



Idaho  
Professional-Technical  
Education

PTE #136

# PRECISION MACHINING TECHNOLOGY CURRICULUM

Idaho Division of Professional Technical  
Education  
650 West State Street  
Boise, ID 83720

2008

## TASK PROFILE

CURRICULUM FRAMEWORK

PROGRAM AREA: Skilled & Technical Sciences

IDAHO DIVISION OF PROFESSIONAL TECHNICAL EDUCATION REVISION DATE: June 2008

PROGRAM TITLE: Precision Machining Technology

IDAHO CODE NUMBER: 6232

CIP#: 48.0503

**MAJOR CONCEPTS/CONTENT:** The purpose of this program is to prepare students for employment as machinists (600.280-022), filers (705.484-010), grinders (603.280-018), buffers (603.382-010), lay out workers (600.281-018), cut off saw operators (607.682-010), drill press operators (606.682-014), lathe operators (604.280-010), mill operators (605.685-030), C.N.C. machine operators (609.662-010), or to provide supplemental training for persons previously or currently employed in these occupations.

The content includes, but is not limited to, communication skills, leadership skills, human relations and employability skills, safe and efficient work practices, shop math and blueprints, shaping metal parts to required size, bench work, precision measurement, layout, and inspection.

**LABORATORY ACTIVITIES:** Machine shop laboratory activities are an integral part of this program and include the set-up and operation of grinders, buffers, cut off saws, drill presses, lathes, milling machines, and machines with computerized numerical controls.

**SPECIAL NOTE:** SkillsUSA is an appropriate vocational student organization for providing communications, leadership, human relations, and employability training experiences and for reinforcing specific vocational skills. When provided, these activities are considered an integral part of this program.

The cooperative method of instruction may be utilized for this program. Whenever the cooperative method is offered, the following is required for each student: a training plan, signed by the student, teacher, and employer which includes instructional objectives and a list of on-the-job and in-school learning experiences; a work station which reflects equipment, skills and tasks relevant to the occupation the student has chosen as a career goal. The student must receive compensation for work performed.

The typical length of the postsecondary program for the average achieving student is 1800 contact hours (2160 clock hours). The recommended length for secondary programs is 900 hours with multi period-blocks of instruction provided to accomplish a major portion of the listed competencies.

## Precision Machining Technology

### COURSE DESCRIPTION:

Precision Machining is a program designed to prepare students with skills to shape metal parts on machines such as lathes, grinders, drill presses, milling machines, and shapers. Programs may also train individuals in the use of one machine tool. Includes instruction in making computations related to work dimensions, CNC and EDM machines, testing feeds and speeds of machines using precision measuring instruments such as layout tools, micrometers, and gauges; machining and heat-treating various metals; and in laying out machine parts. The course also includes training in applied communications, and employability skills including leadership, human relations, and safe efficient work practices. The teacher must be certified as a Professional-Technical E&IS instructor. This involves taking Professional Technical Education Teacher Education coursework in addition to holding the industry certifications. Instructor certification code #6232 or 5022.

### INTENDED OUTCOMES:

After successfully completing this program the student will be able to:

- Demonstrate employability skills and habits.
- Perform prerequisite machining skills.
- Demonstrate proficiency in performing bench work skills.
- Demonstrate proficiency in setting up and operating power saws.
- Demonstrate proficiency in setting up and operating pedestal grinders.
- Demonstrate proficiency in setting up and operating drill presses.
- Demonstrate proficiency in setting up and operating lathes.
- Demonstrate proficiency in setting up and operating milling machines.
- Demonstrate proficiency in setting up and operating surface grinding machines.
- Demonstrate proficiency in applying computerized numerical control operations skills.
- Describe and identify EDM machine functions and operations.

**PRECISION MACHINING  
LEVEL I**

**A course designed to introduce students to basic precision machining and automated manufacturing**

**TASK LISTING**

**STUDENT PERFORMANCE STANDARDS**

**EFFECTIVE DATE: June 2008**

**PROGRAM AREA: Skilled & Technical Sciences**

**PROGRAM TITLE: Precision Machining Technology**

**DEMONSTRATE EMPLOYABILITY SKILLS - The student will be able to:**

**Level I**

- Identify employment opportunities
- Apply employment-seeking skills
- Interpret employment capabilities
- Demonstrate appropriate work behavior
- Maintain a business-like image
- Maintain working relationships with others
- Communicate on the job
- Adapt to change
- Demonstrate knowledge of business operation

**PERFORM PREREQUISITE MACHINING SKILLS - The student will be able to:**

**Level I**

- Demonstrate proficiency in maintaining immediate work area
- Perform mathematical calculations
- Demonstrate proficiency in blueprint reading and machine planning
- Perform measuring operations
- Perform maintenance on machines and tools

**DEMONSTRATE PROFICIENCY IN PERFORMING BENCH WORK SKILLS**

**The student will be able to:**

**Level I**

- Cut materials by using hand hacksaws
- Cut threads by using hand taps and dies
- Ream holes by using hand reamers
- Hand-sharpen cutting tools by using abrasive stones
- Remove damaged screws and other hardware
- Set up and use arbor press broaches
- Deburr work pieces
- Identify and use proper hand finishing tools

**DEMONSTRATE PROFICIENCY IN SETTING UP AND OPERATING POWER SAWS**

The student will be able to:

**Level I**

- Comply with safe and efficient work practices
- Remove and replace saw blades
- Select appropriate blades to perform given sawing operations
- Select and set speeds and feeds for given sawing operations
- Measure and cut off materials using power saws
- Cut and weld band saw blades to insert for contour sawing
- Set up and operate saws for angular cutting

**DEMONSTRATE PROFICIENCY IN SETTING UP AND OPERATING PEDESTAL GRINDERS - The student will be able to:**

**Level I**

- Comply with safe and efficient work practices
- Identify parts of the pedestal grinder
- Mount grinding wheels
- Set up support/tool rests
- Dress grinding wheel
- Grind lathe tools to required angles

**DEMONSTRATE PROFICIENCY IN SETTING UP AND OPERATING DRILL PRESSES - The student will be able to:**

**Level I**

- Comply with safe and efficient work practices
- Identify the parts of the drill press
- Lubricate the drill press
- Sharpen drills
- Center drill, drill and ream a hole in a work piece.
- Center-bore, spot-bore and countersink hole in work piece.
- Hand tap a hole in work piece.
- Power tap a hole in work piece.

# **CURRICULUM STANDARDS FOR PRECISION MACHINING**

## **MODULE 1**

### **EMPLOYABILITY SKILLS**

## MODULE 1 - EMPLOYABILITY SKILLS

This is one of a series of modules which comprise the Idaho Curriculum Guide for Precision Machining. Each module contains a listing of the tasks, performance objectives, and enabling objectives required to enable a student to achieve competency in a specific system or field of study within the basic machining technician occupational field. The numbering of these modules is not intended to dictate an order of instruction or scheduling. The order in which these modules may be taught is determined by each institution and its instructors.

Each task describes an occupational activity which will result in a finished process or product. The tasks listed in each module represent the basic activities required of each student to demonstrate entry level competence for that specific system or field of study within the machining occupation. Individual records of student performance in completing the tasks listed within each module should be maintained.

Although some provision is made for basic mathematics and communication skills within these standards, they may not be adequate to meet the needs of individual students. Counseling, guidance, and diagnostic test results may indicate a need for further preparation in these areas. In such cases, instructors are encouraged to utilize the resources and personnel within the institution to improve or complement the instructional process.

The benefits to students and institutions derived from these curriculum standards should be considerable. Articulation of students from secondary to post-secondary programs will be aided through the use of a single set of curriculum standards. The curriculum standards provide a tool for evaluation of local curricula and programs. The curriculum standards may be used in a flexible manner to assure that Precision Machining programs meet the needs of local business and industry.

It is the goal of this program curriculum guide to provide a level of instruction which will impart entry level employment skills. Students should be carefully counseled on the importance of attaining competency in the tasks assigned. As in virtually all occupations today, machining technicians will require periodic up-dating and review in the future. It is important that each student understand that meeting the program curriculum standards is essential not only to obtain employment today but also to have a base upon which to retain employment in the future.

## MODULE 1 - EMPLOYABILITY SKILLS

**TASK: Identify Employment Opportunities**

Level I

**PERFORMANCE OBJECTIVE:** Given the information resources of a library, obtain and compile the information needed to seek a job.

**ENABLING OBJECTIVES:**

- Identify the requirements for a job.
- Investigate educational opportunities.
- Investigate occupational opportunities.
- Locate resources for finding employment.
- Confer with prospective employers.
- Identify job trends.

**TASK: Apply Employment-Seeking Skills**

Level I

**PERFORMANCE OBJECTIVE:** Given appropriate information, locate a job opportunity, prepare and take an interview for it, complete the required tests, forms and applications, and evaluate a response to the job opportunity.

**ENABLING OBJECTIVES:**

- Locate a job opening.
- Complete a resume.
- Prepare for an interview.
- Participate in an interview.
- Complete tests required.
- Complete forms required.
- Complete an application letter.
- Complete a follow-up letter.
- Complete an acceptance letter.
- Evaluate a job offer.
- Evaluate a job rejection.

**TASK: INTERPRET EMPLOYMENT CAPABILITIES**

Level I

**PERFORMANCE OBJECTIVE:** Given the assignment to explain how your capabilities make you employable, demonstrate how to match skills and experience to a job being sought.

**ENABLING OBJECTIVES:**

- Match an interest to job area.
- Match aptitudes to job area.
- Verify abilities.
- Identify immediate work goal.
- Develop a career plan.

**TASK: DEMONSTRATE APPROPRIATE WORK BEHAVIOR**

**Level I**

**PERFORMANCE OBJECTIVE:** Given the responsibility of an employee in a new job, demonstrate knowledge of appropriate behavior in the work place.

**ENABLING OBJECTIVES:**

- Exhibit dependability.
- Demonstrate punctuality.
- Follow rules and regulations.
- Explain the consequences of dishonesty.
- Complete assignments accurately and on time.
- Control emotions.
- Take responsibility for decisions and actions
- Take pride in work and be a loyal worker.
- Learn to handle pressures and tensions.
- Demonstrate ability to set priorities.
- Demonstrate problem-solving skills.

**TASK: MAINTAIN A BUSINESS-LIKE IMAGE**

**Level I**

**PERFORMANCE OBJECTIVE:** Given a responsibility to perform the duties of a new job, with a new employer, demonstrate a knowledge of the actions and behaviors which will project a business-like image

**ENABLING OBJECTIVES:**

- Participate in the institution's orientation.
- Demonstrate knowledge of company or agency products and services.
- Identify the requirements for a job.
- Investigate educational opportunities.
- Investigate occupational opportunities.
- Locate resources for finding employment.
- Confer with prospective employers.
- Identify job trends.

**TASK: MAINTAIN WORKING RELATIONSHIPS WITH OTHERS**

**Level I**

**PERFORMANCE OBJECTIVE:** Given the responsibility to perform the duties of a new job, with a new employer, demonstrate knowledge of how to successfully work with others.

**ENABLING OBJECTIVES:**

- Work productively with others.
- Show empathy, respect, and support for others.
- Demonstrate procedures and assist others when necessary.
- Recognize problems and work toward their solution.
- Minimize the occurrence of problems.
- Channel emotional reactions in positive ways.

**TASK: COMMUNICATE ON THE JOB**

**Level I**

**PERFORMANCE OBJECTIVE:** Given the responsibility to perform the duties of a new job, with a new employer, demonstrate knowledge of how to communicate on the job.

**ENABLING OBJECTIVES:**

- Read and comprehend written communications.
- Use correct grammar.
- Speak clearly when addressing others.
- Use job-related terminology.
- Listen attentively.
- Write legibly.
- Use telephone etiquette.
- Follow written and oral directions.
- Ask questions.
- Locate information needed to complete the task.
- Prepare written communication.
- Demonstrate keyboarding skills.
- Demonstrate computer skill.

**TASK: ADAPT TO CHANGE**

**Level I**

**PERFORMANCE OBJECTIVE:** Given the responsibility to perform the duties of a new job, with a new employer, demonstrate knowledge of how to adapt to change.

**ENABLING OBJECTIVES:**

- Recognize the need to change.
- Demonstrate a willingness to learn.
- Demonstrate flexibility.
- Participate in continuing education.
- Seek challenge in the work place.
- Adjust goals and plans when necessary.

**CURRICULUM STANDARDS FOR PRECISION MACHINING**

**MODULE 2**

**PREREQUISITE MACHINING**

## MODULE 2 - PREREQUISITE MACHINING

This is one of a series of modules which comprise the Idaho Curriculum Guide for Precision Machining. Each module contains a listing of the tasks, performance objectives, and enabling objectives required to enable a student to achieve competency in a specific system or field of study within the basic machining technician occupational field. The numbering of these modules is not intended to dictate an order of instruction or scheduling. The order in which these modules may be taught is determined by each institution and its instructors.

Each task describes an occupational activity which will result in a finished process or product. The tasks listed in each module represent the basic activities required of each student to demonstrate entry level competence for that specific system or field of study within the machining occupation. Individual records of student performance in completing the tasks listed within each module should be maintained.

Although some provision is made for basic mathematics and communication skills within these standards, they may not be adequate to meet the needs of individual students. Counseling, guidance, and diagnostic test results may indicate a need for further preparation in these areas. In such cases, instructors are encouraged to utilize the resources and personnel within the institution to improve or complement the instructional process.

The benefits to students and institutions derived from these curriculum standards should be considerable. Articulation of students from secondary to post-secondary programs will be aided through the use of a single set of curriculum standards. The curriculum standards provide a tool for evaluation of local curricula and programs. The curriculum standards may be used in a flexible manner to assure that Precision Machining programs meet the needs of local business and industry.

It is the goal of this program curriculum guide to provide a level of instruction which will impart entry level employment skills. Students should be carefully counseled on the importance of attaining competency in the tasks assigned. As in virtually all occupations today, machining technicians will require periodic up-dating and review in the future. It is important that each student understand that meeting the program curriculum standards is essential not only to obtain employment today but also to have a base upon which to retain employment in the future.

## MODULE 2 - PREREQUISITE MACHINING SKILLS

**TASK: Demonstrate Proficiency in Maintaining Immediate Work Area**

Level I

**PERFORMANCE OBJECTIVE:** Given appropriate materials and supplies the student will be able to demonstrate proficiency to maintain work areas in a machine shop.

**ENABLING OBJECTIVES:**

Demonstrate the knowledge of shop safety rules and practices.

Describe procedures for the proper disposal of scrap metal chips, shavings, oil, and coolant.

List shop operating rules and practices.

Demonstrate procedures to clean and maintain work areas affected by operations of work and shop areas.

Demonstrate knowledge of maintaining a clean and orderly shop.

Demonstrate knowledge of leaving work and shop area in a safe condition.

**TASK: Perform Mathematical Calculation's**

Level I

**PERFORMANCE OBJECTIVE:** Given the appropriate tools, equipment and resource material, the student will demonstrate the ability to perform accurate mathematical calculations relating to machine set up, material, and machine shop environment.

**ENABLING OBJECTIVES:**

Accurately perform job related decimal and fraction calculations.

Demonstrate proficiency solving job-related problems using basic formulas.

Demonstrate proficiency solving job-related problems using basic geometry.

Demonstrate proficiency measuring a work piece and compare measurements with blueprint specifications.

Demonstrate proficiency calculating the amount of material that should be removed to obtain correct limits for secondary operations.

Demonstrate proficiency in solving job-related problems using mathematical handbooks, charts, and tables.

Demonstrate proficiency in converting measurements from English to metric and from metric to English units.

Demonstrate proficiency in determining the clearance, relief, and rake of cutting tools.

Demonstrate proficiency in calculating machine speeds and feeds using appropriate formulas.

**TASK: Demonstrate Proficiency in Blueprint Reading and Machine Planning**

**Level I**

**PERFORMANCE OBJECTIVE:** Given the appropriate tools, materials, and prints, the student will demonstrate proficiency in reading blueprints to layout and prepare stock for machining operations.

**ENABLING OBJECTIVES:**

- Interpret view concepts.
- Read lines.
- Read and interpret title blocks.
- Read and interpret change orders on working and assembly prints.
- Read and interpret abbreviations.
- Make shop sketches.
- Read and interpret blueprints, including geometric tolerancing.
- Determine and interpret reference information used in performing machine work.
- Perform layout for precision machine work by using layout instruments.
- Lay out radial and bolt hole circles.
- Select the most productive tool and tooling for a given operation.

**TASK: Perform Measuring Operations**

**Level I**

**PERFORMANCE OBJECTIVE:** Given the appropriate tools and operation pieces, the student will accurately measure work pieces using the proper measuring instruments.

**ENABLING OBJECTIVES:**

- Read and measure with rules and calipers.
- Read and measure with micrometers.
- Read and measure with vernier tools.
- Read and measure with dial indicators.
- Measure using as surface plate.
- Read and interpret surface finish (ANSI Y14)

**TASK: Perform Maintenance on Machines and Tools**

**Level I**

**PERFORMANCE OBJECTIVE:** Given the appropriate tools, equipment, and supplies, the student will be able to perform maintenance functions on machining equipment and tools to restore the equipment to full operating condition.

**ENABLING OBJECTIVES:**

- Inspect work areas to assure a safe working environment.
- Lubricate equipment parts.
- Clean and store hand tools, cutters, fixtures, jigs, and attachments.
- Inspect and repair hand tools.
- Inspect drive pulleys or belts.
- Select lubricants for machining operations.
- Inspect equipment for safe operational conditions.
- Store grinding wheels and precision tools

# **CURRICULUM STANDARDS FOR PRECISION MACHINING**

## **MODULE 3**

### **BENCH WORK**

## MODULE 3 - BENCH WORK

This is one of a series of modules which comprise the Idaho Curriculum Guide for Precision Machining. Each module contains a listing of the tasks, performance objectives, and enabling objectives required to enable a student to achieve competency in a specific system or field of study within the basic machining technician occupational field. The numbering of these modules is not intended to dictate an order of instruction or scheduling. The order in which these modules may be taught is determined by each institution and its instructors.

Each task describes an occupational activity which will result in a finished process or product. The tasks listed in each module represent the basic activities required of each student to demonstrate entry level competence for that specific system or field of study within the machining occupation. Individual records of student performance in completing the tasks listed within each module should be maintained.

Although some provision is made for basic mathematics and communication skills within these standards, they may not be adequate to meet the needs of individual students. Counseling, guidance, and diagnostic test results may indicate a need for further preparation in these areas. In such cases, instructors are encouraged to utilize the resources and personnel within the institution to improve or complement the instructional process.

The benefits to students and institutions derived from these curriculum standards should be considerable. Articulation of students from secondary to post-secondary programs will be aided through the use of a single set of curriculum standards. The curriculum standards provide a tool for evaluation of local curricula and programs. The curriculum standards may be used in a flexible manner to assure that Precision Machining programs meet the needs of local business and industry.

It is the goal of this program curriculum guide to provide a level of instruction which will impart entry level employment skills. Students should be carefully counseled on the importance of attaining competency in the tasks assigned. As in virtually all occupations today, machining technicians will require periodic up-dating and review in the future. It is important that each student understand that meeting the program curriculum standards is essential not only to obtain employment today but also to have a base upon which to retain employment in the future.

## MODULE 3 - PERFORM BENCH WORK SKILLS

**TASK:** Cut materials by using hand hacksaws

Level I

**PERFORMANCE OBJECTIVE:** Given a dimensioned blueprint of a work piece, raw material, and a hand hacksaw, the student will be able to:

**ENABLING OBJECTIVES:**

Explain the safety precautions/procedures for use of a hand hacksaw.

Determine teeth per inch on various hacksaw blades.

Describe the applications for saw blades with different ratios of tooth pitch.

Demonstrate the correct method of sawing materials with a hand hacksaw.

**TASK:** Cut threads by using hand taps and dies

Level I

**PERFORMANCE OBJECTIVE:** Given a dimensioned blueprint, work piece, tap, die, tap wrench, die stock, cutting fluids and measuring instruments, cut internal and external threads to a class #2 fit.

**ENABLING OBJECTIVES:**

Explain safety precautions/procedures for threading with taps and dies.

Identify and explain the use of the three taps used for threading a blind hole.

Select cutting fluids.

Describe the procedure for cutting internal and external threads with a tap or die.

Explain the correct procedure to align a tap with the hole.

**TASK:** Ream holes by using hand reamers

Level I

**PERFORMANCE OBJECTIVE:** Given a hand reamer, ream a series of previously drilled holes to a tolerance of  $\pm .001$ .

**ENABLING OBJECTIVES:**

Demonstrate the proper method of hand reaming holes using both adjustable and non-adjustable reamers.

Explain the types of lubricants and their applications to reaming.

Explain the correct drill sizes as they relate to the various sizes of reamers.

**TASK:** Hand sharpen cutting tools by using abrasive stones

Level I

**PERFORMANCE OBJECTIVE:** Given a bench stone and a variety of cutting tools, hone the cutting edges to remove burrs and smooth the surfaces.

**ENABLING OBJECTIVES:**

Determine and demonstrate how to correctly hold various cutting tools to the angles characteristic to that tool.

Explain why bench stones require lubricants.

**TASK: Remove damaged screws and other hardware**

**Level I**

**PERFORMANCE OBJECTIVE: Given a set of easy outs, a broken bolt in a piece of material, tap extractor and broken tap, remove these broken items from a variety of materials with a minimum of damage to the work piece.**

**ENABLING OBJECTIVES:**

**Explain the safety precautions/procedures for using easy outs and tap extractors.**

**Explain the purpose of easy outs and tap extractors.**

**Determine the correct drill sizes used with various easy outs.**

**Determine the correct tap extractor for various taps.**

**Describe the procedures for using easy outs and tap extractors.**

**Remove damaged screws.**

**TASK: Set up and use arbor press broaches**

**Level I**

**PERFORMANCE OBJECTIVE: Given an arbor press, broaches and lubricant, cut internal spline and keyways to a tolerance of  $\pm.002$ .**

**ENABLING OBJECTIVES:**

**Explain why broaches have to be shimmed.**

**Explain why lubricant is required.**

**Cut splines and keyways utilizing broaches, bushings, shims and arbor presses.**

**TASK: Deburr work pieces**

**Level I**

**PERFORMANCE OBJECTIVE: Given a variety of internal and external geometries, files and scrapers, completely deburr these work pieces to required tolerances.**

**ENABLING OBJECTIVES:**

**Demonstrate how to properly hold files and three corner scrapers.**

**Demonstrate how to sharpen a three corner scraper.**

**Deburr work pieces to required tolerances.**

# **CURRICULUM STANDARDS FOR PRECISION MACHINING**

## **MODULE 4**

### **POWER SAWS**

## MODULE 4 - POWER SAWS

This is one of a series of modules which comprise the Idaho Curriculum Guide for Precision Machining. Each module contains a listing of the tasks, performance objectives, and enabling objectives required to enable a student to achieve competency in a specific system or field of study within the basic machining technician occupational field. The numbering of these modules is not intended to dictate an order of instruction or scheduling. The order in which these modules may be taught is determined by each institution and its instructors.

