions presented in both written and verbal form.
- Demonstrate the ability to communicate effectively in on-the-job situations using written and verbal skills.

EMP - Basic Employability Skills

- Explain the construction industry, the role of the companies that make up the industry, and the role of individual professionals in the industry.
- Demonstrate critical-thinking skills and the ability to solve problems using those skills.
- Demonstrate knowledge of computer systems, and explain common uses for computers in the construction industry.
- Demonstrate effective relationship skills with teammates and supervisors, the ability to work on a team, and appropriate leadership skills.
- Be aware of workplace issues such as sexual harassment, stress, and substance abuse.

National Institute for Metalworking Skills (NIMS)

NIMS Machining Level 1

L1B - Benchwork

Given a process plan, blueprint, and access to hand tools, produce a part with two holes prepared for hand tapping, a hole prepared (reamed) for the press fit of a bushing, and a stud for one of the

tapped holes. Deburr the part, hand drill and hand tap the holes, press in the bushing, and install the stud. File chamfer.

Other Evaluation Criteria

1. Free of sharp edges or burrs

2. Go/NoGo gauge for the threads

3. Length of stud within 0.03 of basic dimension and square to surface

Accuracy Level: +/- 0.015 unless otherwise specified on the blueprint

LIL - Layout

Given a surface plate, surface gage, layout height gage, combination set, scriber, layout ink, prick punch, ball-peen hammer, process plan, and part print, lay out hole locations, radii, and surfaces matching the specifications.

Other Evaluation Criteria

1. Layout ink is applied to the surface appropriately.

2. Lines are struck once.

3. Intersections are clean and clear.

4. Punch marks are centered on intersections.

Accuracy Level: +/- 0.015 unless otherwise specified on the blueprint

1VM - Vertical Milling

Given raw material, print, hand, precision, and cutting tools, as well as access to an appropriate vertical milling machine and its accessories, produce a part matching the blueprint specifications using appropriate trade techniques and speeds and feeds. The part specified should require squaring up from the raw state, have at least one milled slot, require the location of at least two drilled and reamed holes within positional tolerance of 0.014 in., and have three steps controlled by tolerances of +/- 0.005 in.

Other Evaluation Criteria

1. Finishes are at least 125 Ra microinches.

2. No sharp edges

Accuracy Level: +/- 0.015 on all fractions, +/- 0.005 on all decimals unless otherwise specified on the blueprint

Finished surfaces are to be square within 0.005 over 4 in.

Finished surfaces are to be 125 Ra microinches unless otherwise specified.

1DP - Drill Press

Given a part print and hand, precision, and cutting tools, as well as access to a drill press and its accessories, produce a part matching the process plan and the blueprint specifications. Each hole must have at least two secondary operations. The secondary operations will consist of reaming, spot facing, countersinking, counterboring, and counterdrilling. At least one hole must be a blind hole and one a through hole. At least one hole will/may be power tapped.

Other Evaluation Criteria

1. Finishes are at least 250 Ra microinches.

2. No sharp edges

3. The mouths of all holes are lightly countersunk.

Accuracy Level: +/- 1/64 on all fractions, holes square within 0.005 per inch, drilled diameters, +0.006, -0.000

Reamed diameters are +0.001, -0.000, +/- 0.005 on all decimals unless otherwise specified on the blueprint.

1SG - Surface Grinding

Given a block squared up on a mill, part print, hand and precision tools, and choice of a grinding wheels, as well as access to a surface grinder and its accessories, dress the wheel, produce a part matching the print specifications using appropriate trade techniques. The part specified will be in the semi-finished state having been squared up and milled. Finishing the part will require the precision finishing of the six faces of the block to tolerances common to precision grinding for squareness, size, and surface finish characteristics.

Other Evaluation Criteria

1. Finishes are at least 32 Ra microinches or better.

2. Free of sharp edges

Accuracy Level: +/- 0.001 on all decimals unless otherwise specified on the print. Square within 0.001 over 4 in.

1TB - Turning – Between Centers

Given raw material, process plan, part print, and hand, precision, and cutting tools, as well as access to an appropriate turning machine and its accessories, produce a part matching the process plan and the part print specifications using appropriate trade techniques and speeds and feeds. The part specified should have at least three diameters within +/- 0.002, one UNC external thread, one UNF external thread, and require part be turned end for end to complete.

Other Evaluation Criteria

1. Finishes are at least 125 Ra microinches.

2. No sharp edges

Accuracy Level: +/- 0.015 on all fractions, +/- 0.005 on all decimals unless otherwise specified on the part print

Diameters are to be coaxial within 0.002 total runout.

1TC - Turning – Chucking

Given raw material, part print, and hand, precision, and cutting tools, as well as access to an appropriate turning machine and its accessories, produce a part matching the print specifications using appropriate trade techniques and speeds and feeds. The part specified should have at least three diameters within +/- 0.005 in., two bores within +/- 0.005 in., one UNC external thread, and require at least two chuckings or other workholding setup.

Other Evaluation Criteria

1. Finishes are at least 125 Ra microinches.

2. No sharp edges

Accuracy Level: +/- 0.015 on all fractions, +/- 0.005 on all decimals unless otherwise specified on the blueprint

Diameters are to be coaxial within 0.002 total runout.

1CM - CNC Milling

Performance Standard

Write a program at the machine or off-line. Set up the machining operation, and perform standards given on mill operations (2.10) to develop a simple part (with linear and circular interpolations).

Accuracy Level: Match the requirements of the part print and 63 Ra microinch finish.