Each task describes an occupational activity which will result in a finished process or product. The tasks listed in each module represent the basic activities required of each student to demonstrate entry level competence for that specific system or field of study within the machining occupation. Individual records of student performance in completing the tasks listed within each module should be maintained.

Although some provision is made for basic mathematics and communication skills within these standards, they may not be adequate to meet the needs of individual students. Counseling, guidance, and diagnostic test results may indicate a need for further preparation in these areas. In such cases, instructors are encouraged to utilize the resources and personnel within the institution to improve or complement the instructional process.

The benefits to students and institutions derived from these curriculum standards should be considerable. Articulation of students from secondary to post-secondary programs will be aided through the use of a single set of curriculum standards. The curriculum standards provide a tool for evaluation of local curricula and programs. The curriculum standards may be used in a flexible manner to assure that Precision Machining programs meet the needs of local business and industry.

It is the goal of this program curriculum guide to provide a level of instruction which will impart entry level employment skills. Students should be carefully counseled on the importance of attaining competency in the tasks assigned. As in virtually all occupations today, machining technicians will require periodic up-dating and review in the future. It is important that each student understand that meeting the program curriculum standards is essential not only to obtain employment today but also to have a base upon which to retain employment in the future.

**MODULE 4 - DEMONSTRATE PROFICIENCY IN SETTING UP AND OPERATING  
POWER SAWS**

**TASK: Comply with safe and efficient work practices**

**Level I**

**PERFORMANCE OBJECTIVE: Given a band type or reciprocating type power saw, explain the specific safety precautions characteristic to each type.**

**ENABLING OBJECTIVES:**

**Explain what could be the possible injuries resulting from improper safety precautions.**

**Identify hazardous components of saws.**

**TASK: Remove and replace saw blades**

**Level I**

**PERFORMANCE OBJECTIVE: Given a band type and reciprocating type power saw, demonstrate the correct procedure for removing and replacing the two types of blades.**

**ENABLING OBJECTIVES:**

**Explain why the teeth of the blade must point in the correct direction for each type of machine.**

**Explain why the blades of reciprocating saws must be elevated a certain distance above the work piece before starting the machine.**

**Describe the procedures for replacing saw blades.**

**Replace blades in hand and reciprocating saws.**

**TASK: Select appropriate blades to perform given sawing operations**

**Level I**

**PERFORMANCE OBJECTIVE: Given specifications for the size and type of material to be cut, and specification charts on saw blades, select the correct blade for the operation performed.**

**ENABLING OBJECTIVES:**

**Explain how the width of the blade and the radius desired in contour cutting have a direct effect on each other.**

**Explain how the number of teeth per inch and the thickness of the work piece affect each other.**

**Describe a bi-metal saw blade for a reciprocating type machine.**

**TASK:** Select and set speeds and feeds for given sawing operations

Level I

**PERFORMANCE OBJECTIVE:** Given a known hardness of a variety of materials, determine the correct speeds and feeds for power sawing.

**ENABLING OBJECTIVES:**

List the correct cutting speed and feed of the following materials:

1-1/2" cold rolled steel

1" aluminum

1" tool steel

1/6" aluminum.

Explain how coolant can affect speeds and feeds.

Calculate proper cutting speeds and feeds for specific material.

**TASK:** Measure and cut off materials using power saws

Level I

**PERFORMANCE OBJECTIVE:** Given the two types of power saws available, cut material either to a layout line or cut a pre-determined amount of material from the layout line.

**ENABLING OBJECTIVES:**

Determine the proper amount of material that must be left on a work piece for machining.

Explain the safety precautions/procedures before operating power saws.

Describe the procedure to cut material to layout or scribed line.

Cut material to layout or scribed lines.

**TASK:** Cut and weld band saw blades to insert for contour sawing

Level I

**PERFORMANCE OBJECTIVE:** Given a butt welder, a variety of different width blades and a pre-drilled work piece, cut and weld these blades for inside cutting.

**ENABLING OBJECTIVES:**

Describe the procedures for measuring and cutting saw blades to length.

Explain the reasons for annealing the saw blade after the welding operation.

Describe the procedures for grinding a saw blade before installation.

Describe the procedure for selecting the proper guides.

Cut and weld a saw blade for inside cutting.

**TASK:** Set up and operate saws for angular cutting  
Level I

**PERFORMANCE OBJECTIVE:** Given the two types of power saws, determine how to safely hold a work piece for angular cutting and set up the saw for angular cutting.

**ENABLING OBJECTIVES:**

Explain the safety precautions/procedures in sawing angles.

Explain the reasons for cutting as close to the layout lines as possible.

Explain the reasons for cutting angles on a bandsaw as opposed to using other machines.

Set up a saw for angular cutting.

Perform an angular cut on a work piece.

**CURRICULUM STANDARDS FOR PRECISION MACHINING**

**MODULE 5**

**PEDESTAL GRINDERS**

## MODULE 5 - PEDESTAL GRINDERS

This is one of a series of modules which comprise the Idaho Curriculum Guide for Precision Machining. Each module contains a listing of the tasks, performance objectives, and enabling objectives required to enable a student to achieve competency in a specific system or field of study within the basic machining technician occupational field. The numbering of these modules is not intended to dictate an order of instruction or scheduling. The order in which these modules may be taught is determined by each institution and its instructors.

Each task describes an occupational activity which will result in a finished process or product. The tasks listed in each module represent the basic activities required of each student to demonstrate entry level competence for that specific system or field of study within the machining occupation. Individual records of student performance in completing the tasks listed within each module should be maintained.

Although some provision is made for basic mathematics and communication skills within these standards, they may not be adequate to meet the needs of individual students. Counseling, guidance, and diagnostic test results may indicate a need for further preparation in these areas. In such cases, instructors are encouraged to utilize the resources and personnel within the institution to improve or complement the instructional process.

The benefits to students and institutions derived from these curriculum standards should be considerable. Articulation of students from secondary to post-secondary programs will be aided through the use of a single set of curriculum standards. The curriculum standards provide a tool for evaluation of local curricula and programs. The curriculum standards may be used in a flexible manner to assure that Precision Machining programs meet the needs of local business and industry.

It is the goal of this program curriculum guide to provide a level of instruction which will impart entry level employment skills. Students should be carefully counseled on the importance of attaining competency in the tasks assigned. As in virtually all occupations today, machining technicians will require periodic up-dating and review in the future. It is important that each student understand that meeting the program curriculum standards is essential not only to obtain employment today but also to have a base upon which to retain employment in the future.

## MODULE 5 - DEMONSTRATE PROFICIENCY IN SETTING UP AND OPERATING PEDESTAL GRINDERS

**TASK:** Comply with safe and efficient work practices

Level I

**PERFORMANCE OBJECTIVE:** Given a pedestal grinder, identify the specific safety precautions characteristic to grinders.

**ENABLING OBJECTIVES:**

- Apply shop safety rules and procedures.
- Demonstrate the operation of shop safety devices.
- Demonstrate personal safety procedures.
- Demonstrate first aid/emergency treatment procedures.
- Apply fire safety rules and procedures.
- Apply rules for electrical safety.

**TASK:** Identify parts of the pedestal grinder

Level I

**PERFORMANCE OBJECTIVES:** Given a pedestal grinder, manufacturer's manual or general textbook, identify major parts and function of a grinder.

**ENABLING OBJECTIVES:**

- Identify types of pedestal grinders.
- Identify major parts.
- Explain the function of major parts.

**TASK:** Mount grinding wheels

**PERFORMANCE OBJECTIVE:** Given grinder, grinding wheels and access to necessary tools, inspect and mount wheel to meet requirements found in operator's manual and Machinery's Handbook.

**ENABLING OBJECTIVES:**

- Explain the safety precautions/procedures for mounting grinding wheels.
- Explain how to determine if a wheel is cracked before mounting.
- Explain the importance of cleanliness when mounting wheel.
- Explain the importance of the blotters on the wheel.
- Explain the reasons for the manufacturer printing the operating speed on grinding wheels.
- Explain the safety precautions in regard to the diameter of the flanges in relationship to the diameter of the wheel.
- Explain procedure to determine how tight the wheel flanges should be.
- Dress wheel and adjust wheel guard and tool rest.

**TASK:** Set up support tool rests  
Level I

**PERFORMANCE OBJECTIVES:** Given grinder, and the necessary tools, adjust the wheel guard and tool rest to within 1/16 inch of grinding wheel face.

**ENABLING OBJECTIVES:**

Explain the relevant safety precaution/procedures required for adjusting wheel guard and tool rest.

Explain the purpose of the wheel guard and tool rest.

Describe the procedures for adjusting the wheel guard and tool rest.

Set up a tool rest and adjust wheel guard.

**TASK:** Dress grinding wheel  
Level I

**PERFORMANCE OBJECTIVE:** Given grinder, wheel dresser and the necessary tools, true and dress grinding wheel in accordance with the procedures in the Machinery's Handbook. The wheel must run true and the grinding surface must not be loaded nor glazed.

**ENABLING OBJECTIVES:**

Explain the relevant safety precautions/procedures for dressing and truing a grinding wheel.

Identify the different types of wheel dressers.

Determine the type dresser to be used on different grinding wheels.

Explain the correct procedure to true and dress the grinding wheel.

Properly dress a grinding wheel.

**TASK:** Grind lathe tools to required angles  
Level I

**PERFORMANCE OBJECTIVE:** Given a tool blank, blueprint and measuring instruments, shape and sharpen cutting tool to a tolerance of  $\pm 1$  degree on clearance angles.

**ENABLING OBJECTIVES:**

Explain the relevant safety precautions/ procedures.

Describe the procedure for grinding cutting tool.

Describe the procedure for checking cutting tool clearances.

Explain positive and negative rake angles and their uses for machining different types of materials.

Properly sharpen three different cutting tools.

**CURRICULUM STANDARDS FOR PRECISION MACHINING**

**MODULE 6**

**DRILL PRESSES**

## MODULE 6 - DRILL PRESSES

This is one of a series of modules which comprise the Idaho Curriculum Guide, Standards for Precision Machining. Each module contains a listing of the tasks, performance objectives, and enabling objectives required to enable a student to achieve competency in a specific system or field of study within the basic machining technician occupational field. The numbering of these modules is not intended to dictate an order of instruction or scheduling. The order in which these modules may be taught is determined by each institution and its instructors.

Each task describes an occupational activity which will result in a finished process or product. The tasks listed in each module represent the basic activities required of each student to demonstrate entry level competence for that specific system or field of study within the machining occupation. Individual records of student performance in completing the tasks listed within each module should be maintained.

Although some provision is made for basic mathematics and communication skills within these standards, they may not be adequate to meet the needs of individual students. Counseling, guidance, and diagnostic test results may indicate a need for further preparation in these areas. In such cases, instructors are encouraged to utilize the resources and personnel within the institution to improve or complement the instructional process.

The benefits to students and institutions derived from these curriculum standards should be considerable. Articulation of students from secondary to post-secondary programs will be aided through the use of a single set of curriculum standards. The curriculum standards provide a tool for evaluation of local curricula and programs. The curriculum standards may be used in a flexible manner to assure that Precision Machining programs meet the needs of local business and industry.

It is the goal of this program curriculum guide to provide a level of instruction which will impart entry level employment skills. Students should be carefully counseled on the importance of attaining competency in the tasks assigned. As in virtually all occupations today, machining technicians will require periodic up-dating and review in the future. It is important that each student understand that meeting the program curriculum standards is essential not only to obtain employment today but also to have a base upon which to retain employment in the future.

## **MODULE 6 - DEMONSTRATE PROFICIENCY IN SETTING UP AND OPERATING DRILL PRESSES**

**TASK:** Comply with safe and efficient work practices

**Level I**

**PERFORMANCE OBJECTIVE:** Given a drill press, identify the specific safety precautions characteristic to grinders.

**ENABLING OBJECTIVES:**

- Apply shop safety rules and procedures.
- Demonstrate the operation of shop safety devices.
- Demonstrate personal safety procedures.
- Demonstrate first aid/emergency treatment procedures.
- Apply fire safety rules and procedures.
- Apply rules for electrical safety.

**TASK:** Identify the parts of the drill press and explain the uses

**Level I**

**PERFORMANCE OBJECTIVE:** Given parts breakdown sheet, identify the parts of the drill press.

**ENABLING OBJECTIVES:**

- Explain the major parts of the drill press.
- Explain the procedure for adjusting the table height.
- Explain the different types of drill presses.
- Explain the RPM settings and feed settings.
- Explain the need to figure RPM and feed for various size drills and materials.
- Explain safety precautions for operation of drill press.
- Explain the use of the drill chuck and Morse tapered spindle.

**TASK:** Lubricate the drill press

**Level I**

**PERFORMANCE OBJECTIVE:** Given service manual or lubrication chart and access of cleaning fluid, lubricants and lubrication tools, clean, inspect and lubricate drill press in accordance with service manual or lubrication chart. All lubrication points must be supplied with the correct type and amount of lubricant.

**ENABLING OBJECTIVES:**

- Explain the safety precautions/procedures for cleaning, inspecting, and lubricating a drill press.
- Explain the reasons for performing routine cleaning, inspection and lubrication of a drill press.
- Identify the lubricants used in a drill press.
- Locate the lubrication points on the drill press.
- Describe the inspection procedures for a drill press.
- Identify the materials and describe the procedure used for cleaning a drill press.
- Perform lubrication service on a drill press.

**TASK: Hand and machine sharpen drills**

**Level I**

**PERFORMANCE OBJECTIVE:** Given drills, drill gauge, pedestal grinder, and precision measuring instruments, hand sharpen drills. Sharpen drills on pedestal grinder holding a tolerance of  $\pm 1$  degree. Each flute lip must correspond to the other flute lip in length to within  $\pm .005$  inch.

**ENABLING OBJECTIVES:**

Explain the safety precautions/procedures for sharpening twist drills and sing off hand procedures.

Describe the amount of lip clearance a drill must have to perform correctly.

Explain why a drill bit must have the same angle on both flutes and why both flutes must be the same length.

Discuss why different drill point angles are ground for different materials.

Define the following drill terms: (a) chisel edge (b) lip (c) flute (d) margin (e) land

(f) body (g) shank (h) web.

Describe the procedures for hand sharpening a drill bit.

Describe the procedures for correcting a thick web on a drill bit.

Properly sharpen three drill bits using a pedestal grinder.

**TASK: Center drill, drill and ream hole in work piece**

**Level I**

**PERFORMANCE OBJECTIVE:** Given a blueprint, work piece, work holding device, combination square, combination drill and countersink, drills, reamers, cutting fluid and precision measuring instruments and centerdrill, drill and ream a hole in the work piece holding a tolerance of  $+.002$  inch,  $-.000$  for diameter,  $\pm 1/64$  inch for location.

**ENABLING OBJECTIVES:**

Explain the safety precautions/procedures for setting up and operating a drill press.

Describe the procedures for setting up a drill press.

Describe the uses of cutting fluids for drill press.

Calculate cutting speeds for centerdrilling, drilling and reaming operations (S.F.P.M.).

Calculate RPM for centerdrills, drills, reamers, etc.

Describe the procedures for center drilling and drilling holes.

Describe the procedures for reaming holes.

Identify the correct cutting fluids for drilling and reaming.

Centerdrill a hole in a work piece to required tolerance.

Drill and ream hole in a work piece to required tolerance.

**TASK:** Centerbore, spotface and countersink hole in work piece

**Level I**

**PERFORMANCE OBJECTIVE:** Given a blueprint, work piece, work holding device, counterbore spotface and countersink tools, cutting fluid, and precision measuring instruments, counterbore, countersink, and spotface a hole in work piece holding a tolerance of  $\pm .010$  inch.

**ENABLING OBJECTIVES:**

Explain the safety precautions/procedures for counterboring, countersinking and spotfacing operations.

Explain the purpose of counterboring, countersink and spotfacing a hole.

Define the difference between a counterbored, countersunk, and spotfaced hole.

Describe the procedures for counterboring, countersinking and spotfacing holes.

Identify the correct burring fluids for counterboring, countersinking and spotfacing.

Centerdrill a hole in a work piece to required tolerance.

Spotface a hole in a work piece to required tolerance.

Countersink a hole in a work piece to required tolerance.

**TASK:** Hand tap a hole in work piece

**Level I**

**PERFORMANCE OBJECTIVE:** Given a blueprint, work piece, work holding device, center taps, tap wrench, cutting fluids, and precision measuring instruments, hand tap a hole in the work piece holding a tolerance of  $\pm 1/2$  degree for perpendicularity and  $\pm 1/64$  inch for location.

**ENABLING OBJECTIVES:**

Explain the safety precautions/procedures for hand tapping.

Describe the uses of threads.

List the taps in an American National/Unified 60 degree tap set and state the purpose of each tap.

Explain why a tapped hole must be countersunk.

Identify the uses of cutting fluids for tapping.

Describe the procedures for hand tapping a hole with a drill press to assure perpendicularity.

Hand tap a hole in a work piece to required tolerance.

**TASK:** Power tap hole in work piece

**Level I**

**PERFORMANCE OBJECTIVE:** Given a blueprint, work piece, work holding device, tapping head, taps, cutting fluid, and precision measuring instruments, power tap holes in work piece holding a tolerance of  $\pm 1/2$  degree for perpendicularity and  $\pm 1/64$  inch for location.

**ENABLING OBJECTIVES:**

Explain the safety precautions/procedures for power tapping.

Distinguish between power and hand taps.

Calculate the R.P.M. for machine tapping in a drill press for the following:

1/4-20NC-2B, 1/2-13NC-2B, 5/8-11-NC-2B.

Describe the procedures for machine tapping holes.

Identify the correct cutting fluids for power tapping.

Power tap a hole in a work piece to required tolerance.

**PRECISION MACHINING  
LEVEL II**

**Prerequisite: Level I**

**A course designed to provide students with precision machining and automated manufacturing applications.**

## TASK LISTING

STUDENT PERFORMANCE STANDARDS

EFFECTIVE DATE: June 2008

PROGRAM AREA: Trade & Industrial Education

PROGRAM TITLE: Precision Machining Technology

**DEMONSTRATE EMPLOYABILITY SKILLS - The student will be able to:**

Level II

- Identify employment opportunities
- Apply employment-seeking skills
- Interpret employment capabilities
- Demonstrate appropriate work behavior
- Maintain a business-like image
- Maintain working relationships with others
- Communicate on the job
- Adapt to change
- Demonstrate a knowledge of business operation

**PERFORM PREREQUISITE MACHINING SKILLS - The student will be able to:**

Level II

- Demonstrate proficiency in maintaining immediate work area
- Perform mathematical calculations
- Demonstrate proficiency in blueprint reading and machine planning
- Perform measuring operations
- Perform maintenance on machines and tools

**DEMONSTRATE PROFICIENCY IN PERFORMING BENCH WORK SKILLS**

The student will be able to:

Level II

- Cut materials by using hand hacksaws
- Cut threads by using hand taps and dies
- Ream holes by using hand reamers
- Hand-sharpen cutting tools by using abrasive stones
- Remove damaged screws and other hardware
- Set up and use arbor press broaches
- Deburr work pieces
- Identify and use proper hand finishing tools

**DEMONSTRATE PROFICIENCY IN SETTING UP AND OPERATING POWER SAWS**

The student will be able to:

**Level II**

- Comply with safe and efficient work practices
- Remove and replace saw blades
- Select appropriate blades to perform given sawing operations
- Select and set speeds and feeds for given sawing operations
- Measure and cut off materials using power saws
- Cut and weld band saw blades to insert for contour sawing
- Set up and operate saws for angular cutting

**DEMONSTRATE PROFICIENCY IN SETTING UP AND OPERATING PEDESTAL GRINDERS - The student will be able to:**

**Level II**

- Comply with safe and efficient work practices
- Identify parts of the pedestal grinder
- Mount grinding wheels
- Set up support/tool rests
- Dress grinding wheel
- Grind lathe tools to required angles

**DEMONSTRATE PROFICIENCY IN SETTING UP AND OPERATING DRILL PRESSES - The student will be able to:**

**Level II**

- Comply with safe and efficient work practices
- Identify the parts of the drill press
- Lubricate the drill press
- Sharpen drills
- Center drill, drill and ream a hole in a work piece.
- Center-bore, spot-bore and countersink hole in work piece.
- Hand tap a hole in work piece.
- Power tap a hole in work piece.

**DEMONSTRATE PROFICIENCY IN SETTING UP AND OPERATING LATHES -**

The student will be able to:

**Level II**

- Identify the parts of the lathe
- Comply with safe and efficient work practices
- Measure stock
- Set up an engine lathe
- Secure tools, tool-holders and fixtures or attachments
- Select and set feeds and speeds
- Set up lathes and face work pieces held in chucks
- Rough-cut and finish-cut with lathes
- Deburr parts using filing procedures

Align lathe centers using accurate methods  
Drill holes with lathes  
Countersink holes with lathes  
Ream holes with lathes  
Tap threads with lathes  
Die-cut threads with lathes  
Counter bore holes with lathes  
Bore holes with lathes  
Knurl parts with lathes  
Cut external threads with lathes  
Re-chase threads with lathes  
Cut internal threads with lathes  
Set up and perform taper turning with taper attachments  
Set up and perform taper turning with compound  
Cut internal tapered surfaces  
Set up and operate tool post grinders  
Perform contour, angular or radial cuts with lathes  
Set up and use follow and steady-rests  
Set up face plates and dogs

**DEMONSTRATE PROFICIENCY IN SETTING UP AND OPERATING MILLING MACHINES - The student will be able to:**

**Level II**

Identify the parts of the horizontal and vertical milling machine  
Lubricate milling machines.  
True up the head and align milling machines fixtures  
Select and set feeds and speeds for milling work  
Square up work pieces with a table vise  
Perform end milling  
Perform fly-cutting operations  
Drill holes with a milling machine  
Perform reaming operations  
Cut external keyways  
Bore holes with milling machines  
Perform form milling  
Perform indexing operations using a dividing head  
Set up and operate rotary tables  
Mill cylindrical work  
Mill an external radius  
Mill an angle  
Align milling machine attachments  
Mill internal slots with a slotter and attachment  
Perform cutting-off operations  
Set up and perform slab mill operations  
Use an edge finder and wiggler  
Use digital readouts  
Set up and use a sine vise

# **CURRICULUM STANDARDS FOR PRECISION MACHINING**

## **MODULE 1**

### **EMPLOYABILITY SKILLS**

## MODULE 1 - EMPLOYABILITY SKILLS

This is one of a series of modules which comprise the Idaho Curriculum Guide for Precision Machining. Each module contains a listing of the tasks, performance objectives, and enabling objectives required to enable a student to achieve competency in a specific system or field of study within the basic machining technician occupational field. The numbering of these modules is not intended to dictate an order of instruction or scheduling. The order in which these modules may be taught is determined by each institution and its instructors.

Each task describes an occupational activity which will result in a finished process or product. The tasks listed in each module represent the basic activities required of each student to demonstrate entry level competence for that specific system or field of study within the machining occupation. Individual records of student performance in completing the tasks listed within each module should be maintained.

Although some provision is made for basic mathematics and communication skills within these standards, they may not be adequate to meet the needs of individual students. Counseling, guidance, and diagnostic test results may indicate a need for further preparation in these areas. In such cases, instructors are encouraged to utilize the resources and personnel within the institution to improve or complement the instructional process.

The benefits to students and institutions derived from these curriculum standards should be considerable. Articulation of students from secondary to post-secondary programs will be aided through the use of a single set of curriculum standards. The curriculum standards provide a tool for evaluation of local curricula and programs. The curriculum standards may be used in a flexible manner to assure that Precision Machining programs meet the needs of local business and industry.

It is the goal of this program curriculum guide to provide a level of instruction which will impart entry level employment skills. Students should be carefully counseled on the importance of attaining competency in the tasks assigned. As in virtually all occupations today, machining technicians will require periodic up-dating and review in the future. It is important that each student understand that meeting the program curriculum standards is essential not only to obtain employment today but also to have a base upon which to retain employment in the future.

## MODULE 1 - EMPLOYABILITY SKILLS

**TASK: Identify Employment Opportunities**

Level II

**PERFORMANCE OBJECTIVE:** Given the information resources of a library, obtain and compile the information needed to seek a job.

**ENABLING OBJECTIVES:**

- Identify the requirements for a job.
- Investigate educational opportunities.
- Investigate occupational opportunities.
- Locate resources for finding employment.
- Confer with prospective employers.
- Identify job trends.

**TASK: Apply Employment-Seeking Skills**

Level II

**PERFORMANCE OBJECTIVE:** Given appropriate information, locate a job opportunity, prepare and take an interview for it, complete the required tests, forms and applications, and evaluate a response to the job opportunity.

**ENABLING OBJECTIVES:**

- Locate a job opening.
- Complete a resume.
- Prepare for an interview.
- Participate in an interview.
- Complete tests required.
- Complete forms required.
- Complete an application letter.
- Complete a follow-up letter.
- Complete an acceptance letter.
- Evaluate a job offer.
- Evaluate a job rejection.

**TASK: INTERPRET EMPLOYMENT CAPABILITIES**

Level II

**PERFORMANCE OBJECTIVE:** Given the assignment to explain how your capabilities make you employable, demonstrate how to match skills and experience to a job being sought.

**ENABLING OBJECTIVES:**

- Match an interest to job area.
- Match aptitudes to job area.
- Verify abilities.
- Identify immediate work goal.
- Develop a career plan.

**TASK: DEMONSTRATE APPROPRIATE WORK BEHAVIOR**

**Level II**

**PERFORMANCE OBJECTIVE:** Given the responsibility of an employee in a new job, demonstrate knowledge of appropriate behavior in the work place.

**ENABLING OBJECTIVES:**

- Exhibit dependability.
- Demonstrate punctuality.
- Follow rules and regulations.
- Explain the consequences of dishonesty.
- Complete assignments accurately and on time.
- Control emotions.
- Take responsibility for decisions and actions
- Take pride in work and be a loyal worker.
- Learn to handle pressures and tensions.
- Demonstrate ability to set priorities.
- Demonstrate problem-solving skills.

**TASK: MAINTAIN A BUSINESS-LIKE IMAGE**

**Level II**

**PERFORMANCE OBJECTIVE:** Given a responsibility to perform the duties of a new job, with a new employer, demonstrate a knowledge of the actions and behaviors which will project a business-like image

**ENABLING OBJECTIVES:**

- Participate in the institution's orientation.
- Demonstrate knowledge of company or agency products and services.
- Identify the requirements for a job.
- Investigate educational opportunities.
- Investigate occupational opportunities.
- Locate resources for finding employment.
- Confer with prospective employers.
- Identify job trends.

**TASK: MAINTAIN WORKING RELATIONSHIPS WITH OTHERS**

**Level II**

**PERFORMANCE OBJECTIVE:** Given the responsibility to perform the duties of a new job, with a new employer, demonstrate knowledge of how to successfully work with others.

**ENABLING OBJECTIVES:**

- Work productively with others.
- Show empathy, respect, and support for others.
- Demonstrate procedures and assist others when necessary.
- Recognize problems and work toward their solution.
- Minimize the occurrence of problems.
- Channel emotional reactions in positive ways.

**TASK: COMMUNICATE ON THE JOB**

**Level II**

**PERFORMANCE OBJECTIVE:** Given the responsibility to perform the duties of a new job, with a new employer, demonstrate knowledge of how to communicate on the job.

**ENABLING OBJECTIVES:**

- Read and comprehend written communications.
- Use correct grammar.
- Speak clearly when addressing others.
- Use job-related terminology.
- Listen attentively.
- Write legibly.
- Use telephone etiquette.
- Follow written and oral directions.
- Ask questions.
- Locate information needed to complete the task.
- Prepare written communication.
- Demonstrate keyboarding skills.
- Demonstrate computer skill.

**TASK: ADAPT TO CHANGE**

**Level II**

**PERFORMANCE OBJECTIVE:** Given the responsibility to perform the duties of a new job, with a new employer, demonstrate knowledge of how to adapt to change.

**ENABLING OBJECTIVES:**

- Recognize the need to change.
- Demonstrate a willingness to learn.
- Demonstrate flexibility.
- Participate in continuing education.
- Seek challenge in the work place.
- Adjust goals and plans when necessary.

**CURRICULUM STANDARDS FOR PRECISION MACHINING**

**MODULE 2**

**PREREQUISITE MACHINING**

## MODULE 2 - PREREQUISITE MACHINING

This is one of a series of modules which comprise the Idaho Curriculum Guide for Precision Machining. Each module contains a listing of the tasks, performance objectives, and enabling objectives required to enable a student to achieve competency in a specific system or field of study within the basic machining technician occupational field. The numbering of these modules is not intended to dictate an order of instruction or scheduling. The order in which these modules may be taught is determined by each institution and its instructors.

Each task describes an occupational activity which will result in a finished process or product. The tasks listed in each module represent the basic activities required of each student to demonstrate entry level competence for that specific system or field of study within the machining occupation. Individual records of student performance in completing the tasks listed within each module should be maintained.

Although some provision is made for basic mathematics and communication skills within these standards, they may not be adequate to meet the needs of individual students. Counseling, guidance, and diagnostic test results may indicate a need for further preparation in these areas. In such cases, instructors are encouraged to utilize the resources and personnel within the institution to improve or complement the instructional process.

The benefits to students and institutions derived from these curriculum standards should be considerable. Articulation of students from secondary to post-secondary programs will be aided through the use of a single set of curriculum standards. The curriculum standards provide a tool for evaluation of local curricula and programs. The curriculum standards may be used in a flexible manner to assure that Precision Machining programs meet the needs of local business and industry.

It is the goal of this program curriculum guide to provide a level of instruction which will impart entry level employment skills. Students should be carefully counseled on the importance of attaining competency in the tasks assigned. As in virtually all occupations today, machining technicians will require periodic up-dating and review in the future. It is important that each student understand that meeting the program curriculum standards is essential not only to obtain employment today but also to have a base upon which to retain employment in the future.

## MODULE 2 - PREREQUISITE MACHINING SKILLS

**TASK: Demonstrate Proficiency in Maintaining Immediate Work Area**

**Level II**

**PERFORMANCE OBJECTIVE:** Given appropriate materials and supplies the student will be able to demonstrate proficiency to maintain work areas in a machine shop.

**ENABLING OBJECTIVES:**

Demonstrate the knowledge of shop safety rules and practices.

Describe procedures for the proper disposal of scrap metal chips, shavings, oil, and coolant.

List shop operating rules and practices.

Demonstrate procedures to clean and maintain work areas affected by operations of work and shop areas.

Demonstrate knowledge of maintaining a clean and orderly shop.

Demonstrate knowledge of leaving work and shop area in a safe condition.

**TASK: Perform Mathematical Calculation's**

**Level II**

**PERFORMANCE OBJECTIVE:** Given the appropriate tools, equipment and resource material, the student will demonstrate the ability to perform accurate mathematical calculations relating to machine set up, material, and machine shop environment.

**ENABLING OBJECTIVES:**

Accurately perform job related decimal and fraction calculations.

Demonstrate proficiency solving job-related problems using basic formulas.

Demonstrate proficiency solving job-related problems using basic geometry.

Demonstrate proficiency measuring a work piece and compare measurements with blueprint specifications.

Demonstrate proficiency calculating the amount of material that should be removed to obtain correct limits for secondary operations.

Demonstrate proficiency in solving job-related problems using mathematical handbooks, charts, and tables.

Demonstrate proficiency in converting measurements from English to metric and from metric to English units.

Demonstrate proficiency in determining the clearance, relief, and rake of cutting tools.

Demonstrate proficiency in calculating machine speeds and feeds using appropriate formulas.

**TASK: Demonstrate Proficiency in Blueprint Reading and Machine Planning**

**Level II**

**PERFORMANCE OBJECTIVE:** Given the appropriate tools, materials, and prints, the student will demonstrate proficiency in reading blueprints to layout and prepare stock for machining operations.

**ENABLING OBJECTIVES:**

- Interpret view concepts.
- Read lines.
- Read and interpret title blocks.
- Read and interpret change orders on working and assembly prints.
- Read and interpret abbreviations.
- Make shop sketches.
- Read and interpret blueprints, including geometric tolerancing.
- Determine and interpret reference information used in performing machine work.
- Perform layout for precision machine work by using layout instruments.
- Lay out radial and bolt hole circles.
- Select the most productive tool and tooling for a given operation.

**TASK: Perform Measuring Operations**

**Level II**

**PERFORMANCE OBJECTIVE:** Given the appropriate tools and operation pieces, the student will accurately measure work pieces using the proper measuring instruments.

**ENABLING OBJECTIVES:**

- Read and measure with rules and calipers.
- Read and measure with micrometers.
- Read and measure with vernier tools.
- Read and measure with dial indicators.
- Measure using as surface plate.
- Read and interpret surface finish (ANSI Y14)

**TASK: Perform Maintenance on Machines and Tools**

**Level II**

**PERFORMANCE OBJECTIVE:** Given the appropriate tools, equipment, and supplies, the student will be able to perform maintenance functions on machining equipment and tools to restore the equipment to full operating condition.

**ENABLING OBJECTIVES:**

- Inspect work areas to assure a safe working environment.
- Lubricate equipment parts.
- Clean and store hand tools, cutters, fixtures, jigs, and attachments.
- Inspect and repair hand tools.
- Inspect drive pulleys or belts.
- Select lubricants for machining operations.
- Inspect equipment for safe operational conditions.
- Store grinding wheels and precision tools

# **CURRICULUM STANDARDS FOR PRECISION MACHINING**

## **MODULE 3**

### **BENCH WORK**

## MODULE 3 - BENCH WORK

This is one of a series of modules which comprise the Idaho Curriculum Guide for Precision Machining. Each module contains a listing of the tasks, performance objectives, and enabling objectives required to enable a student to achieve competency in a specific system or field of study within the basic machining technician occupational field. The numbering of these modules is not intended to dictate an order of instruction or scheduling. The order in which these modules may be taught is determined by each institution and its instructors.

Each task describes an occupational activity which will result in a finished process or product. The tasks listed in each module represent the basic activities required of each student to demonstrate entry level competence for that specific system or field of study within the machining occupation. Individual records of student performance in completing the tasks listed within each module should be maintained.

Although some provision is made for basic mathematics and communication skills within these standards, they may not be adequate to meet the needs of individual students. Counseling, guidance, and diagnostic test results may indicate a need for further preparation in these areas. In such cases, instructors are encouraged to utilize the resources and personnel within the institution to improve or complement the instructional process.

The benefits to students and institutions derived from these curriculum standards should be considerable. Articulation of students from secondary to post-secondary programs will be aided through the use of a single set of curriculum standards. The curriculum standards provide a tool for evaluation of local curricula and programs. The curriculum standards may be used in a flexible manner to assure that Precision Machining programs meet the needs of local business and industry.

It is the goal of this program curriculum guide to provide a level of instruction which will impart entry level employment skills. Students should be carefully counseled on the importance of attaining competency in the tasks assigned. As in virtually all occupations today, machining technicians will require periodic up-dating and review in the future. It is important that each student understand that meeting the program curriculum standards is essential not only to obtain employment today but also to have a base upon which to retain employment in the future.

## MODULE 3 - PERFORM BENCH WORK SKILLS

**TASK:** Cut materials by using hand hacksaws

Level II

**PERFORMANCE OBJECTIVE:** Given a dimensioned blueprint of a work piece, raw material, and a hand hacksaw, the student will be able to:

**ENABLING OBJECTIVES:**

Explain the safety precautions/procedures for use of a hand hacksaw.

Determine teeth per inch on various hacksaw blades.

Describe the applications for saw blades with different ratios of tooth pitch.

Demonstrate the correct method of sawing materials with a hand hacksaw.

**TASK:** Cut threads by using hand taps and dies

Level II

**PERFORMANCE OBJECTIVE:** Given a dimensioned blueprint, work piece, tap, die, tap wrench, die stock, cutting fluids and measuring instruments, cut internal and external threads to a class #2 fit.

**ENABLING OBJECTIVES:**

Explain safety precautions/procedures for threading with taps and dies.

Identify and explain the use of the three taps used for threading a blind hole.

Select cutting fluids.

Describe the procedure for cutting internal and external threads with a tap or die.

Explain the correct procedure to align a tap with the hole.

**TASK:** Ream holes by using hand reamers

Level II

**PERFORMANCE OBJECTIVE:** Given a hand reamer, ream a series of previously drilled holes to a tolerance of  $\pm .001$ .

**ENABLING OBJECTIVES:**

Demonstrate the proper method of hand reaming holes using both adjustable and non-adjustable reamers.

Explain the types of lubricants and their applications to reaming.

Explain the correct drill sizes as they relate to the various sizes of reamers.

**TASK:** Hand sharpen cutting tools by using abrasive stones

Level II

**PERFORMANCE OBJECTIVE:** Given a bench stone and a variety of cutting tools, hone the cutting edges to remove burrs and smooth the surfaces.

**ENABLING OBJECTIVES:**

Determine and demonstrate how to correctly hold various cutting tools to the angles characteristic to that tool.

Explain why bench stones require lubricants.

**TASK:** Remove damaged screws and other hardware

**Level II**

**PERFORMANCE OBJECTIVE:** Given a set of easy outs, a broken bolt in a piece of material, tap extractor and broken tap, remove these broken items from a variety of materials with a minimum of damage to the work piece.

**ENABLING OBJECTIVES:**

Explain the safety precautions/procedures for using easy outs and tap extractors.

Explain the purpose of easy outs and tap extractors.

Determine the correct drill sizes used with various easy outs.

Determine the correct tap extractor for various taps.

Describe the procedures for using easy outs and tap extractors.

Remove damaged screws.

**TASK:** Set up and use arbor press broaches

**Level II**

**PERFORMANCE OBJECTIVE:** Given an arbor press, broaches and lubricant, cut internal spline and keyways to a tolerance of  $\pm.002$ .

**ENABLING OBJECTIVES:**

Explain why broaches have to be shimmed.

Explain why lubricant is required.

Cut splines and keyways utilizing broaches, bushings, shims and arbor presses.

**TASK:** Deburr work pieces

**Level II**

**PERFORMANCE OBJECTIVE:** Given a variety of internal and external geometries, files and scrapers, completely deburr these work pieces to required tolerances.

**ENABLING OBJECTIVES:**

Demonstrate how to properly hold files and three corner scrapers.

Demonstrate how to sharpen a three corner scraper.

Deburr work pieces to required tolerances.

# **CURRICULUM STANDARDS FOR PRECISION MACHINING**

## **MODULE 4**

### **POWER SAWS**

## MODULE 4 - POWER SAWS

This is one of a series of modules which comprise the Idaho Curriculum Guide for Precision Machining. Each module contains a listing of the tasks, performance objectives, and enabling objectives required to enable a student to achieve competency in a specific system or field of study within the basic machining technician occupational field. The numbering of these modules is not intended to dictate an order of instruction or scheduling. The order in which these modules may be taught is determined by each institution and its instructors.

Each task describes an occupational activity which will result in a finished process or product. The tasks listed in each module represent the basic activities required of each student to demonstrate entry level competence for that specific system or field of study within the machining occupation. Individual records of student performance in completing the tasks listed within each module should be maintained.

Although some provision is made for basic mathematics and communication skills within these standards, they may not be adequate to meet the needs of individual students. Counseling, guidance, and diagnostic test results may indicate a need for further preparation in these areas. In such cases, instructors are encouraged to utilize the resources and personnel within the institution to improve or complement the instructional process.

The benefits to students and institutions derived from these curriculum standards should be considerable. Articulation of students from secondary to post-secondary programs will be aided through the use of a single set of curriculum standards. The curriculum standards provide a tool for evaluation of local curricula and programs. The curriculum standards may be used in a flexible manner to assure that Precision Machining programs meet the needs of local business and industry.

It is the goal of this program curriculum guide to provide a level of instruction which will impart entry level employment skills. Students should be carefully counseled on the importance of attaining competency in the tasks assigned. As in virtually all occupations today, machining technicians will require periodic up-dating and review in the future. It is important that each student understand that meeting the program curriculum standards is essential not only to obtain employment today but also to have a base upon which to retain employment in the future.

**MODULE 4 - DEMONSTRATE PROFICIENCY IN SETTING UP AND OPERATING  
POWER SAWS**

**TASK: Comply with safe and efficient work practices**

**Level II**

**PERFORMANCE OBJECTIVE: Given a band type or reciprocating type power saw, explain the specific safety precautions characteristic to each type.**

**ENABLING OBJECTIVES:**

**Explain what could be the possible injuries resulting from improper safety precautions.**

**Identify hazardous components of saws.**

**TASK: Remove and replace saw blades**

**Level II**

**PERFORMANCE OBJECTIVE: Given a band type and reciprocating type power saw, demonstrate the correct procedure for removing and replacing the two types of blades.**

**ENABLING OBJECTIVES:**

**Explain why the teeth of the blade must point in the correct direction for each type of machine.**

**Explain why the blades of reciprocating saws must be elevated a certain distance above the work piece before starting the machine.**

**Describe the procedures for replacing saw blades.**

**Replace blades in hand and reciprocating saws.**

**TASK: Select appropriate blades to perform given sawing operations**

**Level II**

**PERFORMANCE OBJECTIVE: Given specifications for the size and type of material to be cut, and specification charts on saw blades, select the correct blade for the operation performed.**

**ENABLING OBJECTIVES:**

**Explain how the width of the blade and the radius desired in contour cutting have a direct effect on each other.**

**Explain how the number of teeth per inch and the thickness of the work piece affect each other.**

**Describe a bi-metal saw blade for a reciprocating type machine.**

**TASK:** Select and set speeds and feeds for given sawing operations

Level II

**PERFORMANCE OBJECTIVE:** Given a known hardness of a variety of materials, determine the correct speeds and feeds for power sawing.

**ENABLING OBJECTIVES:**

List the correct cutting speed and feed of the following materials:

1-1/2" cold rolled steel

1" aluminum

1" tool steel

1/6" aluminum.

Explain how coolant can affect speeds and feeds.

Calculate proper cutting speeds and feeds for specific material.

**TASK:** Measure and cut off materials using power saws

Level II

**PERFORMANCE OBJECTIVE:** Given the two types of power saws available, cut material either to a layout line or cut a pre-determined amount of material from the layout line.

**ENABLING OBJECTIVES:**

Determine the proper amount of material that must be left on a work piece for machining.

Explain the safety precautions/procedures before operating power saws.

Describe the procedure to cut material to layout or scribed line.

Cut material to layout or scribed lines.

**TASK:** Cut and weld band saw blades to insert for contour sawing

Level II

**PERFORMANCE OBJECTIVE:** Given a butt welder, a variety of different width blades and a pre-drilled work piece, cut and weld these blades for inside cutting.

**ENABLING OBJECTIVES:**

Describe the procedures for measuring and cutting saw blades to length.

Explain the reasons for annealing the saw blade after the welding operation.

Describe the procedures for grinding a saw blade before installation.

Describe the procedure for selecting the proper guides.

Cut and weld a saw blade for inside cutting.

**TASK: Set up and operate saws for angular cutting**  
**Level II**

**PERFORMANCE OBJECTIVE: Given the two types of power saws, determine how to safely hold a work piece for angular cutting and set up the saw for angular cutting.**

**ENABLING OBJECTIVES:**

**Explain the safety precautions/procedures in sawing angles.**

**Explain the reasons for cutting as close to the layout lines as possible.**

**Explain the reasons for cutting angles on a bandsaw as opposed to using other machines.**

**Set up a saw for angular cutting.**

**Perform an angular cut on a work piece.**

**CURRICULUM STANDARDS FOR PRECISION MACHINING**

**MODULE 5**

**PEDESTAL GRINDERS**

## MODULE 5 - PEDESTAL GRINDERS

This is one of a series of modules which comprise the Idaho Curriculum Guide for Precision Machining. Each module contains a listing of the tasks, performance objectives, and enabling objectives required to enable a student to achieve competency in a specific system or field of study within the basic machining technician occupational field. The numbering of these modules is not intended to dictate an order of instruction or scheduling. The order in which these modules may be taught is determined by each institution and its instructors.

Each task describes an occupational activity which will result in a finished process or product. The tasks listed in each module represent the basic activities required of each student to demonstrate entry level competence for that specific system or field of study within the machining occupation. Individual records of student performance in completing the tasks listed within each module should be maintained.