1CT - CNC Turning

Performance Standard

Write a program at the machine or off-line. Set up the machining operation, and perform all standards given on lathe operations (2.9) to develop a simple part (with linear and circular interpolations).

Accuracy Level: Match the requirements of the part print.

NIMS Machining Level II

2TB - Turning – Between Centers

Given raw material, process plan, part print, and hand, precision, and cutting tools, as well as access to an appropriate turning machine and its accessories, produce a part matching the process plan and the part print specifications using appropriate trade techniques and speeds and feeds. The part specified should have at least two straight diameters within +/- 0.001 and an appropriate taper at each end of the part, and it should require a reversal of the part end for end.

Accuracy Level: +/- 0.015 on all fractions and+/- 0.005 on all decimals unless otherwise specified on the part print. Diameters are to be concentric within 0.001 TIR.

Surface finish of 63 Ra microinches or better

2TC - Turning – Chucking

Given a print detailing a part requiring milling, drilling, turning, and grinding, verbal instructions, and appropriate references, formulate a set of strategies to manufacture the part, and write a detailed process plan including a quality plan for that part. Provide sketches as needed. Make a presentation explaining each of the process plan steps to be taken; identify all major components and functions of the machine tools, all major hand tools, measuring tools, tools and fixtures, and work materials; and provide the rationale for the speeds and feeds selected.

2PL - Milling – Precision Locations

Produce three bores to specification. The holes will be between 0.75 and 1.5, and their locations are to be held within +/- 0.001 and hold diameters within +/- 0.0005. One hole is to be counterbored to a decimal depth holding +/- 0.002 and counterbore diameter within +/- 0.005.

Accuracy Level: +/- 0.005 on all decimals unless otherwise specified on the part print and 63 microinch finish

2FA - Grinding – Flats and Angles

Given a block roughed out on a mill, a process plan, part print, hand and precision tools, and choice of a grinding wheels, as well as access to a surface grinder and its accessories, dress the wheel and grind the specified radii and angled surfaces to a finish matching the process plan and the part print specifications using appropriate trade techniques. The part specified will be in the semi-finished state having been roughed out. Finishing the part will require the precision finishing of the specified surfaces of the block to tolerances common to precision grinding for squareness, size, and surface finish characteristics.

Accuracy Level: +/- 0.0005 on all decimals unless otherwise specified on the part print

Square within 0.0001 over 1 in. Angles are to be held within +/- 15'. Radii +/- 001

2CG - Cylindrical Grinding

Dress the wheel. Given a part rough finished on three diameters, mount the part between centers and grind the required diameters to finish.

Accuracy Level: +/- 0.005 on decimals, +/- 0.0005 on ground diameters

2CM - CNC Milling

Given a CNC mill, create a qualified CNC program, set up and operate the mill, change tool values as necessary, and replace and qualify tooling as necessary.

Accuracy Level: Match the requirements of the part print and 63 Ra microinch finish.

2CT - CNC Turning

Given a CNC lathe, create a qualified CNC program, set up and operate the lathe, change tool values as necessary, and replace and qualify tooling as necessary.

Accuracy Level: Match the requirements of the part print and 63 Ra microinch finish.

Appendix E: National Educational Technology Standards for Students

T1 Creativity and Innovation
T2 Communication and Collaboration
T3 Research and Information Fluency
T4 Critical Thinking, Problem Solving, and Decision Making
T5 Digital Citizenship
T6 Technology Operations and Concepts

T1 Creativity and Innovation

Students demonstrate creative thinking, construct knowledge, and develop innovative products and processes using technology. Students do the following:

a. Apply existing knowledge to generate new ideas, products, or processes.
b. Create original works as a means of personal or group expression.
c. Use models and simulations to explore complex systems and issues.
d. Identify trends and forecast possibilities.

T2 Communication and Collaboration

Students use digital media and environments to communicate and work collaboratively, including at a distance, to support individual learning and contribute to the learning of others. Students do the following:

a. Interact, collaborate, and publish with peers, experts, or others employing a variety of digital environments and media.
b. Communicate information and ideas effectively to multiple audiences using a variety of media and formats.
c. Develop cultural understanding and global awareness by engaging with learners of other cultures.
d. Contribute to project teams to produce original works or solve problems.

T3 Research and Information Fluency

Students apply digital tools to gather, evaluate, and use information. Students do the following:

a. Plan strategies to guide inquiry.
b. Locate, organize, analyze, evaluate, synthesize, and ethically use information from a variety of sources and media.
c. Evaluate and select information sources and digital tools based on the appropriateness to specific tasks.
d. Process data and report results.

T4 Critical Thinking, Problem Solving, and Decision Making

Students use critical-thinking skills to plan and conduct research, manage projects, solve problems, and make informed decisions using appropriate digital tools and resources. Students do the following:

a. Identify and define authentic problems and significant questions for investigation.

b. Plan and manage activities to develop a solution or complete a project.
c. Collect and analyze data to identify solutions and/or make informed decisions.
d. Use multiple processes and diverse perspectives to explore alternative solutions.

T5 Digital Citizenship

Students understand human, cultural, and societal issues related to technology and practice legal and ethical behavior. Students do the following:

a. Advocate and practice safe, legal, and responsible use of information and technology.
b. Exhibit a positive attitude toward using technology that supports collaboration, learning, and productivity.
c. Demonstrate personal responsibility for lifelong learning.
d. Exhibit leadership for digital citizenship.

T6 Technology Operations and Concepts

Students demonstrate a sound understanding of technology concepts, systems, and operations. Students do the following:

a. Understand and use technology systems.
b. Select and use applications effectively and productively.
c. Troubleshoot systems and applications.
d. Transfer current knowledge to learning of new technologies.