Although some provision is made for basic mathematics and communication skills within these standards, they may not be adequate to meet the needs of individual students. Counseling, guidance, and diagnostic test results may indicate a need for further preparation in these areas. In such cases, instructors are encouraged to utilize the resources and personnel within the institution to improve or complement the instructional process.

The benefits to students and institutions derived from these curriculum standards should be considerable. Articulation of students from secondary to post-secondary programs will be aided through the use of a single set of curriculum standards. The curriculum standards provide a tool for evaluation of local curricula and programs. The curriculum standards may be used in a flexible manner to assure that Precision Machining programs meet the needs of local business and industry.

It is the goal of this program curriculum guide to provide a level of instruction which will impart entry level employment skills. Students should be carefully counseled on the importance of attaining competency in the tasks assigned. As in virtually all occupations today, machining technicians will require periodic up-dating and review in the future. It is important that each student understand that meeting the program curriculum standards is essential not only to obtain employment today but also to have a base upon which to retain employment in the future.

## MODULE 5 - DEMONSTRATE PROFICIENCY IN SETTING UP AND OPERATING PEDESTAL GRINDERS

**TASK:** Comply with safe and efficient work practices

Level II

**PERFORMANCE OBJECTIVE:** Given a pedestal grinder, identify the specific safety precautions characteristic to grinders.

**ENABLING OBJECTIVES:**

Apply shop safety rules and procedures.

Demonstrate the operation of shop safety devices.

Demonstrate personal safety procedures.

Demonstrate first aid/emergency treatment procedures.

Apply fire safety rules and procedures.

Apply rules for electrical safety.

**TASK:** Identify parts of the pedestal grinder

Level II

**PERFORMANCE OBJECTIVES:** Given a pedestal grinder, manufacturer's manual or general textbook, identify major parts and function of a grinder.

**ENABLING OBJECTIVES:**

Identify types of pedestal grinders.

Identify major parts.

Explain the function of major parts.

**TASK:** Mount grinding wheels

Level II

**PERFORMANCE OBJECTIVE:** Given grinder, grinding wheels and access to necessary tools, inspect and mount wheel to meet requirements found in operator's manual and Machinery's Handbook.

**ENABLING OBJECTIVES:**

Explain the safety precautions/procedures for mounting grinding wheels.

Explain how to determine if a wheel is cracked before mounting.

Explain the importance of cleanliness when mounting wheel.

Explain the importance of the blotters on the wheel.

Explain the reasons for the manufacturer printing the operating speed on grinding wheels.

Explain the safety precautions in regard to the diameter of the flanges in relationship to the diameter of the wheel.

Explain procedure to determine how tight the wheel flanges should be.

Dress wheel and adjust wheel guard and tool rest.

**TASK:** Set up support tool rests  
Level II

**PERFORMANCE OBJECTIVES:** Given grinder, and the necessary tools, adjust the wheel guard and tool rest to within 1/16 inch of grinding wheel face.

**ENABLING OBJECTIVES:**

Explain the relevant safety precaution/procedures required for adjusting wheel guard and tool rest.

Explain the purpose of the wheel guard and tool rest.

Describe the procedures for adjusting the wheel guard and tool rest.

Set up a tool rest and adjust wheel guard.

**TASK:** Dress grinding wheel  
Level II

**PERFORMANCE OBJECTIVE:** Given grinder, wheel dresser and the necessary tools, true and dress grinding wheel in accordance with the procedures in the Machinery's Handbook. The wheel must run true and the grinding surface must not be loaded nor glazed.

**ENABLING OBJECTIVES:**

Explain the relevant safety precautions/procedures for dressing and truing a grinding wheel.

Identify the different types of wheel dressers.

Determine the type dresser to be used on different grinding wheels.

Explain the correct procedure to true and dress the grinding wheel.

Properly dress a grinding wheel.

**TASK:** Grind lathe tools to required angles  
Level II

**PERFORMANCE OBJECTIVE:** Given a tool blank, blueprint and measuring instruments, shape and sharpen cutting tool to a tolerance of  $\pm 1$  degree on clearance angles.

**ENABLING OBJECTIVES:**

Explain the relevant safety precautions/ procedures.

Describe the procedure for grinding cutting tool.

Describe the procedure for checking cutting tool clearances.

Explain positive and negative rake angles and their uses for machining different types of materials.

Properly sharpen three different cutting tools.

**CURRICULUM STANDARDS FOR PRECISION MACHINING**

**MODULE 6**

**DRILL PRESSES**

## MODULE 6 - DRILL PRESSES

This is one of a series of modules which comprise the Idaho Curriculum Guide, Standards for Precision Machining. Each module contains a listing of the tasks, performance objectives, and enabling objectives required to enable a student to achieve competency in a specific system or field of study within the basic machining technician occupational field. The numbering of these modules is not intended to dictate an order of instruction or scheduling. The order in which these modules may be taught is determined by each institution and its instructors.

Each task describes an occupational activity which will result in a finished process or product. The tasks listed in each module represent the basic activities required of each student to demonstrate entry level competence for that specific system or field of study within the machining occupation. Individual records of student performance in completing the tasks listed within each module should be maintained.

Although some provision is made for basic mathematics and communication skills within these standards, they may not be adequate to meet the needs of individual students. Counseling, guidance, and diagnostic test results may indicate a need for further preparation in these areas. In such cases, instructors are encouraged to utilize the resources and personnel within the institution to improve or complement the instructional process.

The benefits to students and institutions derived from these curriculum standards should be considerable. Articulation of students from secondary to post-secondary programs will be aided through the use of a single set of curriculum standards. The curriculum standards provide a tool for evaluation of local curricula and programs. The curriculum standards may be used in a flexible manner to assure that Precision Machining programs meet the needs of local business and industry.

It is the goal of this program curriculum guide to provide a level of instruction which will impart entry level employment skills. Students should be carefully counseled on the importance of attaining competency in the tasks assigned. As in virtually all occupations today, machining technicians will require periodic up-dating and review in the future. It is important that each student understand that meeting the program curriculum standards is essential not only to obtain employment today but also to have a base upon which to retain employment in the future.

## MODULE 6 - DEMONSTRATE PROFICIENCY IN SETTING UP AND OPERATING DRILL PRESSES

**TASK:** Comply with safe and efficient work practices

Level II

**PERFORMANCE OBJECTIVE:** Given a drill press, identify the specific safety precautions characteristic to grinders.

**ENABLING OBJECTIVES:**

- Apply shop safety rules and procedures.
- Demonstrate the operation of shop safety devices.
- Demonstrate personal safety procedures.
- Demonstrate first aid/emergency treatment procedures.
- Apply fire safety rules and procedures.
- Apply rules for electrical safety.

**TASK:** Identify the parts of the drill press and explain the uses

Level II

**PERFORMANCE OBJECTIVE:** Given parts breakdown sheet, identify the parts of the drill press.

**ENABLING OBJECTIVES:**

- Explain the major parts of the drill press.
- Explain the procedure for adjusting the table height.
- Explain the different types of drill presses.
- Explain the RPM settings and feed settings.
- Explain the need to figure RPM and feed for various size drills and materials.
- Explain safety precautions for operation of drill press.
- Explain the use of the drill chuck and Morse tapered spindle.

**TASK:** Lubricate the drill press

Level II

**PERFORMANCE OBJECTIVE:** Given service manual or lubrication chart and access of cleaning fluid, lubricants and lubrication tools, clean, inspect and lubricate drill press in accordance with service manual or lubrication chart. All lubrication points must be supplied with the correct type and amount of lubricant.

**ENABLING OBJECTIVES:**

- Explain the safety precautions/procedures for cleaning, inspecting, and lubricating a drill press.
- Explain the reasons for performing routine cleaning, inspection and lubrication of a drill press.
- Identify the lubricants used in a drill press.
- Locate the lubrication points on the drill press.
- Describe the inspection procedures for a drill press.
- Identify the materials and describe the procedure used for cleaning a drill press.
- Perform lubrication service on a drill press.

**TASK: Hand and machine sharpen drills**

**Level II**

**PERFORMANCE OBJECTIVE:** Given drills, drill gauge, pedestal grinder, and precision measuring instruments, hand sharpen drills. Sharpen drills on pedestal grinder holding a tolerance of  $\pm 1$  degree. Each flute lip must correspond to the other flute lip in length to within  $\pm .005$  inch.

**ENABLING OBJECTIVES:**

Explain the safety precautions/procedures for sharpening twist drills and sing off hand procedures.

Describe the amount of lip clearance a drill must have to perform correctly.

Explain why a drill bit must have the same angle on both flutes and why both flutes must be the same length.

Discuss why different drill point angles are ground for different materials.

Define the following drill terms: (a) chisel edge (b) lip (c) flute (d) margin (e) land

(f) body (g) shank (h) web.

Describe the procedures for hand sharpening a drill bit.

Describe the procedures for correcting a thick web on a drill bit.

Properly sharpen three drill bits using a pedestal grinder.

**TASK: Center drill, drill and ream hole in work piece**

**Level II**

**PERFORMANCE OBJECTIVE:** Given a blueprint, work piece, work holding device, combination square, combination drill and countersink, drills, reamers, cutting fluid and precision measuring instruments and centerdrill, drill and ream a hole in the work piece holding a tolerance of  $+.002$  inch,  $-.000$  for diameter,  $\pm 1/64$  inch for location.

**ENABLING OBJECTIVES:**

Explain the safety precautions/procedures for setting up and operating a drill press.

Describe the procedures for setting up a drill press.

Describe the uses of cutting fluids for drill press.

Calculate cutting speeds for centerdrilling, drilling and reaming operations (S.F.P.M.).

Calculate RPM for centerdrills, drills, reamers, etc.

Describe the procedures for center drilling and drilling holes.

Describe the procedures for reaming holes.

Identify the correct cutting fluids for drilling and reaming.

Centerdrill a hole in a work piece to required tolerance.

Drill and ream hole in a work piece to required tolerance.

**TASK:** Centerbore, spotface and countersink hole in work piece

**Level II**

**PERFORMANCE OBJECTIVE:** Given a blueprint, work piece, work holding device, counterbore spotface and countersink tools, cutting fluid, and precision measuring instruments, counterbore, countersink, and spotface a hole in work piece holding a tolerance of  $\pm .010$  inch.

**ENABLING OBJECTIVES:**

Explain the safety precautions/procedures for counterboring, countersinking and spotfacing operations.

Explain the purpose of counterboring, countersink and spotfacing a hole.

Define the difference between a counterbored, countersunk, and spotfaced hole.

Describe the procedures for counterboring, countersinking and spotfacing holes.

Identify the correct burring fluids for counterboring, countersinking and spotfacing.

Centerdrill a hole in a work piece to required tolerance.

Spotface a hole in a work piece to required tolerance.

Countersink a hole in a work piece to required tolerance.

**TASK:** Hand tap a hole in work piece

**Level II**

**PERFORMANCE OBJECTIVE:** Given a blueprint, work piece, work holding device, center taps, tap wrench, cutting fluids, and precision measuring instruments, hand tap a hole in the work piece holding a tolerance of  $\pm 1/2$  degree for perpendicularity and  $\pm 1/64$  inch for location.

**ENABLING OBJECTIVES:**

Explain the safety precautions/procedures for hand tapping.

Describe the uses of threads.

List the taps in an American National/Unified 60 degree tap set and state the purpose of each tap.

Explain why a tapped hole must be countersunk.

Identify the uses of cutting fluids for tapping.

Describe the procedures for hand tapping a hole with a drill press to assure perpendicularity.

Hand tap a hole in a work piece to required tolerance.

**TASK:** Power tap hole in work piece

**Level II**

**PERFORMANCE OBJECTIVE:** Given a blueprint, work piece, work holding device, tapping head, taps, cutting fluid, and precision measuring instruments, power tap holes in work piece holding a tolerance of  $\pm 1/2$  degree for perpendicularity and  $\pm 1/64$  inch for location.

**ENABLING OBJECTIVES:**

Explain the safety precautions/procedures for power tapping.

Distinguish between power and hand taps.

Calculate the R.P.M. for machine tapping in a drill press for the following:

1/4-20NC-2B, 1/2-13NC-2B, 5/8-11-NC-2B.

Describe the procedures for machine tapping holes.

Identify the correct cutting fluids for power tapping.

Power tap a hole in a work piece to required tolerance.

# CURRICULUM STANDARDS FOR PRECISION MACHINING

## MODULE 7

### LATHES

## **MODULE 7 - DEMONSTRATE PROFICIENCY IN SETTING UP AND OPERATING LATHES**

This is one of a series of modules which comprise the Idaho Curriculum Guide for Precision Machining. Each module contains a listing of the tasks, performance objectives, and enabling objectives required to enable a student to achieve competency in a specific system or field of study within the basic machining technician occupational field. The numbering of these modules is not intended to dictate an order of instruction or scheduling. The order in which these modules may be taught is determined by each institution and its instructors.

Each task describes an occupational activity which will result in a finished process or product. The tasks listed in each module represent the basic activities required of each student to demonstrate entry level competence for that specific system or field of study within the machining occupation. Individual records of student performance in completing the tasks listed within each module should be maintained.

Although some provision is made for basic mathematics and communication skills within these standards, they may not be adequate to meet the needs of individual students. Counseling, guidance, and diagnostic test results may indicate a need for further preparation in these areas. In such cases, instructors are encouraged to utilize the resources and personnel within the institution to improve or complement the instructional process.

The benefits to students and institutions derived from these curriculum standards should be considerable. Articulation of students from secondary to post-secondary programs will be aided through the use of a single set of curriculum standards. The curriculum standards provide a tool for evaluation of local curricula and programs. The curriculum standards may be used in a flexible manner to assure that Precision Machining programs meet the needs of local business and industry.

It is the goal of this program curriculum guide to provide a level of instruction which will impart entry level employment skills. Students should be carefully counseled on the importance of attaining competency in the tasks assigned. As in virtually all occupations today, machining technicians will require periodic up-dating and review in the future. It is important that each student understand that meeting the program curriculum standards is essential not only to obtain employment today but also to have a base upon which to retain employment in the future.

## MODULE 7 - DEMONSTRATE PROFICIENCY IN SETTING UP AND OPERATING LATHES

**TASK:** Identify the parts of the lathe.

Level II

**PERFORMANCE OBJECTIVE:** Given a parts breakdown sheet, identify the main parts of the lathe.

**ENABLING OBJECTIVES:**

Explain the major parts of the lathe.

Explain the function of the bed.

Explain the function of the carriage and the parts therein.

Explain the function of the head stock and the parts therein.

Explain the function of the tail stock and the parts therein.

**TASK:** Comply with general safe and efficient work practices.

Level II

**PERFORMANCE OBJECTIVE:** Given an engine lathe, identify the major safety hazards characteristic to rotating work pieces.

**ENABLING OBJECTIVES:**

Explain the need for safety glasses.

Explain the hazards of chip handling.

Explain the set up hazards.

Explain the chuck removal and installation hazards.

Explain the hazards of work piece burrs.

Explain the proper housekeeping and tool hazards.

Demonstrate knowledge of safety by completing a written safety test

**TASK:** Measure stock

Level II

**PERFORMANCE OBJECTIVE:** Given a cylindrical work piece with external threads and a counterbored hole and a corresponding uni-dimensioned blueprint, outside, inside, and depth micrometers, telescope work piece, small hole gauge, vernier caliper, and surface plate, precision measure the work piece. Measure the external diameters, pitch diameters, internal bores, hole depths, and linear measurements of a work piece to a tolerance of  $\pm .002$  inches. Transpose dimensions onto blueprint in accordance with machine drafting procedures.

**ENABLING OBJECTIVES:**

Explain correct drafting standards for dimensioning blueprints.

Demonstrate the proper care, use, and calibrations of precision measuring instruments.

List accepted drafting abbreviations and/or symbols for the following terms:

Outside diameter

Inside diameter

Threads per inch

Inch

Millimeter

Counterbore

Depth

Measure a cylindrical work piece.

**TASK:** Set up an engine lathe

Level II

**PERFORMANCE OBJECTIVE:** Given independent, universal and collect chucks, lathe operation manual and dial indicator, mount chucks on lathe in accordance with operation manual so that there is no horizontal or vertical movement of the chuck. Set up a lathe using follower and steady rests.

**ENABLING OBJECTIVES:**

Explain the relevant safety precautions/procedures for mounting chucks on lathes.

Explain the operation of lathe.

Describe the use of wood blocks as cradles between bedways and chuck.

Discuss the applications for independent, universal, and collect chucks.

Describe the procedures for mounting chucks on lathe.

Describe the procedures for mounting face plates.

Describe the procedures for mounting and using follower and steady rests.

**TASK:** Secure tools, tool-holders, and fixtures or attachments

Level II

**PERFORMANCE OBJECTIVE:** Given independent, universal and collet chucks, lathe operation manual, and dial indicator, mount chucks on lathe in accordance with operation manual so that there is no horizontal or vertical movement of the chuck. Mount tool bits, fixtures or attachments on lathe.

**ENABLING OBJECTIVES:**

Explain the relevant safety precautions/procedures for mounting chucks on lathes.

Explain the operation of lathe.

Describe the use of tool holders, fixtures and attachments.

Determine and discuss the applications for independent, universal and collect chucks.

Describe the mounting of tool bits.

Demonstrate mounting and use of steady and follower rests.

**TASK:** Select and set feeds and speeds

Level II

**PERFORMANCE OBJECTIVE:** Given work sheet with check list, set assigned machines for each specified lathe spindle speed and feed.

**ENABLING OBJECTIVES:**

Explain lathe safety.

Locate, speed and feed chart on each machine.

List spindle speed formula and calculate RPM as per work sheet.

Identify lathe parts as listed on worksheet.

Adjust speed and feed settings for specified work sheet.

**TASK:** Set up lathes and face work pieces held in chucks

**Level II**

**PERFORMANCE OBJECTIVE:** Given blueprint, work piece, tool blanks, cutting fluids, and precision measuring instruments face the work piece holding a tolerance of  $\pm .005$  inch and to a surface finish of 125 micro inches.

**ENABLING OBJECTIVES:**

- Explain the safety precautions/procedures for facing.
- Describe the uses of carbide, high speed, and cutting tools as applied to facing operations.
- Define micro-inch.
- Calculate cutting speeds and feeds for facing operations.
- Describe the procedures for facing.
- Identify the correct cutting fluids for facing.
- Face a work piece to specifications.

**TASK:** Rough-cut and finish-cut with lathes

**Level II**

**PERFORMANCE OBJECTIVE:** Given bar stock and drawing, cutter bits, cutting fluids, measuring tools, make the required rough and finish cuts to required specifications.

**ENABLING OBJECTIVES:**

- Explain safety for lathe operation.
- Explain lathe feeds and describe the guideline
- Select speeds and feeds and mount stock in work holding devices.
- Explain tool position and tool geometry (angles).
- Define trial cuts.
- Make required trial cuts.
- Using appropriate measuring tools, measure work piece.
- Perform required rough and finish cuts to specifications.

**TASK:** Perform lathe filing to deburr parts

**Level II**

**PERFORMANCE OBJECTIVE:** Given work piece and work sheet; file, polish and deburr the work piece.

**ENABLING OBJECTIVES:**

- Explain lathe safety.
- Select spindle speed and mount project in lathe.
- Define micro-inch finishes.
- List names of different deburr tools.
- Explain grit size of abrasive clothes.
- List and identify shape, cut and size of files as required by worksheet.
- List other tools needed.
- File, polish and deburr a work piece.

**TASK:** Align lathe centers using accurate methods.

**Level II**

**PERFORMANCE OBJECTIVE:** Given a live and dead center, show methods of aligning lathe centers.

**ENABLING OBJECTIVES:**

- Describe the geometry of alignment of centers.
- Align centers using the point to point method.
- Align centers using a precision ground centered shaft.
- Align centers using the cut and measuring method.

**TASK:** Drill holes with lathes.

**Level II**

**PERFORMANCE OBJECTIVE:** Given blueprint, work piece, drill, lathe attachments, and cutting fluid, drill hole in work piece to a tolerance of  $\pm .005$  inch,  $-.000$  for diameter.

**ENABLING OBJECTIVES:**

- Explain the safety precautions/procedures for drilling operations.
- Calculate speeds for drilling operations.
- Describe the procedures for drilling on a lathe.
- Identify the correct cutting fluid for drilling operations.
- Drill a hole in a work piece.

**TASK:** Countersink holes with lathes

**Level II**

**PERFORMANCE OBJECTIVES:** Given blueprint, countersink tool, work piece, lathe attachments, cutting fluid, and measuring instruments, countersink hole in work piece to a tolerance of  $+.010$  inch,  $-.000$  for diameter.

**ENABLING OBJECTIVES:**

- Explain the safety precautions/procedures for countersinking operations.
- Calculate speeds for countersinking operations.
- Describe the procedures for countersinking on a lathe.
- Identify the correct cutting fluid for countersinking.
- Countersink a hole in a work piece.

**TASK:** Ream holes with lathes

**Level II**

**PERFORMANCE OBJECTIVE:** Given a blueprint, work piece, reamer, lathe attachments, cutting fluid, and inside measuring instruments, ream hole in work piece to a tolerance of  $+.002$ ,  $-.000$  for diameter.

**ENABLING OBJECTIVES:**

- Explain the safety precautions/procedures for reaming operations.
- Calculate speeds for reaming operations.
- Describe the procedures for reaming.
- Identify the correct cutting fluid for reaming.
- Ream a hold in a work piece.

**TASK: Tap threads with lathes**

**Level II**

**PERFORMANCE OBJECTIVE:** Given blueprint, work piece, tap, tap wrench, lathe attachments, cutting fluid, and thread plug gauge, tap hole in work piece to a class 2 fit.

**ENABLING OBJECTIVE:**

- Explain the safety precautions/procedures for tapping operations.
- Determine tap drill size using the charts and formulas.
- Describe the procedures for tapping on a lathe.
- Identify the correct cutting fluid for tapping.
- Describe the proper use of a plug gauge.
- Tap threads in a work piece.

**TASK: Die-cut threads with lathes**

**Level II**

**PERFORMANCE OBJECTIVE:** Given blueprint, work piece and threading die and die stock, die cut external threads using a lathe.

**ENABLING OBJECTIVES:**

- Explain safety requirements for cutting external threads.
- Calculate lathe RPM.
- Set up work piece in chuck.
- Remove tail stock center and explain how to follow the die with the tailstock spindle.
- Describe procedures for cutting external threads.
- Identify the proper cutting fluid.
- Die cut external threads on a work piece.

**TASK: Counterbore holes with lathes**

**Level II**

**PERFORMANCE OBJECTIVE:** Given blueprint, work piece, lathe attachments, boring bar, cutting fluid, and precision measuring instruments, counterbore hole in work piece to a tolerance of  $\pm .001$  inch for diameter and depth.

**ENABLING OBJECTIVES:**

- Explain the safety precautions/procedures for counter-boring operations.
- Calculate speeds for counter-boring operations.
- Describe the procedures for counter-boring.
- Identify the correct cutting fluid for counter-boring operations.
- Counterbore a hole in a work piece.

**TASK: Bore holes with lathes**

**Level II**

**PERFORMANCE OBJECTIVES:** Given blueprint, work piece, boring bar, tool blank, boring bar holder, cutting fluid, and precision measuring instruments, bore hole with lathe to a tolerance of  $\pm .001$  inch for location, diameter, depth, and to print surface finish specifications.

**ENABLING OBJECTIVES:**

- Explain the safety precautions/procedures for boring holes with a lathe.
- Calculate speeds for boring operations on lathes.
- Describe the procedures for boring holes.
- Identify the correct cutting fluids for boring.
- Bore a hole in a work piece.

**TASK: Knurl parts with lathes**

**Level II**

**PERFORMANCE OBJECTIVE:** Given blueprint, work piece, diamond and/or straight knurling tools, cutting fluid, knurl work piece in accordance with Machinery's Handbook specifications for knurling.

**ENABLING OBJECTIVES:**

- Explain the safety precautions/procedures for knurling a work piece.
- Explain the proper use of knurling tools.
- Calculate speeds and feeds for knurling operations.
- Describe the procedures for knurling a work piece.
- Identify the correct cutting fluid for knurling.
- Knurl a work piece.

**TASK: Cut external threads with lathes**

**Level II**

**PERFORMANCE OBJECTIVE:** Given blueprint, work piece, tool holder, tool blank, center gauge, cutting fluids, and precision measuring instruments, cut external threads on work piece to tolerances for class 2 fit for external threads and in accordance with Machinery's Handbook. Use thread micrometer and/or three-wire system for checking threads.

**ENABLING OBJECTIVES:**

- Explain the safety precautions/procedures for cutting external threads.
- Explain the formulas used in the three wire system for measuring external threads.
- Calculate proper speeds for cutting external threads.
- Describe the procedures for cutting external threads.
- Select the correct cutting fluid for threading operations.
- Calculate thread depth.
- Calculate total in feed of compound.
- Determine depth per pass.
- Determine compound off-set angle (right or left hand threads).
- Cut external threads on a work piece.

**TASK:** Re-chase threads with lathes

Level II

**PERFORMANCE OBJECTIVE:** Given a damaged thread, set up and catch thread to repair it.

**ENABLING OBJECTIVES:**

- Explain safety precautions for re-chasing threads.
- Describe procedure for setting up a lathe to re-chase threads.
- Identify tools needed to re-chase threads.
- Select correct cutting fluid for re-chasing threads.
- Re-chase threads on a work piece.

**TASK:** Cut internal threads with lathes

Level II

**PERFORMANCE OBJECTIVE:** Given blueprint, work piece, tool holder, tool blank, thread center gauge, cutting fluids and precision measuring instruments, cut internal threads on work pieces to tolerances for class 2 fit for internal threads in accordance with Machinery's Handbook. Use threaded part or plug gauge for checking threads.

**ENABLING OBJECTIVES:**

- Explain the safety precautions/procedures for chasing internal threads.
- Calculate total in feed of compound for unified threading.
- Calculate proper speeds and hole size for cutting internal threads.
- Describe the procedures for cutting internal threads.
- Select the correct cutting fluid for threading.
- Determine depth of cut per pass.
- Determine compound off-set angle.
- Cut internal threads on a work piece.

**TASK:** Set up and perform taper turning with taper attachments

Level II

**PERFORMANCE OBJECTIVE:** Given blueprint, work piece, turning tool, tool holder, dial indicator, micrometer carriage stop, cutting fluids, and precision measuring instruments, machine external taper on work piece holding a tolerance of .001 per 4 inches in length and a surface finish as specified by the blueprint.

**ENABLING OBJECTIVES:**

- Explain the safety precautions/procedures for machining an external taper.
- Explain the use of taper attachments.
- Describe the procedures for cutting external tapers.
- Calculate speeds and feeds for external tapering operations.
- Explain how to check taper over a 4.000 inch length.
- Identify the correct cutting fluids for external tapering operations.
- Turn an external taper on a work piece.

**TASK:** Set up and perform taper turning with compound.

Level II

**PERFORMANCE OBJECTIVE:** Given blueprint, work piece, tool holder, cutting tool, cutting fluid, and precision measuring instruments, cut external angle with compound on work piece holding a tolerance of  $\pm 30$  minutes for the angle, and a surface finish to print requirements.

**ENABLING OBJECTIVES:**

- Explain the safety precautions/procedures.
- Calculate cutting speed for cutting external angle with compound.
- Describe the procedures for cutting external angles.
- Identify the correct cutting fluid for cutting external angles.
- Cut an external taper with a compound on a work piece.

**TASK:** Cut internal tapered surfaces

Level II

**PERFORMANCE OBJECTIVE:** Given blueprint, work piece, boring bar, tool blank, boring bar holder, cutting fluid, and precision measuring instruments, cut internal tapered surface on work piece using taper attachment to a tolerance of  $\pm .002$  inch on the diameter, and  $\pm .005$  on the length, and to print surface finish requirements.

**ENABLING OBJECTIVES:**

- Explain the safety precautions/procedures for cutting internal tapered surface.
- Calculate speeds and feeds for internal tapering operations.
- Describe the procedures for boring internal tapers with taper attachment.
- Identify the correct cutting fluids for boring internal tapers.
- Cut an internal taper on a work piece.

**TASK:** Perform contour, angular, or radial cuts with lathes

Level II

**PERFORMANCE OBJECTIVE:** Given blueprints, work piece, tool blanks, tool holder, cutting fluid, radius work piece, and precision measuring instruments, free hand form work piece to concave and convex radii and angular into per blueprint and visual inspection.

**ENABLING OBJECTIVES:**

- Explain the safety precautions/procedures for free hand forming a work piece.
- Describe the procedures for angular concave or contour cuts with lathes.
- Explain the proper use of radius gauges.
- Calculate speeds for free hand forming operations.
- Describe the procedures for free hand forming concave and convex radii.
- Identify the correct cutting fluids.
- Cut contour, concave and angular surfaces on a work piece.

**TASK: Set up and use follower and steady-rests**

**Level II**

**PERFORMANCE OBJECTIVE: Given blueprint, face plate, dog, steady rest and follower rest, turn long shaft between centers.**

**ENABLING OBJECTIVES:**

**Explain safety precautions for using follow and steady rests.**

**Install face plate.**

**Describe the procedure to install work using a lathe dog and faceplate.**

**Install steady rest or follower rest and adjust to part.**

**Turn work to size with proper follow and steady rest setup.**

**TASK: Set up face plates and lathe dogs**

**Level II**

**PERFORMANCE OBJECTIVE: Given blueprint, face plate, clamping tools, tool blanks, center drill, drill, boring bar, and work piece, face, drill and bore work piece holding a tolerance of  $\pm .005$  on all dimensions and to a surface finish as specified on print.**

**ENABLING OBJECTIVES:**

**Explain the safety precautions/procedures for facing, drilling, and boring operations.**

**Describe the use of the face plate and the importance of counter-balancing the work piece.**

**Describe the procedure for clamping and aligning part to face plate.**

**Calculate cutting speeds for facing, drilling and boring.**

**Identify the correct fluid for facing, drilling and boring operations.**

**CURRICULUM STANDARDS FOR PRECISION MACHINING**

**MODULE 8**

**MILLING MACHINES**

## MODULE 8 - MILLING MACHINES

This is one of a series of modules which comprise the Idaho Curriculum Guide for Precision Machining. Each module contains a listing of the tasks, performance objectives, and enabling objectives required to enable a student to achieve competency in a specific system or field of study within the basic machining technician occupational field. The numbering of these modules is not intended to dictate an order of instruction or scheduling. The order in which these modules may be taught is determined by each institution and its instructors.

Each task describes an occupational activity which will result in a finished process or product. The tasks listed in each module represent the basic activities required of each student to demonstrate entry level competence for that specific system or field of study within the machining occupation. Individual records of student performance in completing the tasks listed within each module should be maintained.

Although some provision is made for basic mathematics and communication skills within these standards, they may not be adequate to meet the needs of individual students. Counseling, guidance, and diagnostic test results may indicate a need for further preparation in these areas. In such cases, instructors are encouraged to utilize the resources and personnel within the institution to improve or complement the instructional process.

The benefits to students and institutions derived from these curriculum standards should be considerable. Articulation of students from secondary to post-secondary programs will be aided through the use of a single set of curriculum standards. The curriculum standards provide a tool for evaluation of local curricula and programs. The curriculum standards may be used in a flexible manner to assure that Precision Machining programs meet the needs of local business and industry.

It is the goal of this program curriculum guide to provide a level of instruction which will impart entry level employment skills. Students should be carefully counseled on the importance of attaining competency in the tasks assigned. As in virtually all occupations today, machining technicians will require periodic up-dating and review in the future. It is important that each student understand that meeting the program curriculum standards is essential not only to obtain employment today but also to have a base upon which to retain employment in the future.

## **MODULE 8 - DEMONSTRATE PROFICIENCY IN SETTING UP AND OPERATING MILLING MACHINES**

**TASK: Identify the parts of the Horizontal and Vertical Milling Machine**

**Level II**

**PERFORMANCE OBJECTIVE:** Given a milling machine and service manual, identify major parts and their function.

**ENABLING OBJECTIVES:**

Identify types of milling machines.

Identify major parts of milling machines.

Describe the function of major parts.

**TASK: Lubricate Milling Machines**

**Level II**

**PERFORMANCE OBJECTIVES:** Given service manual and/or lubrication chart, lubricants and tools, clean, inspect and lubricate the milling machine in accordance with charts in operation manual. All lubrication points will be supplied with the correct amount and type of lubricant.

**ENABLING OBJECTIVES:**

Explain the safety precautions/procedures for cleaning, lubricating and inspecting the milling machine.

Explain the reasons for performing routine cleaning, inspection, and lubrication of milling machines.

Determine the proper lubricants to be used for milling machines.

Explain the meaning of the terms (a) climb; (b) conventional milling.

Describe the procedures for cleaning, lubricating and inspecting the milling machine.

Lubricate a milling machine.

**TASK: True up the Head and Align Milling Machine Fixtures**

**Level II**

**PERFORMANCE OBJECTIVE:** Given a milling machine with a swivel type head and dial indicator with attachments, align the table and must be aligned to within .001 inch T.I.R. at a 4 inch radius and align vise on milling machine table to within .001 inch T.I.R.

**ENABLING OBJECTIVES:**

Explain the safety precautions/procedures in alignment of heads.

Explain the operation of a swivel head on a mill.

Explain the use of dial indicator for aligning swivel heads.

Describe the procedures for aligning the head of a milling machine.

Describe the procedures for aligning a vise on a milling table.

Align a vise on a milling table.

Align a head of a milling machine.

**TASK: Select and Set Feeds and Speeds for Milling Work**

**Level II**

**PERFORMANCE OBJECTIVE:** Given a known hardness of a variety of materials, determine the correct speeds and feeds for milling using handbook.

**ENABLING OBJECTIVES:**

List the correct cutting speed and feed for the following materials:

cold rolled steel, with 1/2" end mill.

aluminum, with 1/4" end mill.

tool steel, with 3/8" end mill.

Set correct feeds and speeds on a milling machine for selected material.

**TASK: Square up Work pieces with a Table Vise**

**Level II**

**PERFORMANCE OBJECTIVES:** Given a blueprint, work piece, end mill or face mill, cutting fluids, milling machine vise, parallels, soft face hammer, and precision measuring instruments, mill a block of metal square holding a tolerance of  $\pm .001$  inch for linear dimensions.

**ENABLING OBJECTIVES:**

Explain the safety precautions/procedures for milling operations.

Calculate the correct speed and feed for various cutters.

Describe the procedures for setting-up and machining a work piece parallel and square.

Identify the correct cutting fluids for milling.

Mill a block of metal to square within required tolerances.

**TASK: Perform End Milling**

**Level II**

**PERFORMANCE OBJECTIVES:** Given blueprint, work piece holding device, end mill, cutting fluid, and precision measuring instrument, mill a flat surface to .001 T.I.R.

**ENABLING OBJECTIVE:**

Explain the safety precautions/procedures for end milling.

Calculate proper speeds, feeds and depth of cut with end milling.

Describe the procedures for setting up and end milling a flat surface.

Identify the correct cutting fluids for milling.

End mill a flat surface to .001 T.I.R.

**TASK: Perform Fly-Cutting Operations**

**Level II**

**PERFORMANCE OBJECTIVE:** Given a blueprint, work piece, fly-cutter, cutting tool blank, and precision measuring instruments, fly-cut work piece surface to print requirements.

**ENABLING OBJECTIVES:**

- Explain the safety precautions/procedures for fly-cutting a work piece surface.
- Define surface roughness, waviness, lay and identify their symbols.
- Explain the purpose of fly-cutters.
- Calculate speeds, feeds, and determine depth of cut for fly-cutting surfaces.
- Describe the procedures for fly-cutting surfaces.
- Fly-cut a work piece surface to required tolerances.

**TASK: Drill Holes with a Milling Machine**

**Level II**

**PERFORMANCE OBJECTIVE:** Given a blueprint, work piece, center drill and drill, layout materials, and precision measuring instruments, drill equally spaced holes in work piece holding a tolerance of  $\pm .002$  inch for location and diameter, and  $\pm 1$  degree for perpendicularity.

**ENABLING OBJECTIVES:**

- Explain safety precautions/procedure for drilling holes.
- Describe the procedures for using milling machine dials for accurate table positioning.
- Calculate the amount of table movement for each position.
- Describe the procedures for compensating for backlash out the lead screws.
- Calculate the correct speed and feed.
- Drill holes in a work piece to specified tolerances using a milling machine.

**TASK: Perform Reaming Operations**

**Level II**

**PERFORMANCE OBJECTIVES:** Given blueprint, work piece, holding device, centerdrill, drill, reamer, cutting fluid, and precision measuring instruments, centerdrill, drill and ream a hole holding a tolerance of  $+ .002$ ,  $- .000$  for diameter, and  $.002$  for the hole's true position according to print specifications.

**ENABLING OBJECTIVES:**

- Explain the safety precautions/procedures for centerdrilling and reaming a hole.
- Explain the uses of centerdrills, drills, and reamers.
- Calculate proper speeds and feeds for centerdrilling, drilling, and reaming operations.
- Describe the procedures for centerdrilling, drilling, and reaming on a milling machine.
- Identify the correct cutting fluids for centerdrilling, drilling and reaming.
- Determine the proper drill size for reaming.
- Ream a hole in a work piece holding required tolerances.

**TASK: Cut External Keyways**

**Level II**

**PERFORMANCE OBJECTIVE:** Given blueprint, work piece holding device, end mill, cutting fluid, and precision measuring instruments, end mill keyseat in the work piece holding a tolerance of + .001, - .000 inch for width, + .005, - .000 depth,  $\pm$  1/64 inch for length.

**ENABLING OBJECTIVES:**

- Explain the safety precautions/procedures for end milling keyseats.
- Calculating proper speeds, feeds, and depth of cut when milling keyseats.
- Describe the procedures for setting up and milling keyseats.
- Identify the correct cutting fluids for milling keyseats.
- Determine keyway depth.
- End mill a keyseat in a work piece holding required tolerances.

**TASK: Bore Hole with Milling Machines**

**Level II**

**PERFORMANCE OBJECTIVE:** Given a blueprint with bore specifications, work piece, work holding device, boring head, cutting fluid and precision measuring instruments, bore hole in work piece with boring head holding print tolerances.

**ENABLING OBJECTIVES:**

- Explain the safety precautions/procedures for boring and counterboring holes.
- Explain the procedures for accurately adjusting a boring head.
- Calculate speeds and feeds for boring operations.
- Describe the procedures for setting up and completing boring operations.
- Identify the correct cutting fluids for boring and counterboring.
- Bore a hole in a work piece using a boring head on a milling machine to required tolerances.

**TASK: Perform Form Milling**

**Level II**

**PERFORMANCE OBJECTIVE:** Given a blueprint, work piece, form cutter, cutting fluids, and precision measuring instruments, form mill work piece holding print tolerances.

**ENABLING OBJECTIVES:**

- Explain the safety precautions/procedures for form milling.
- Define the terms concave and convex as they pertain to milling cutters.
- Calculate speeds, feeds, and depth of cut for milling cutter.
- Describe the procedures for form milling.
- Identify the correct cutting fluids.
- Form mill a work piece to required tolerances.

**TASK: Perform Indexing Operations Using a Dividing Head**

**Level II**

**PERFORMANCE OBJECTIVE:** Given blueprint, milling machine with an indexing head, Machinery's Handbook, change gears, cutting tools, cutting fluids, and precision measuring instruments, machine work piece using differential indexing locating odd numbers of divisions over 40.

**ENABLING OBJECTIVES:**

- Explain the safety precautions/procedures for machining using the differential indexing method.
- Explain the calculations for the indexing head when performing differential indexing.
- Explain the proper technique for assembling gears in gear train.
- Define simple gearing and compound gearing.
- Explain the use of an idler gear.
- Describe the procedures for machining a work piece using differential indexing.
- Identify the correct cutting fluids.
- Explain the use of wide range indexing.
- Machine a work piece with differential indexing using a dividing head.

**TASK: Set Up and Operate Rotary Tables**

**Level II**

**PERFORMANCE OBJECTIVE:** Given blueprint, work piece, milling machine with rotary table, end mills, cutting fluids, and precision measuring instruments, machine an outside radius holding print tolerances.

**ENABLING OBJECTIVES:**

- Explain the safety precautions/procedures for milling radii using a rotary table.
- Describe set up and clamping procedures for a rotary table.
- List the applications for a rotary table.
- Explain the procedures for avoiding backlash of rotary table and milling machine screws.
- Calculate the correct speeds for machining outside radius.
- Describe the procedure for milling outside radius using a rotary table.
- Identify the correct cutting fluids.
- Describe the procedures for centering spindle with rotary table.
- Mill an outside radius using a rotary table on a machining machine.

**TASK: Mill an External Radius**

**Level II**

**PERFORMANCE OBJECTIVE:** Given blueprint, work piece, milling machine with rotary table, end mills, cutting fluids, and precision measuring instruments, machine an inside radius holding print tolerances.

**ENABLING OBJECTIVES:**

Explain the safety precautions/procedures for cutting radii using a rotary table.

Calculate the correct speeds for milling inside radius.

Describe the procedures for machining inside radii using a rotary table.

Identify the correct cutting fluids.

Machine an internal radius using a rotary table on a milling machine.

**TASK: Mill an Angle**

**Level II**

**PERFORMANCE OBJECTIVE:** Give blueprint, milling machine, with an indexing head, drills, Machinery's Handbook, work piece, cutting fluids, and precision measuring instruments, drill holes in work piece to specified angles using the indexing head.

**ENABLING OBJECTIVES:**

Explain the safety precautions/procedures for milling holes using angular indexing.

Explain the calculations required for the indexing head when performing angular indexing.

Calculate speeds and feeds for angular indexing operations.

Describe the procedures for milling holes using angular indexing.

Identify the correct cutting fluids.

Drill holes in a work piece to specified angles using an indexing head.

**TASK: Align Milling Machine Attachments**

**Level II**

**PERFORMANCE OBJECTIVE:** Given a milling machine and a dial indicator with attachments, align milling machine attachments to within .001 inch T.I.R.

**ENABLING OBJECTIVES:**

Explain the safety precautions/procedures in alignment of attachment.

Explain the use of dial indicator for aligning attachment.

Describe the procedures for aligning the milling attachment.

Align various milling machine attachments to within .001 T.I.R.

**TASK: Mill Internal Slots with a slotting attachment**

**Level II**

**PERFORMANCE OBJECTIVE:** Given a blueprint, work piece, milling machine with slotting attachment, cutting fluids, precision measuring instruments, and tool blanks, machine internal slots and keyway holding a tolerance as specified on blueprint.

**ENABLING OBJECTIVES:**

Explain the safety precautions/procedures for cutting internal slots and keyways.

Explain the ability to grind and sharpen cutting tools.

Determine the correct cutters for various applications.

Calculate depth and size of keyways and slots.

Describe set up procedures for the length of stroke.

Calculate speed in strokes per minute.

Describe procedures for machining internal slots and keyways.

**TASK: Perform Cutting-Off Operation**

**Level II**

**PERFORMANCE OBJECTIVE:** Given a milling machine, arbor and slitting saw, cut multiple work pieces to precision lengths and slot various shapes of work pieces.

**ENABLING OBJECTIVES:**

Explain how to calculate depths, speeds and feeds for slitting saws.

Explain how to set up work pieces with kickers to cut precision lengths.

Cut work pieces to precision lengths.

Slot various shapes of work pieces.

**TASK: Set Up and Perform Slab Mill Operations**

**Level II**

**PERFORMANCE OBJECTIVE:** Given blueprint, work piece, horizontal milling machine, slab milling cutter, arbor with spacers, work holding device, cutting fluids, and precision measuring instruments, mill the work piece. After rough and finish cut, parallelism must be within .002 inch per 6 inches of length.

**ENABLING OBJECTIVES:**

Explain the safety precautions/procedures for slab milling.

Explain the importance of maintaining a clean milling machine.

Describe procedures for mounting cutter and arbor in the milling machine.

Explain why the cutter should always be mounted on the arbor as close to the column of the milling machine as possible.

Describe the procedures for slab milling operations.

Identify the correct cutting fluid.

Explain the purpose of the applications for using climb milling and conventional milling.

Mill, rough and finish cut a work piece to required tolerances.

**TASK: Use an Edge Finder and Wiggler**

**Level II**

**PERFORMANCE OBJECTIVE:** Given a work piece and an edge finder or wiggler locate the center of the work piece to within  $\pm .001$  inch.

**ENABLING OBJECTIVES:**

Explain the safety precautions/procedures.

Explain the correct care and use of an edge finder or wiggler.

Describe the procedures for touching off with an edge finder and a wiggler.

Mark the center of a work piece after locating it with a wiggler or edge finder.

**TASK: Use Digital Readouts**

**Level II**

**PERFORMANCE OBJECTIVE:** Given a blueprint, work piece, center drill and drill, layout materials, digital read out, and precision measuring instruments, drill equally spaced holes in work piece holding a tolerance of  $\pm .0005$  non-cumulative location.

**ENABLING OBJECTIVES:**

Explain the safety cutting precautions/procedures for drilling holes.

Describe the procedures for using digital read out for accurate table positioning.

Calculate the amount of table movement for each position.

Describe the procedures for keeping backlash out of lead screws.

Calculate the correct cutting speed and feed.

Describe the procedures for drilling equally spaced holes.

Identify the correct cutting fluids for drilling.

Drill equally spaced holes in a work piece using digital read outs to locate centers.

**TASK: Perform Straddle Milling Operations on the Horizontal Mill**

**Level II**

**PERFORMANCE OBJECTIVE:** Given a blueprint, work piece, work holding device, milling cutter, arbor spacer, cutting fluids, and precision measuring instruments, gang mill work pieces holding a tolerance of  $\pm .005$  on depth, width and spacing.

**ENABLING OBJECTIVES:**

Explain the safety precautions/procedures.

Explain the purpose of and applications for gang milling operations.

Describe the procedures for mounting cutters and arbor in machine.

Explain why a key is needed in the arbor.

Calculate speed, feed, and depth of cut for gang milling operations.

Describe the procedures for gang milling.

**TASK: Set Up and Use a Sine Vise**

**Level II**

**PERFORMANCE OBJECTIVE:** Given a milling sine vise, work piece, parallels, soft face hammer, and precision measuring instruments, seat work piece in vise to within .003 T.I.R. per 4 inches.

**ENABLING OBJECTIVES:**

Explain the safety precautions/procedures.

Describe the care and use of parallels.

Describe the procedures for seating a part in a milling sine vise.

Set up and seat a work piece in a sine vise.

**PRECISION MACHINING  
LEVEL III**

**Prerequisite: Level II**

**A course designed to provide student with team work, critical thinking, problem solving, diagnostics, and repairing/producing to industry standards**

## TASK LISTING

STUDENT PERFORMANCE STANDARDS

EFFECTIVE DATE: June 2008

PROGRAM AREA: Trade & Industrial Education

PROGRAM TITLE: Precision Machining Technology

**DEMONSTRATE EMPLOYABILITY SKILLS - The student will be able to:**

Level III

- Identify employment opportunities
- Apply employment-seeking skills
- Interpret employment capabilities
- Demonstrate appropriate work behavior
- Maintain a business-like image
- Maintain working relationships with others
- Communicate on the job
- Adapt to change
- Demonstrate a knowledge of business operation

**PERFORM PREREQUISITE MACHINING SKILLS - The student will be able to:**

Level III

- Demonstrate proficiency in maintaining immediate work area
- Perform mathematical calculations
- Demonstrate proficiency in blueprint reading and machine planning
- Perform measuring operations
- Perform maintenance on machines and tools

**DEMONSTRATE PROFICIENCY IN PERFORMING BENCH WORK SKILLS**

The student will be able to:

Level III

- Cut materials by using hand hacksaws
- Cut threads by using hand taps and dies
- Ream holes by using hand reamers
- Hand-sharpen cutting tools by using abrasive stones
- Remove damaged screws and other hardware
- Set up and use arbor press broaches
- Deburr work pieces
- Identify and use proper hand finishing tools

**DEMONSTRATE PROFICIENCY IN SETTING UP AND OPERATING LATHES -**

The student will be able to:

**Level III**

- Identify the parts of the lathe
- Comply with safe and efficient work practices
- Measure stock
- Set up an engine lathe
- Secure tools, tool-holders and fixtures or attachments
- Select and set feeds and speeds
- Set up lathes and face work pieces held in chucks
- Rough-cut and finish-cut with lathes
- Deburr parts using filing procedures
- Align lathe centers using accurate methods
- Drill holes with lathes
- Countersink holes with lathes
- Ream holes with lathes
- Tap threads with lathes
- Die-cut threads with lathes
- Counter bore holes with lathes
- Bore holes with lathes
- Knurl parts with lathes
- Cut external threads with lathes
- Re-chase threads with lathes
- Cut internal threads with lathes
- Set up and perform taper turning with taper attachments
- Set up and perform taper turning with compound
- Cut internal tapered surfaces
- Set up and operate tool post grinders
- Perform contour, angular or radial cuts with lathes
- Set up and use follow and steady-rests
- Set up face plates and dogs

**DEMONSTRATE PROFICIENCY IN SETTING UP AND OPERATING MILLING MACHINES - The student will be able to:**

**Level III**

- Identify the parts of the horizontal and vertical milling machine
- Lubricate milling machines.
- True up the head and align milling machines fixtures
- Select and set feeds and speeds for milling work
- Square up work pieces with a table vise
- Perform end milling
- Perform fly-cutting operations
- Drill holes with a milling machine
- Perform reaming operations
- Cut external keyways
- Bore holes with milling machines
- Perform form milling

- Perform indexing operations using a dividing head
- Set up and operate rotary tables
- Mill cylindrical work
- Mill an external radius
- Mill an angle
- Align milling machine attachments
- Mill internal slots with a slotter and attachment
- Perform cutting-off operations
- Set up and perform slab mill operations
- Use an edge finder and wiggler
- Use digital readouts
- Set up and use a sine vise

**DEMONSTRATE PROFICIENCY IN SETTING UP AND OPERATING SURFACE GRINDING MACHINES - The student will be able to:**

**Level III**

- Identify the parts of the machine
- Comply with safe and efficient work practices
- Clean and lubricate surface grinding machine
- Select the proper wheel
- Inspect, balance, dress, and true grinding wheels
- Attach and align work pieces for grinding operations
- Set up and grind parallel flat surfaces
- Set up and grind four sides square
- Set up and use angle plates
- Cut off or part work pieces with grinding machines
- Measure, inspect, and rework work pieces on grinding machines
- Set up, grind, and sharpen pre-shaped lathe tools
- Set up and use radius dressers

**DEMONSTRATE PROFICIENCY IN APPLYING COMPUTERIZED NUMERICAL CONTROL OPERATIONS - The student will be able to:**

**Level III**

- Identify the parts of the machine
- Comply with safe and efficient work practices
- Identify and select proper machine controls
- Write a program and apply basic programming skills to a turning and/or a milling operation
- Select proper work holders
- Select proper cutting tools
- Machine parts to blueprint tolerances
- Demonstrate the use of CAD/CAM system for part program development

**CURRICULUM STANDARDS FOR PRECISION MACHINING**

**MODULE 1**

**EMPLOYABILITY SKILLS**

## MODULE 1 - EMPLOYABILITY SKILLS

This is one of a series of modules which comprise the Idaho Curriculum Guide for Precision Machining. Each module contains a listing of the tasks, performance objectives, and enabling objectives required to enable a student to achieve competency in a specific system or field of study within the basic machining technician occupational field. The numbering of these modules is not intended to dictate an order of instruction or scheduling. The order in which these modules may be taught is determined by each institution and its instructors.

Each task describes an occupational activity which will result in a finished process or product. The tasks listed in each module represent the basic activities required of each student to demonstrate entry level competence for that specific system or field of study within the machining occupation. Individual records of student performance in completing the tasks listed within each module should be maintained.

Although some provision is made for basic mathematics and communication skills within these standards, they may not be adequate to meet the needs of individual students. Counseling, guidance, and diagnostic test results may indicate a need for further preparation in these areas. In such cases, instructors are encouraged to utilize the resources and personnel within the institution to improve or complement the instructional process.

The benefits to students and institutions derived from these curriculum standards should be considerable. Articulation of students from secondary to post-secondary programs will be aided through the use of a single set of curriculum standards. The curriculum standards provide a tool for evaluation of local curricula and programs. The curriculum standards may be used in a flexible manner to assure that Precision Machining programs meet the needs of local business and industry.

It is the goal of this program curriculum guide to provide a level of instruction which will impart entry level employment skills. Students should be carefully counseled on the importance of attaining competency in the tasks assigned. As in virtually all occupations today, machining technicians will require periodic up-dating and review in the future. It is important that each student understand that meeting the program curriculum standards is essential not only to obtain employment today but also to have a base upon which to retain employment in the future.

## MODULE 1 - EMPLOYABILITY SKILLS

**TASK: Identify Employment Opportunities**

Level III

**PERFORMANCE OBJECTIVE:** Given the information resources of a library, obtain and compile the information needed to seek a job.

**ENABLING OBJECTIVES:**

- Identify the requirements for a job.
- Investigate educational opportunities.
- Investigate occupational opportunities.
- Locate resources for finding employment.
- Confer with prospective employers.
- Identify job trends.

**TASK: Apply Employment-Seeking Skills**

Level III

**PERFORMANCE OBJECTIVE:** Given appropriate information, locate a job opportunity, prepare and take an interview for it, complete the required tests, forms and applications, and evaluate a response to the job opportunity.

**ENABLING OBJECTIVES:**

- Locate a job opening.
- Complete a resume.
- Prepare for an interview.
- Participate in an interview.
- Complete tests required.
- Complete forms required.
- Complete an application letter.
- Complete a follow-up letter.
- Complete an acceptance letter.
- Evaluate a job offer.
- Evaluate a job rejection.

**TASK: INTERPRET EMPLOYMENT CAPABILITIES**

Level III

**PERFORMANCE OBJECTIVE:** Given the assignment to explain how your capabilities make you employable, demonstrate how to match skills and experience to a job being sought.

**ENABLING OBJECTIVES:**

- Match an interest to job area.
- Match aptitudes to job area.
- Verify abilities.
- Identify immediate work goal.
- Develop a career plan.

**TASK: DEMONSTRATE APPROPRIATE WORK BEHAVIOR**

**Level III**

**PERFORMANCE OBJECTIVE:** Given the responsibility of an employee in a new job, demonstrate knowledge of appropriate behavior in the work place.

**ENABLING OBJECTIVES:**

- Exhibit dependability.
- Demonstrate punctuality.
- Follow rules and regulations.
- Explain the consequences of dishonesty.
- Complete assignments accurately and on time.
- Control emotions.
- Take responsibility for decisions and actions
- Take pride in work and be a loyal worker.
- Learn to handle pressures and tensions.
- Demonstrate ability to set priorities.
- Demonstrate problem-solving skills.

**TASK: MAINTAIN A BUSINESS-LIKE IMAGE**

**Level III**

**PERFORMANCE OBJECTIVE:** Given a responsibility to perform the duties of a new job, with a new employer, demonstrate a knowledge of the actions and behaviors which will project a business-like image

**ENABLING OBJECTIVES:**

- Participate in the institution's orientation.
- Demonstrate knowledge of company or agency products and services.
- Identify the requirements for a job.
- Investigate educational opportunities.
- Investigate occupational opportunities.
- Locate resources for finding employment.
- Confer with prospective employers.
- Identify job trends.

**TASK: MAINTAIN WORKING RELATIONSHIPS WITH OTHERS**

**Level III**

**PERFORMANCE OBJECTIVE:** Given the responsibility to perform the duties of a new job, with a new employer, demonstrate knowledge of how to successfully work with others.

**ENABLING OBJECTIVES:**

- Work productively with others.
- Show empathy, respect, and support for others.
- Demonstrate procedures and assist others when necessary.
- Recognize problems and work toward their solution.
- Minimize the occurrence of problems.
- Channel emotional reactions in positive ways.

**TASK: COMMUNICATE ON THE JOB**

**Level III**

**PERFORMANCE OBJECTIVE:** Given the responsibility to perform the duties of a new job, with a new employer, demonstrate knowledge of how to communicate on the job.

**ENABLING OBJECTIVES:**

- Read and comprehend written communications.
- Use correct grammar.
- Speak clearly when addressing others.
- Use job-related terminology.
- Listen attentively.
- Write legibly.
- Use telephone etiquette.
- Follow written and oral directions.
- Ask questions.
- Locate information needed to complete the task.
- Prepare written communication.
- Demonstrate keyboarding skills.
- Demonstrate computer skill.

**TASK: ADAPT TO CHANGE**

**Level III**

**PERFORMANCE OBJECTIVE:** Given the responsibility to perform the duties of a new job, with a new employer, demonstrate knowledge of how to adapt to change.

**ENABLING OBJECTIVES:**

- Recognize the need to change.
- Demonstrate a willingness to learn.
- Demonstrate flexibility.
- Participate in continuing education.
- Seek challenge in the work place.
- Adjust goals and plans when necessary.

**CURRICULUM STANDARDS FOR PRECISION MACHINING**

**MODULE 2**

**PREREQUISITE MACHINING**

## MODULE 2 - PREREQUISITE MACHINING

This is one of a series of modules which comprise the Idaho Curriculum Guide for Precision Machining. Each module contains a listing of the tasks, performance objectives, and enabling objectives required to enable a student to achieve competency in a specific system or field of study within the basic machining technician occupational field. The numbering of these modules is not intended to dictate an order of instruction or scheduling. The order in which these modules may be taught is determined by each institution and its instructors.

Each task describes an occupational activity which will result in a finished process or product. The tasks listed in each module represent the basic activities required of each student to demonstrate entry level competence for that specific system or field of study within the machining occupation. Individual records of student performance in completing the tasks listed within each module should be maintained.

Although some provision is made for basic mathematics and communication skills within these standards, they may not be adequate to meet the needs of individual students. Counseling, guidance, and diagnostic test results may indicate a need for further preparation in these areas. In such cases, instructors are encouraged to utilize the resources and personnel within the institution to improve or complement the instructional process.

The benefits to students and institutions derived from these curriculum standards should be considerable. Articulation of students from secondary to post-secondary programs will be aided through the use of a single set of curriculum standards. The curriculum standards provide a tool for evaluation of local curricula and programs. The curriculum standards may be used in a flexible manner to assure that Precision Machining programs meet the needs of local business and industry.

It is the goal of this program curriculum guide to provide a level of instruction which will impart entry level employment skills. Students should be carefully counseled on the importance of attaining competency in the tasks assigned. As in virtually all occupations today, machining technicians will require periodic up-dating and review in the future. It is important that each student understand that meeting the program curriculum standards is essential not only to obtain employment today but also to have a base upon which to retain employment in the future.

## MODULE 2 - PREREQUISITE MACHINING SKILLS

**TASK: Demonstrate Proficiency in Maintaining Immediate Work Area**

**Level III**

**PERFORMANCE OBJECTIVE:** Given appropriate materials and supplies the student will be able to demonstrate proficiency to maintain work areas in a machine shop.

**ENABLING OBJECTIVES:**

Demonstrate the knowledge of shop safety rules and practices.

Describe procedures for the proper disposal of scrap metal chips, shavings, oil, and coolant.

List shop operating rules and practices.

Demonstrate procedures to clean and maintain work areas affected by operations of work and shop areas.

Demonstrate knowledge of maintaining a clean and orderly shop.

Demonstrate knowledge of leaving work and shop area in a safe condition.

**TASK: Perform Mathematical Calculation's**

**Level III**

**PERFORMANCE OBJECTIVE:** Given the appropriate tools, equipment and resource material, the student will demonstrate the ability to perform accurate mathematical calculations relating to machine set up, material, and machine shop environment.

**ENABLING OBJECTIVES:**

Accurately perform job related decimal and fraction calculations.

Demonstrate proficiency solving job-related problems using basic formulas.

Demonstrate proficiency solving job-related problems using basic geometry.

Demonstrate proficiency measuring a work piece and compare measurements with blueprint specifications.

Demonstrate proficiency calculating the amount of material that should be removed to obtain correct limits for secondary operations.

Demonstrate proficiency in solving job-related problems using mathematical handbooks, charts, and tables.

Demonstrate proficiency in converting measurements from English to metric and from metric to English units.

Demonstrate proficiency in determining the clearance, relief, and rake of cutting tools.

Demonstrate proficiency in calculating machine speeds and feeds using appropriate formulas.

**TASK: Demonstrate Proficiency in Blueprint Reading and Machine Planning**

**Level III**

**PERFORMANCE OBJECTIVE:** Given the appropriate tools, materials, and prints, the student will demonstrate proficiency in reading blueprints to layout and prepare stock for machining operations.

**ENABLING OBJECTIVES:**

- Interpret view concepts.
- Read lines.
- Read and interpret title blocks.
- Read and interpret change orders on working and assembly prints.
- Read and interpret abbreviations.
- Make shop sketches.
- Read and interpret blueprints, including geometric tolerancing.
- Determine and interpret reference information used in performing machine work.
- Perform layout for precision machine work by using layout instruments.
- Lay out radial and bolt hole circles.
- Select the most productive tool and tooling for a given operation.

**TASK: Perform Measuring Operations**

**Level III**

**PERFORMANCE OBJECTIVE:** Given the appropriate tools and operation pieces, the student will accurately measure work pieces using the proper measuring instruments.

**ENABLING OBJECTIVES:**

- Read and measure with rules and calipers.
- Read and measure with micrometers.
- Read and measure with vernier tools.
- Read and measure with dial indicators.
- Measure using as surface plate.
- Read and interpret surface finish (ANSI Y14)

**TASK: Perform Maintenance on Machines and Tools**

**Level III**

**PERFORMANCE OBJECTIVE:** Given the appropriate tools, equipment, and supplies, the student will be able to perform maintenance functions on machining equipment and tools to restore the equipment to full operating condition.

**ENABLING OBJECTIVES:**

- Inspect work areas to assure a safe working environment.
- Lubricate equipment parts.
- Clean and store hand tools, cutters, fixtures, jigs, and attachments.
- Inspect and repair hand tools.
- Inspect drive pulleys or belts.
- Select lubricants for machining operations.
- Inspect equipment for safe operational conditions.
- Store grinding wheels and precision tools

**CURRICULUM STANDARDS FOR PRECISION MACHINING**

**MODULE 3**

**BENCH WORK**

## MODULE 3 - BENCH WORK

This is one of a series of modules which comprise the Idaho Curriculum Guide for Precision Machining. Each module contains a listing of the tasks, performance objectives, and enabling objectives required to enable a student to achieve competency in a specific system or field of study within the basic machining technician occupational field. The numbering of these modules is not intended to dictate an order of instruction or scheduling. The order in which these modules may be taught is determined by each institution and its instructors.

Each task describes an occupational activity which will result in a finished process or product. The tasks listed in each module represent the basic activities required of each student to demonstrate entry level competence for that specific system or field of study within the machining occupation. Individual records of student performance in completing the tasks listed within each module should be maintained.

Although some provision is made for basic mathematics and communication skills within these standards, they may not be adequate to meet the needs of individual students. Counseling, guidance, and diagnostic test results may indicate a need for further preparation in these areas. In such cases, instructors are encouraged to utilize the resources and personnel within the institution to improve or complement the instructional process.

The benefits to students and institutions derived from these curriculum standards should be considerable. Articulation of students from secondary to post-secondary programs will be aided through the use of a single set of curriculum standards. The curriculum standards provide a tool for evaluation of local curricula and programs. The curriculum standards may be used in a flexible manner to assure that Precision Machining programs meet the needs of local business and industry.

It is the goal of this program curriculum guide to provide a level of instruction which will impart entry level employment skills. Students should be carefully counseled on the importance of attaining competency in the tasks assigned. As in virtually all occupations today, machining technicians will require periodic up-dating and review in the future. It is important that each student understand that meeting the program curriculum standards is essential not only to obtain employment today but also to have a base upon which to retain employment in the future.

## MODULE 3 - PERFORM BENCH WORK SKILLS

**TASK:** Cut materials by using hand hacksaws

Level III

**PERFORMANCE OBJECTIVE:** Given a dimensioned blueprint of a work piece, raw material, and a hand hacksaw, the student will be able to:

**ENABLING OBJECTIVES:**

- Explain the safety precautions/procedures for use of a hand hacksaw.
- Determine teeth per inch on various hacksaw blades.
- Describe the applications for saw blades with different ratios of tooth pitch.
- Demonstrate the correct method of sawing materials with a hand hacksaw.

**TASK:** Cut threads by using hand taps and dies

Level III

**PERFORMANCE OBJECTIVE:** Given a dimensioned blueprint, work piece, tap, die, tap wrench, die stock, cutting fluids and measuring instruments, cut internal and external threads to a class #2 fit.

**ENABLING OBJECTIVES:**

- Explain safety precautions/procedures for threading with taps and dies.
- Identify and explain the use of the three taps used for threading a blind hole.
- Select cutting fluids.
- Describe the procedure for cutting internal and external threads with a tap or die.
- Explain the correct procedure to align a tap with the hole.

**TASK:** Ream holes by using hand reamers

Level III

**PERFORMANCE OBJECTIVE:** Given a hand reamer, ream a series of previously drilled holes to a tolerance of  $\pm .001$ .

**ENABLING OBJECTIVES:**

- Demonstrate the proper method of hand reaming holes using both adjustable and non-adjustable reamers.
- Explain the types of lubricants and their applications to reaming.
- Explain the correct drill sizes as they relate to the various sizes of reamers.

**TASK:** Hand sharpen cutting tools by using abrasive stones

Level III

**PERFORMANCE OBJECTIVE:** Given a bench stone and a variety of cutting tools, hone the cutting edges to remove burrs and smooth the surfaces.

**ENABLING OBJECTIVES:**

- Determine and demonstrate how to correctly hold various cutting tools to the angles characteristic to that tool.

Explain why bench stones require lubricants.

**TASK:** Remove damaged screws and other hardware

Level III

**PERFORMANCE OBJECTIVE:** Given a set of easy outs, a broken bolt in a piece of material, tap extractor and broken tap, remove these broken items from a variety of materials with a minimum of damage to the work piece.

**ENABLING OBJECTIVES:**

Explain the safety precautions/procedures for using easy outs and tap extractors.

Explain the purpose of easy outs and tap extractors.

Determine the correct drill sizes used with various easy outs.

Determine the correct tap extractor for various taps.

Describe the procedures for using easy outs and tap extractors.

Remove damaged screws.

**TASK:** Set up and use arbor press broaches

Level III

**PERFORMANCE OBJECTIVE:** Given an arbor press, broaches and lubricant, cut internal spline and keyways to a tolerance of  $\pm.002$ .

**ENABLING OBJECTIVES:**

Explain why broaches have to be shimmed.

Explain why lubricant is required.

Cut splines and keyways utilizing broaches, bushings, shims and arbor presses.

**TASK:** Deburr work pieces

Level III

**PERFORMANCE OBJECTIVE:** Given a variety of internal and external geometries, files and scrapers, completely deburr these work pieces to required tolerances.

**ENABLING OBJECTIVES:**

Demonstrate how to properly hold files and three corner scrapers.

Demonstrate how to sharpen a three corner scraper.

Deburr work pieces to required tolerances.

**CURRICULUM STANDARDS FOR PRECISION MACHINING**

**MODULE 7**

**LATHES**

## **MODULE 7 - DEMONSTRATE PROFICIENCY IN SETTING UP AND OPERATING LATHES**

This is one of a series of modules which comprise the Idaho Curriculum Guide for Precision Machining. Each module contains a listing of the tasks, performance objectives, and enabling objectives required to enable a student to achieve competency in a specific system or field of study within the basic machining technician occupational field. The numbering of these modules is not intended to dictate an order of instruction or scheduling. The order in which these modules may be taught is determined by each institution and its instructors.

Each task describes an occupational activity which will result in a finished process or product. The tasks listed in each module represent the basic activities required of each student to demonstrate entry level competence for that specific system or field of study within the machining occupation. Individual records of student performance in completing the tasks listed within each module should be maintained.

Although some provision is made for basic mathematics and communication skills within these standards, they may not be adequate to meet the needs of individual students. Counseling, guidance, and diagnostic test results may indicate a need for further preparation in these areas. In such cases, instructors are encouraged to utilize the resources and personnel within the institution to improve or complement the instructional process.

The benefits to students and institutions derived from these curriculum standards should be considerable. Articulation of students from secondary to post-secondary programs will be aided through the use of a single set of curriculum standards. The curriculum standards provide a tool for evaluation of local curricula and programs. The curriculum standards may be used in a flexible manner to assure that Precision Machining programs meet the needs of local business and industry.

It is the goal of this program curriculum guide to provide a level of instruction which will impart entry level employment skills. Students should be carefully counseled on the importance of attaining competency in the tasks assigned. As in virtually all occupations today, machining technicians will require periodic up-dating and review in the future. It is important that each student understand that meeting the program curriculum standards is essential not only to obtain employment today but also to have a base upon which to retain employment in the future.

## MODULE 7 - DEMONSTRATE PROFICIENCY IN SETTING UP AND OPERATING LATHES

**TASK:** Identify the parts of the lathe.

Level II

**PERFORMANCE OBJECTIVE:** Given a parts breakdown sheet, identify the main parts of the lathe.

**ENABLING OBJECTIVES:**

Explain the major parts of the lathe.

Explain the function of the bed.

Explain the function of the carriage and the parts therein.

Explain the function of the head stock and the parts therein.

Explain the function of the tail stock and the parts therein.

**TASK:** Comply with general safe and efficient work practices.

Level II

**PERFORMANCE OBJECTIVE:** Given an engine lathe, identify the major safety hazards characteristic to rotating work pieces.

**ENABLING OBJECTIVES:**

Explain the need for safety glasses.

Explain the hazards of chip handling.

Explain the set up hazards.

Explain the chuck removal and installation hazards.

Explain the hazards of work piece burrs.

Explain the proper housekeeping and tool hazards.

Demonstrate knowledge of safety by completing a written safety test

**TASK:** Measure stock

Level II

**PERFORMANCE OBJECTIVE:** Given a cylindrical work piece with external threads and a counterbored hole and a corresponding uni-dimensioned blueprint, outside, inside, and depth micrometers, telescope work piece, small hole gauge, vernier caliper, and surface plate, precision measure the work piece. Measure the external diameters, pitch diameters, internal bores, hole depths, and linear measurements of a work piece to a tolerance of  $\pm .002$  inches. Transpose dimensions onto blueprint in accordance with machine drafting procedures.

**ENABLING OBJECTIVES:**

Explain correct drafting standards for dimensioning blueprints.

Demonstrate the proper care, use, and calibrations of precision measuring instruments.

List accepted drafting abbreviations and/or symbols for the following terms:

Outside diameter

Inside diameter

Threads per inch

Inch

Millimeter

Counterbore

Depth

Measure a cylindrical work piece.

**TASK:** Set up an engine lathe

Level II

**PERFORMANCE OBJECTIVE:** Given independent, universal and collect chucks, lathe operation manual and dial indicator, mount chucks on lathe in accordance with operation manual so that there is no horizontal or vertical movement of the chuck. Set up a lathe using follower and steady rests.

**ENABLING OBJECTIVES:**

Explain the relevant safety precautions/procedures for mounting chucks on lathes.

Explain the operation of lathe.

Describe the use of wood blocks as cradles between bedways and chuck.

Discuss the applications for independent, universal, and collect chucks.

Describe the procedures for mounting chucks on lathe.

Describe the procedures for mounting face plates.

Describe the procedures for mounting and using follower and steady rests.

**TASK:** Secure tools, tool-holders, and fixtures or attachments

Level II

**PERFORMANCE OBJECTIVE:** Given independent, universal and collet chucks, lathe operation manual, and dial indicator, mount chucks on lathe in accordance with operation manual so that there is no horizontal or vertical movement of the chuck. Mount tool bits, fixtures or attachments on lathe.

**ENABLING OBJECTIVES:**

Explain the relevant safety precautions/procedures for mounting chucks on lathes.

Explain the operation of lathe.

Describe the use of tool holders, fixtures and attachments.

Determine and discuss the applications for independent, universal and collect chucks.

Describe the mounting of tool bits.

Demonstrate mounting and use of steady and follower rests.

**TASK:** Select and set feeds and speeds

Level II

**PERFORMANCE OBJECTIVE:** Given work sheet with check list, set assigned machines for each specified lathe spindle speed and feed.

**ENABLING OBJECTIVES:**

Explain lathe safety.

Locate, speed and feed chart on each machine.

List spindle speed formula and calculate RPM as per work sheet.

Identify lathe parts as listed on worksheet.

Adjust speed and feed settings for specified work sheet.

**TASK:** Set up lathes and face work pieces held in chucks

Level II

**PERFORMANCE OBJECTIVE:** Given blueprint, work piece, tool blanks, cutting fluids, and precision measuring instruments face the work piece holding a tolerance of  $\pm .005$  inch and to a surface finish of 125 micro inches.

**ENABLING OBJECTIVES:**

- Explain the safety precautions/procedures for facing.
- Describe the uses of carbide, high speed, and cutting tools as applied to facing operations.
- Define micro-inch.
- Calculate cutting speeds and feeds for facing operations.
- Describe the procedures for facing.
- Identify the correct cutting fluids for facing.
- Face a work piece to specifications.

**TASK:** Rough-cut and finish-cut with lathes

Level II

**PERFORMANCE OBJECTIVE:** Given bar stock and drawing, cutter bits, cutting fluids, measuring tools, make the required rough and finish cuts to required specifications.

**ENABLING OBJECTIVES:**

- Explain safety for lathe operation.
- Explain lathe feeds and describe the guideline
- Select speeds and feeds and mount stock in work holding devices.
- Explain tool position and tool geometry (angles).
- Define trial cuts.
- Make required trial cuts.
- Using appropriate measuring tools, measure work piece.
- Perform required rough and finish cuts to specifications.

**TASK:** Perform lathe filing to deburr parts

Level II

**PERFORMANCE OBJECTIVE:** Given work piece and work sheet; file, polish and deburr the work piece.

**ENABLING OBJECTIVES:**

- Explain lathe safety.
- Select spindle speed and mount project in lathe.
- Define micro-inch finishes.
- List names of different deburr tools.
- Explain grit size of abrasive clothes.
- List and identify shape, cut and size of files as required by worksheet.
- List other tools needed.
- File, polish and deburr a work piece.

**TASK:** Align lathe centers using accurate methods.

**Level II**

**PERFORMANCE OBJECTIVE:** Given a live and dead center, show methods of aligning lathe centers.

**ENABLING OBJECTIVES:**

- Describe the geometry of alignment of centers.
- Align centers using the point to point method.
- Align centers using a precision ground centered shaft.
- Align centers using the cut and measuring method.

**TASK:** Drill holes with lathes.

**Level II**

**PERFORMANCE OBJECTIVE:** Given blueprint, work piece, drill, lathe attachments, and cutting fluid, drill hole in work piece to a tolerance of  $\pm .005$  inch,  $-.000$  for diameter.

**ENABLING OBJECTIVES:**

- Explain the safety precautions/procedures for drilling operations.
- Calculate speeds for drilling operations.
- Describe the procedures for drilling on a lathe.
- Identify the correct cutting fluid for drilling operations.
- Drill a hole in a work piece.

**TASK:** Countersink holes with lathes

**Level II**

**PERFORMANCE OBJECTIVES:** Given blueprint, countersink tool, work piece, lathe attachments, cutting fluid, and measuring instruments, countersink hole in work piece to a tolerance of  $+.010$  inch,  $-.000$  for diameter.

**ENABLING OBJECTIVES:**

- Explain the safety precautions/procedures for countersinking operations.
- Calculate speeds for countersinking operations.
- Describe the procedures for countersinking on a lathe.
- Identify the correct cutting fluid for countersinking.
- Countersink a hole in a work piece.

**TASK:** Ream holes with lathes

**Level II**

**PERFORMANCE OBJECTIVE:** Given a blueprint, work piece, reamer, lathe attachments, cutting fluid, and inside measuring instruments, ream hole in work piece to a tolerance of  $+.002$ ,  $-.000$  for diameter.

**ENABLING OBJECTIVES:**

- Explain the safety precautions/procedures for reaming operations.
- Calculate speeds for reaming operations.
- Describe the procedures for reaming.
- Identify the correct cutting fluid for reaming.
- Ream a hole in a work piece.

**TASK: Tap threads with lathes**

**Level II**

**PERFORMANCE OBJECTIVE:** Given blueprint, work piece, tap, tap wrench, lathe attachments, cutting fluid, and thread plug gauge, tap hole in work piece to a class 2 fit.

**ENABLING OBJECTIVE:**

- Explain the safety precautions/procedures for tapping operations.
- Determine tap drill size using the charts and formulas.
- Describe the procedures for tapping on a lathe.
- Identify the correct cutting fluid for tapping.
- Describe the proper use of a plug gauge.
- Tap threads in a work piece.

**TASK: Die-cut threads with lathes**

**Level II**

**PERFORMANCE OBJECTIVE:** Given blueprint, work piece and threading die and die stock, die cut external threads using a lathe.

**ENABLING OBJECTIVES:**

- Explain safety requirements for cutting external threads.
- Calculate lathe RPM.
- Set up work piece in chuck.
- Remove tail stock center and explain how to follow the die with the tailstock spindle.
- Describe procedures for cutting external threads.
- Identify the proper cutting fluid.
- Die cut external threads on a work piece.

**TASK: Counterbore holes with lathes**

**Level II**

**PERFORMANCE OBJECTIVE:** Given blueprint, work piece, lathe attachments, boring bar, cutting fluid, and precision measuring instruments, counterbore hole in work piece to a tolerance of  $\pm .001$  inch for diameter and depth.

**ENABLING OBJECTIVES:**

- Explain the safety precautions/procedures for counter-boring operations.
- Calculate speeds for counter-boring operations.
- Describe the procedures for counter-boring.
- Identify the correct cutting fluid for counter-boring operations.
- Counterbore a hole in a work piece.

**TASK: Bore holes with lathes**

**Level II**

**PERFORMANCE OBJECTIVES:** Given blueprint, work piece, boring bar, tool blank, boring bar holder, cutting fluid, and precision measuring instruments, bore hole with lathe to a tolerance of  $\pm .001$  inch for location, diameter, depth, and to print surface finish specifications.

**ENABLING OBJECTIVES:**

- Explain the safety precautions/procedures for boring holes with a lathe.
- Calculate speeds for boring operations on lathes.
- Describe the procedures for boring holes.
- Identify the correct cutting fluids for boring.
- Bore a hole in a work piece.

**TASK: Knurl parts with lathes**

**Level II**

**PERFORMANCE OBJECTIVE:** Given blueprint, work piece, diamond and/or straight knurling tools, cutting fluid, knurl work piece in accordance with Machinery's Handbook specifications for knurling.

**ENABLING OBJECTIVES:**

- Explain the safety precautions/procedures for knurling a work piece.
- Explain the proper use of knurling tools.
- Calculate speeds and feeds for knurling operations.
- Describe the procedures for knurling a work piece.
- Identify the correct cutting fluid for knurling.
- Knurl a work piece.

**TASK: Cut external threads with lathes**

**Level II**

**PERFORMANCE OBJECTIVE:** Given blueprint, work piece, tool holder, tool blank, center gauge, cutting fluids, and precision measuring instruments, cut external threads on work piece to tolerances for class 2 fit for external threads and in accordance with Machinery's Handbook. Use thread micrometer and/or three-wire system for checking threads.

**ENABLING OBJECTIVES:**

- Explain the safety precautions/procedures for cutting external threads.
- Explain the formulas used in the three wire system for measuring external threads.
- Calculate proper speeds for cutting external threads.
- Describe the procedures for cutting external threads.
- Select the correct cutting fluid for threading operations.
- Calculate thread depth.
- Calculate total in feed of compound.
- Determine depth per pass.
- Determine compound off-set angle (right or left hand threads).
- Cut external threads on a work piece.

**TASK:** Re-chase threads with lathes

Level II

**PERFORMANCE OBJECTIVE:** Given a damaged thread, set up and catch thread to repair it.

**ENABLING OBJECTIVES:**

- Explain safety precautions for re-chasing threads.
- Describe procedure for setting up a lathe to re-chase threads.
- Identify tools needed to re-chase threads.
- Select correct cutting fluid for re-chasing threads.
- Re-chase threads on a work piece.

**TASK:** Cut internal threads with lathes

Level II

**PERFORMANCE OBJECTIVE:** Given blueprint, work piece, tool holder, tool blank, thread center gauge, cutting fluids and precision measuring instruments, cut internal threads on work pieces to tolerances for class 2 fit for internal threads in accordance with Machinery's Handbook. Use threaded part or plug gauge for checking threads.

**ENABLING OBJECTIVES:**

- Explain the safety precautions/procedures for chasing internal threads.
- Calculate total in feed of compound for unified threading.
- Calculate proper speeds and hole size for cutting internal threads.
- Describe the procedures for cutting internal threads.
- Select the correct cutting fluid for threading.
- Determine depth of cut per pass.
- Determine compound off-set angle.
- Cut internal threads on a work piece.

**TASK:** Set up and perform taper turning with taper attachments

Level II

**PERFORMANCE OBJECTIVE:** Given blueprint, work piece, turning tool, tool holder, dial indicator, micrometer carriage stop, cutting fluids, and precision measuring instruments, machine external taper on work piece holding a tolerance of .001 per 4 inches in length and a surface finish as specified by the blueprint.

**ENABLING OBJECTIVES:**

- Explain the safety precautions/procedures for machining an external taper.
- Explain the use of taper attachments.
- Describe the procedures for cutting external tapers.
- Calculate speeds and feeds for external tapering operations.
- Explain how to check taper over a 4.000 inch length.
- Identify the correct cutting fluids for external tapering operations.
- Turn an external taper on a work piece.

**TASK:** Set up and perform taper turning with compound.

Level II

**PERFORMANCE OBJECTIVE:** Given blueprint, work piece, tool holder, cutting tool, cutting fluid, and precision measuring instruments, cut external angle with compound on work piece holding a tolerance of  $\pm 30$  minutes for the angle, and a surface finish to print requirements.

**ENABLING OBJECTIVES:**

- Explain the safety precautions/procedures.
- Calculate cutting speed for cutting external angle with compound.
- Describe the procedures for cutting external angles.
- Identify the correct cutting fluid for cutting external angles.
- Cut an external taper with a compound on a work piece.

**TASK:** Cut internal tapered surfaces

Level II

**PERFORMANCE OBJECTIVE:** Given blueprint, work piece, boring bar, tool blank, boring bar holder, cutting fluid, and precision measuring instruments, cut internal tapered surface on work piece using taper attachment to a tolerance of  $\pm .002$  inch on the diameter, and  $\pm .005$  on the length, and to print surface finish requirements.

**ENABLING OBJECTIVES:**

- Explain the safety precautions/procedures for cutting internal tapered surface.
- Calculate speeds and feeds for internal tapering operations.
- Describe the procedures for boring internal tapers with taper attachment.
- Identify the correct cutting fluids for boring internal tapers.
- Cut an internal taper on a work piece.

**TASK:** Perform contour, angular, or radial cuts with lathes

Level II

**PERFORMANCE OBJECTIVE:** Given blueprints, work piece, tool blanks, tool holder, cutting fluid, radius work piece, and precision measuring instruments, free hand form work piece to concave and convex radii and angular into per blueprint and visual inspection.

**ENABLING OBJECTIVES:**

- Explain the safety precautions/procedures for free hand forming a work piece.
- Describe the procedures for angular concave or contour cuts with lathes.
- Explain the proper use of radius gauges.
- Calculate speeds for free hand forming operations.
- Describe the procedures for free hand forming concave and convex radii.
- Identify the correct cutting fluids.
- Cut contour, concave and angular surfaces on a work piece.

**TASK: Set up and use follower and steady-rests**

**Level II**

**PERFORMANCE OBJECTIVE: Given blueprint, face plate, dog, steady rest and follower rest, turn long shaft between centers.**

**ENABLING OBJECTIVES:**

**Explain safety precautions for using follow and steady rests.**

**Install face plate.**

**Describe the procedure to install work using a lathe dog and faceplate.**

**Install steady rest or follower rest and adjust to part.**

**Turn work to size with proper follow and steady rest setup.**

**TASK: Set up face plates and lathe dogs**

**Level II**

**PERFORMANCE OBJECTIVE: Given blueprint, face plate, clamping tools, tool blanks, center drill, drill, boring bar, and work piece, face, drill and bore work piece holding a tolerance of  $\pm .005$  on all dimensions and to a surface finish as specified on print.**

**ENABLING OBJECTIVES:**

**Explain the safety precautions/procedures for facing, drilling, and boring operations.**

**Describe the use of the face plate and the importance of counter-balancing the work piece.**

**Describe the procedure for clamping and aligning part to face plate.**

**Calculate cutting speeds for facing, drilling and boring.**

**Identify the correct fluid for facing, drilling and boring operations.**

**CURRICULUM STANDARDS FOR PRECISION MACHINING**

**MODULE 8**

**MILLING MACHINES**

## MODULE 8 - MILLING MACHINES

This is one of a series of modules which comprise the Idaho Curriculum Guide for Precision Machining. Each module contains a listing of the tasks, performance objectives, and enabling objectives required to enable a student to achieve competency in a specific system or field of study within the basic machining technician occupational field. The numbering of these modules is not intended to dictate an order of instruction or scheduling. The order in which these modules may be taught is determined by each institution and its instructors.

Each task describes an occupational activity which will result in a finished process or product. The tasks listed in each module represent the basic activities required of each student to demonstrate entry level competence for that specific system or field of study within the machining occupation. Individual records of student performance in completing the tasks listed within each module should be maintained.

Although some provision is made for basic mathematics and communication skills within these standards, they may not be adequate to meet the needs of individual students. Counseling, guidance, and diagnostic test results may indicate a need for further preparation in these areas. In such cases, instructors are encouraged to utilize the resources and personnel within the institution to improve or complement the instructional process.

The benefits to students and institutions derived from these curriculum standards should be considerable. Articulation of students from secondary to post-secondary programs will be aided through the use of a single set of curriculum standards. The curriculum standards provide a tool for evaluation of local curricula and programs. The curriculum standards may be used in a flexible manner to assure that Precision Machining programs meet the needs of local business and industry.

It is the goal of this program curriculum guide to provide a level of instruction which will impart entry level employment skills. Students should be carefully counseled on the importance of attaining competency in the tasks assigned. As in virtually all occupations today, machining technicians will require periodic up-dating and review in the future. It is important that each student understand that meeting the program curriculum standards is essential not only to obtain employment today but also to have a base upon which to retain employment in the future.

## **MODULE 8 - DEMONSTRATE PROFICIENCY IN SETTING UP AND OPERATING MILLING MACHINES**

**TASK: Identify the parts of the Horizontal and Vertical Milling Machine**

**Level II**

**PERFORMANCE OBJECTIVE:** Given a milling machine and service manual, identify major parts and their function.

**ENABLING OBJECTIVES:**

Identify types of milling machines.

Identify major parts of milling machines.

Describe the function of major parts.

**TASK: Lubricate Milling Machines**

**Level II**

**PERFORMANCE OBJECTIVES:** Given service manual and/or lubrication chart, lubricants and tools, clean, inspect and lubricate the milling machine in accordance with charts in operation manual. All lubrication points will be supplied with the correct amount and type of lubricant.

**ENABLING OBJECTIVES:**

Explain the safety precautions/procedures for cleaning, lubricating and inspecting the milling machine.

Explain the reasons for performing routine cleaning, inspection, and lubrication of milling machines.

Determine the proper lubricants to be used for milling machines.

Explain the meaning of the terms (a) climb; (b) conventional milling.

Describe the procedures for cleaning, lubricating and inspecting the milling machine.

Lubricate a milling machine.

**TASK: True up the Head and Align Milling Machine Fixtures**

**Level II**

**PERFORMANCE OBJECTIVE:** Given a milling machine with a swivel type head and dial indicator with attachments, align the table and must be aligned to within .001 inch T.I.R. at a 4 inch radius and align vise on milling machine table to within .001 inch T.I.R.

**ENABLING OBJECTIVES:**

Explain the safety precautions/procedures in alignment of heads.

Explain the operation of a swivel head on a mill.

Explain the use of dial indicator for aligning swivel heads.

Describe the procedures for aligning the head of a milling machine.

Describe the procedures for aligning a vise on a milling table.

Align a vise on a milling table.

Align a head of a milling machine.

**TASK: Select and Set Feeds and Speeds for Milling Work**

**Level II**

**PERFORMANCE OBJECTIVE:** Given a known hardness of a variety of materials, determine the correct speeds and feeds for milling using handbook.

**ENABLING OBJECTIVES:**

List the correct cutting speed and feed for the following materials:

cold rolled steel, with 1/2" end mill.

aluminum, with 1/4" end mill.

tool steel, with 3/8" end mill.

Set correct feeds and speeds on a milling machine for selected material.

**TASK: Square up Work pieces with a Table Vise**

**Level II**

**PERFORMANCE OBJECTIVES:** Given a blueprint, work piece, end mill or face mill, cutting fluids, milling machine vise, parallels, soft face hammer, and precision measuring instruments, mill a block of metal square holding a tolerance of  $\pm .001$  inch for linear dimensions.

**ENABLING OBJECTIVES:**

Explain the safety precautions/procedures for milling operations.

Calculate the correct speed and feed for various cutters.

Describe the procedures for setting-up and machining a work piece parallel and square.

Identify the correct cutting fluids for milling.

Mill a block of metal to square within required tolerances.

**TASK: Perform End Milling**

**Level II**

**PERFORMANCE OBJECTIVES:** Given blueprint, work piece holding device, end mill, cutting fluid, and precision measuring instrument, mill a flat surface to .001 T.I.R.

**ENABLING OBJECTIVE:**

Explain the safety precautions/procedures for end milling.

Calculate proper speeds, feeds and depth of cut with end milling.

Describe the procedures for setting up and end milling a flat surface.

Identify the correct cutting fluids for milling.

End mill a flat surface to .001 T.I.R.

**TASK: Perform Fly-Cutting Operations**

**Level II**

**PERFORMANCE OBJECTIVE:** Given a blueprint, work piece, fly-cutter, cutting tool blank, and precision measuring instruments, fly-cut work piece surface to print requirements.

**ENABLING OBJECTIVES:**

- Explain the safety precautions/procedures for fly-cutting a work piece surface.
- Define surface roughness, waviness, lay and identify their symbols.
- Explain the purpose of fly-cutters.
- Calculate speeds, feeds, and determine depth of cut for fly-cutting surfaces.
- Describe the procedures for fly-cutting surfaces.
- Fly-cut a work piece surface to required tolerances.

**TASK: Drill Holes with a Milling Machine**

**Level II**

**PERFORMANCE OBJECTIVE:** Given a blueprint, work piece, center drill and drill, layout materials, and precision measuring instruments, drill equally spaced holes in work piece holding a tolerance of  $\pm .002$  inch for location and diameter, and  $\pm 1$  degree for perpendicularity.

**ENABLING OBJECTIVES:**

- Explain safety precautions/procedure for drilling holes.
- Describe the procedures for using milling machine dials for accurate table positioning.
- Calculate the amount of table movement for each position.
- Describe the procedures for compensating for backlash out the lead screws.
- Calculate the correct speed and feed.
- Drill holes in a work piece to specified tolerances using a milling machine.

**TASK: Perform Reaming Operations**

**Level II**

**PERFORMANCE OBJECTIVES:** Given blueprint, work piece, holding device, centerdrill, drill, reamer, cutting fluid, and precision measuring instruments, centerdrill, drill and ream a hole holding a tolerance of  $+ .002$ ,  $- .000$  for diameter, and  $.002$  for the hole's true position according to print specifications.

**ENABLING OBJECTIVES:**

- Explain the safety precautions/procedures for centerdrilling and reaming a hole.
- Explain the uses of centerdrills, drills, and reamers.
- Calculate proper speeds and feeds for centerdrilling, drilling, and reaming operations.
- Describe the procedures for centerdrilling, drilling, and reaming on a milling machine.
- Identify the correct cutting fluids for centerdrilling, drilling and reaming.
- Determine the proper drill size for reaming.
- Ream a hole in a work piece holding required tolerances.

**TASK: Cut External Keyways**

**Level II**

**PERFORMANCE OBJECTIVE:** Given blueprint, work piece holding device, end mill, cutting fluid, and precision measuring instruments, end mill keyseat in the work piece holding a tolerance of + .001, - .000 inch for width, + .005, - .000 depth,  $\pm$  1/64 inch for length.

**ENABLING OBJECTIVES:**

- Explain the safety precautions/procedures for end milling keyseats.
- Calculating proper speeds, feeds, and depth of cut when milling keyseats.
- Describe the procedures for setting up and milling keyseats.
- Identify the correct cutting fluids for milling keyseats.
- Determine keyway depth.
- End mill a keyseat in a work piece holding required tolerances.

**TASK: Bore Hole with Milling Machines**

**Level II**

**PERFORMANCE OBJECTIVE:** Given a blueprint with bore specifications, work piece, work holding device, boring head, cutting fluid and precision measuring instruments, bore hole in work piece with boring head holding print tolerances.

**ENABLING OBJECTIVES:**

- Explain the safety precautions/procedures for boring and counterboring holes.
- Explain the procedures for accurately adjusting a boring head.
- Calculate speeds and feeds for boring operations.
- Describe the procedures for setting up and completing boring operations.
- Identify the correct cutting fluids for boring and counterboring.
- Bore a hole in a work piece using a boring head on a milling machine to required tolerances.

**TASK: Perform Form Milling**

**Level II**

**PERFORMANCE OBJECTIVE:** Given a blueprint, work piece, form cutter, cutting fluids, and precision measuring instruments, form mill work piece holding print tolerances.

**ENABLING OBJECTIVES:**

- Explain the safety precautions/procedures for form milling.
- Define the terms concave and convex as they pertain to milling cutters.
- Calculate speeds, feeds, and depth of cut for milling cutter.
- Describe the procedures for form milling.
- Identify the correct cutting fluids.
- Form mill a work piece to required tolerances.

**TASK: Perform Indexing Operations Using a Dividing Head**

**Level II**

**PERFORMANCE OBJECTIVE:** Given blueprint, milling machine with an indexing head, Machinery's Handbook, change gears, cutting tools, cutting fluids, and precision measuring instruments, machine work piece using differential indexing locating odd numbers of divisions over 40.

**ENABLING OBJECTIVES:**

- Explain the safety precautions/procedures for machining using the differential indexing method.
- Explain the calculations for the indexing head when performing differential indexing.
- Explain the proper technique for assembling gears in gear train.
- Define simple gearing and compound gearing.
- Explain the use of an idler gear.
- Describe the procedures for machining a work piece using differential indexing.
- Identify the correct cutting fluids.
- Explain the use of wide range indexing.
- Machine a work piece with differential indexing using a dividing head.

**TASK: Set Up and Operate Rotary Tables**

**Level II**

**PERFORMANCE OBJECTIVE:** Given blueprint, work piece, milling machine with rotary table, end mills, cutting fluids, and precision measuring instruments, machine an outside radius holding print tolerances.

**ENABLING OBJECTIVES:**

- Explain the safety precautions/procedures for milling radii using a rotary table.
- Describe set up and clamping procedures for a rotary table.
- List the applications for a rotary table.
- Explain the procedures for avoiding backlash of rotary table and milling machine screws.
- Calculate the correct speeds for machining outside radius.
- Describe the procedure for milling outside radius using a rotary table.
- Identify the correct cutting fluids.
- Describe the procedures for centering spindle with rotary table.
- Mill an outside radius using a rotary table on a machining machine.

**TASK: Mill an External Radius**

**Level II**

**PERFORMANCE OBJECTIVE:** Given blueprint, work piece, milling machine with rotary table, end mills, cutting fluids, and precision measuring instruments, machine an inside radius holding print tolerances.

**ENABLING OBJECTIVES:**

Explain the safety precautions/procedures for cutting radii using a rotary table.

Calculate the correct speeds for milling inside radius.

Describe the procedures for machining inside radii using a rotary table.

Identify the correct cutting fluids.

Machine an internal radius using a rotary table on a milling machine.

**TASK: Mill an Angle**

**Level II**

**PERFORMANCE OBJECTIVE:** Give blueprint, milling machine, with an indexing head, drills, Machinery's Handbook, work piece, cutting fluids, and precision measuring instruments, drill holes in work piece to specified angles using the indexing head.

**ENABLING OBJECTIVES:**

Explain the safety precautions/procedures for milling holes using angular indexing.

Explain the calculations required for the indexing head when performing angular indexing.

Calculate speeds and feeds for angular indexing operations.

Describe the procedures for milling holes using angular indexing.

Identify the correct cutting fluids.

Drill holes in a work piece to specified angles using an indexing head.

**TASK: Align Milling Machine Attachments**

**Level II**

**PERFORMANCE OBJECTIVE:** Given a milling machine and a dial indicator with attachments, align milling machine attachments to within .001 inch T.I.R.

**ENABLING OBJECTIVES:**

Explain the safety precautions/procedures in alignment of attachment.

Explain the use of dial indicator for aligning attachment.

Describe the procedures for aligning the milling attachment.

Align various milling machine attachments to within .001 T.I.R.

**TASK: Mill Internal Slots with a slotting attachment**

**Level II**

**PERFORMANCE OBJECTIVE:** Given a blueprint, work piece, milling machine with slotting attachment, cutting fluids, precision measuring instruments, and tool blanks, machine internal slots and keyway holding a tolerance as specified on blueprint.

**ENABLING OBJECTIVES:**

Explain the safety precautions/procedures for cutting internal slots and keyways.

Explain the ability to grind and sharpen cutting tools.

Determine the correct cutters for various applications.

Calculate depth and size of keyways and slots.

Describe set up procedures for the length of stroke.

Calculate speed in strokes per minute.

Describe procedures for machining internal slots and keyways.

**TASK: Perform Cutting-Off Operation**

**Level II**

**PERFORMANCE OBJECTIVE:** Given a milling machine, arbor and slitting saw, cut multiple work pieces to precision lengths and slot various shapes of work pieces.

**ENABLING OBJECTIVES:**

Explain how to calculate depths, speeds and feeds for slitting saws.

Explain how to set up work pieces with kickers to cut precision lengths.

Cut work pieces to precision lengths.

Slot various shapes of work pieces.

**TASK: Set Up and Perform Slab Mill Operations**

**Level II**

**PERFORMANCE OBJECTIVE:** Given blueprint, work piece, horizontal milling machine, slab milling cutter, arbor with spacers, work holding device, cutting fluids, and precision measuring instruments, mill the work piece. After rough and finish cut, parallelism must be within .002 inch per 6 inches of length.

**ENABLING OBJECTIVES:**

Explain the safety precautions/procedures for slab milling.

Explain the importance of maintaining a clean milling machine.

Describe procedures for mounting cutter and arbor in the milling machine.

Explain why the cutter should always be mounted on the arbor as close to the column of the milling machine as possible.

Describe the procedures for slab milling operations.

Identify the correct cutting fluid.

Explain the purpose of the applications for using climb milling and conventional milling.

Mill, rough and finish cut a work piece to required tolerances.

**TASK: Use an Edge Finder and Wiggler**

**Level II**

**PERFORMANCE OBJECTIVE:** Given a work piece and an edge finder or wiggler locate the center of the work piece to within  $\pm .001$  inch.

**ENABLING OBJECTIVES:**

Explain the safety precautions/procedures.

Explain the correct care and use of an edge finder or wiggler.

Describe the procedures for touching off with an edge finder and a wiggler.

Mark the center of a work piece after locating it with a wiggler or edge finder.

**TASK: Use Digital Readouts**

**Level II**

**PERFORMANCE OBJECTIVE:** Given a blueprint, work piece, center drill and drill, layout materials, digital read out, and precision measuring instruments, drill equally spaced holes in work piece holding a tolerance of  $\pm .0005$  non-cumulative location.

**ENABLING OBJECTIVES:**

Explain the safety cutting precautions/procedures for drilling holes.

Describe the procedures for using digital read out for accurate table positioning.

Calculate the amount of table movement for each position.

Describe the procedures for keeping backlash out of lead screws.

Calculate the correct cutting speed and feed.

Describe the procedures for drilling equally spaced holes.

Identify the correct cutting fluids for drilling.

Drill equally spaced holes in a work piece using digital read outs to locate centers.

**TASK: Perform Straddle Milling Operations on the Horizontal Mill**

**Level II**

**PERFORMANCE OBJECTIVE:** Given a blueprint, work piece, work holding device, milling cutter, arbor spacer, cutting fluids, and precision measuring instruments, gang mill work pieces holding a tolerance of  $\pm .005$  on depth, width and spacing.

**ENABLING OBJECTIVES:**

Explain the safety precautions/procedures.

Explain the purpose of and applications for gang milling operations.

Describe the procedures for mounting cutters and arbor in machine.

Explain why a key is needed in the arbor.

Calculate speed, feed, and depth of cut for gang milling operations.

Describe the procedures for gang milling.

**TASK: Set Up and Use a Sine Vise**

**Level II**

**PERFORMANCE OBJECTIVE:** Given a milling sine vise, work piece, parallels, soft face hammer, and precision measuring instruments, seat work piece in vise to within .003 T.I.R. per 4 inches.

**ENABLING OBJECTIVES:**

Explain the safety precautions/procedures.

Describe the care and use of parallels.

Describe the procedures for seating a part in a milling sine vise.

Set up and seat a work piece in a sine vise.

**PRECISION MACHINING  
LEVEL III**

**Prerequisite: Level II**

**A course designed to provide student with team work, critical thinking, problem solving, diagnostics, and repairing/producing to industry standards.**

## TASK LISTING

STUDENT PERFORMANCE STANDARDS

EFFECTIVE DATE: June 2008

PROGRAM AREA: Trade & Industrial Education

PROGRAM TITLE: Precision Machining Technology

**DEMONSTRATE EMPLOYABILITY SKILLS - The student will be able to:**

Level III

- Identify employment opportunities
- Apply employment-seeking skills
- Interpret employment capabilities
- Demonstrate appropriate work behavior
- Maintain a business-like image
- Maintain working relationships with others
- Communicate on the job
- Adapt to change
- Demonstrate a knowledge of business operation

**PERFORM PREREQUISITE MACHINING SKILLS - The student will be able to:**

Level III

- Demonstrate proficiency in maintaining immediate work area
- Perform mathematical calculations
- Demonstrate proficiency in blueprint reading and machine planning
- Perform measuring operations
- Perform maintenance on machines and tools

**DEMONSTRATE PROFICIENCY IN PERFORMING BENCH WORK SKILLS**

The student will be able to:

Level III

- Cut materials by using hand hacksaws
- Cut threads by using hand taps and dies
- Ream holes by using hand reamers
- Hand-sharpen cutting tools by using abrasive stones
- Remove damaged screws and other hardware
- Set up and use arbor press broaches
- Deburr work pieces
- Identify and use proper hand finishing tools

## **DEMONSTRATE PROFICIENCY IN SETTING UP AND OPERATING LATHES -**

The student will be able to:

### **Level III**

- Identify the parts of the lathe
- Comply with safe and efficient work practices
- Measure stock
- Set up an engine lathe
- Secure tools, tool-holders and fixtures or attachments
- Select and set feeds and speeds
- Set up lathes and face work pieces held in chucks
- Rough-cut and finish-cut with lathes
- Deburr parts using filing procedures
- Align lathe centers using accurate methods
- Drill holes with lathes
- Countersink holes with lathes
- Ream holes with lathes
- Tap threads with lathes
- Die-cut threads with lathes
- Counter bore holes with lathes
- Bore holes with lathes
- Knurl parts with lathes
- Cut external threads with lathes
- Re-chase threads with lathes
- Cut internal threads with lathes
- Set up and perform taper turning with taper attachments
- Set up and perform taper turning with compound
- Cut internal tapered surfaces
- Set up and operate tool post grinders
- Perform contour, angular or radial cuts with lathes
- Set up and use follow and steady-rests
- Set up face plates and dogs

## **DEMONSTRATE PROFICIENCY IN SETTING UP AND OPERATING MILLING MACHINES - The student will be able to:**

**Level III**

- Identify the parts of the horizontal and vertical milling machine
- Lubricate milling machines.
- True up the head and align milling machines fixtures
- Select and set feeds and speeds for milling work
- Square up work pieces with a table vise
- Perform end milling
- Perform fly-cutting operations
- Drill holes with a milling machine
- Perform reaming operations
- Cut external keyways
- Bore holes with milling machines
- Perform form milling

- Perform indexing operations using a dividing head
- Set up and operate rotary tables
- Mill cylindrical work
- Mill an external radius
- Mill an angle
- Align milling machine attachments
- Mill internal slots with a slotter and attachment
- Perform cutting-off operations
- Set up and perform slab mill operations
- Use an edge finder and wiggler
- Use digital readouts
- Set up and use a sine vise

**DEMONSTRATE PROFICIENCY IN SETTING UP AND OPERATING SURFACE GRINDING MACHINES - The student will be able to:**

**Level III**

- Identify the parts of the machine
- Comply with safe and efficient work practices
- Clean and lubricate surface grinding machine
- Select the proper wheel
- Inspect, balance, dress, and true grinding wheels
- Attach and align work pieces for grinding operations
- Set up and grind parallel flat surfaces
- Set up and grind four sides square
- Set up and use angle plates
- Cut off or part work pieces with grinding machines
- Measure, inspect, and rework work pieces on grinding machines
- Set up, grind, and sharpen pre-shaped lathe tools
- Set up and use radius dressers

**DEMONSTRATE PROFICIENCY IN APPLYING COMPUTERIZED NUMERICAL CONTROL OPERATIONS - The student will be able to:**

**Level III**

- Identify the parts of the machine
- Comply with safe and efficient work practices
- Identify and select proper machine controls
- Write a program and apply basic programming skills to a turning and/or a milling operation
- Select proper work holders
- Select proper cutting tools
- Machine parts to blueprint tolerances
- Demonstrate the use of CAD/CAM system for part program development

# **CURRICULUM STANDARDS FOR PRECISION MACHINING**

## **MODULE 1**

### **EMPLOYABILITY SKILLS**

## MODULE 1 - EMPLOYABILITY SKILLS

This is one of a series of modules which comprise the Idaho Curriculum Guide for Precision Machining. Each module contains a listing of the tasks, performance objectives, and enabling objectives required to enable a student to achieve competency in a specific system or field of study within the basic machining technician occupational field. The numbering of these modules is not intended to dictate an order of instruction or scheduling. The order in which these modules may be taught is determined by each institution and its instructors.

Each task describes an occupational activity which will result in a finished process or product. The tasks listed in each module represent the basic activities required of each student to demonstrate entry level competence for that specific system or field of study within the machining occupation. Individual records of student performance in completing the tasks listed within each module should be maintained.

Although some provision is made for basic mathematics and communication skills within these standards, they may not be adequate to meet the needs of individual students. Counseling, guidance, and diagnostic test results may indicate a need for further preparation in these areas. In such cases, instructors are encouraged to utilize the resources and personnel within the institution to improve or complement the instructional process.

The benefits to students and institutions derived from these curriculum standards should be considerable. Articulation of students from secondary to post-secondary programs will be aided through the use of a single set of curriculum standards. The curriculum standards provide a tool for evaluation of local curricula and programs. The curriculum standards may be used in a flexible manner to assure that Precision Machining programs meet the needs of local business and industry.

It is the goal of this program curriculum guide to provide a level of instruction which will impart entry level employment skills. Students should be carefully counseled on the importance of attaining competency in the tasks assigned. As in virtually all occupations today, machining technicians will require periodic up-dating and review in the future. It is important that each student understand that meeting the program curriculum standards is essential not only to obtain employment today but also to have a base upon which to retain employment in the future.

## MODULE 1 - EMPLOYABILITY SKILLS

**TASK: Identify Employment Opportunities**

Level III

**PERFORMANCE OBJECTIVE:** Given the information resources of a library, obtain and compile the information needed to seek a job.

**ENABLING OBJECTIVES:**

- Identify the requirements for a job.
- Investigate educational opportunities.
- Investigate occupational opportunities.
- Locate resources for finding employment.
- Confer with prospective employers.
- Identify job trends.

**TASK: Apply Employment-Seeking Skills**

Level III

**PERFORMANCE OBJECTIVE:** Given appropriate information, locate a job opportunity, prepare and take an interview for it, complete the required tests, forms and applications, and evaluate a response to the job opportunity.

**ENABLING OBJECTIVES:**

- Locate a job opening.
- Complete a resume.
- Prepare for an interview.
- Participate in an interview.
- Complete tests required.
- Complete forms required.
- Complete an application letter.
- Complete a follow-up letter.
- Complete an acceptance letter.
- Evaluate a job offer.
- Evaluate a job rejection.

**TASK: INTERPRET EMPLOYMENT CAPABILITIES**

Level III

**PERFORMANCE OBJECTIVE:** Given the assignment to explain how your capabilities make you employable, demonstrate how to match skills and experience to a job being sought.

**ENABLING OBJECTIVES:**

- Match an interest to job area.
- Match aptitudes to job area.
- Verify abilities.
- Identify immediate work goal.
- Develop a career plan.

**TASK: DEMONSTRATE APPROPRIATE WORK BEHAVIOR**

**Level III**

**PERFORMANCE OBJECTIVE:** Given the responsibility of an employee in a new job, demonstrate knowledge of appropriate behavior in the work place.

**ENABLING OBJECTIVES:**

- Exhibit dependability.
- Demonstrate punctuality.
- Follow rules and regulations.
- Explain the consequences of dishonesty.
- Complete assignments accurately and on time.
- Control emotions.
- Take responsibility for decisions and actions
- Take pride in work and be a loyal worker.
- Learn to handle pressures and tensions.
- Demonstrate ability to set priorities.
- Demonstrate problem-solving skills.

**TASK: MAINTAIN A BUSINESS-LIKE IMAGE**

**Level III**

**PERFORMANCE OBJECTIVE:** Given a responsibility to perform the duties of a new job, with a new employer, demonstrate a knowledge of the actions and behaviors which will project a business-like image

**ENABLING OBJECTIVES:**

- Participate in the institution's orientation.
- Demonstrate knowledge of company or agency products and services.
- Identify the requirements for a job.
- Investigate educational opportunities.
- Investigate occupational opportunities.
- Locate resources for finding employment.
- Confer with prospective employers.
- Identify job trends.

**TASK: MAINTAIN WORKING RELATIONSHIPS WITH OTHERS**

**Level III**

**PERFORMANCE OBJECTIVE:** Given the responsibility to perform the duties of a new job, with a new employer, demonstrate knowledge of how to successfully work with others.

**ENABLING OBJECTIVES:**

- Work productively with others.
- Show empathy, respect, and support for others.
- Demonstrate procedures and assist others when necessary.
- Recognize problems and work toward their solution.
- Minimize the occurrence of problems.
- Channel emotional reactions in positive ways.

**TASK: COMMUNICATE ON THE JOB**

**Level III**

**PERFORMANCE OBJECTIVE:** Given the responsibility to perform the duties of a new job, with a new employer, demonstrate knowledge of how to communicate on the job.

**ENABLING OBJECTIVES:**

- Read and comprehend written communications.
- Use correct grammar.
- Speak clearly when addressing others.
- Use job-related terminology.
- Listen attentively.
- Write legibly.
- Use telephone etiquette.
- Follow written and oral directions.
- Ask questions.
- Locate information needed to complete the task.
- Prepare written communication.
- Demonstrate keyboarding skills.
- Demonstrate computer skill.

**TASK: ADAPT TO CHANGE**

**Level III**

**PERFORMANCE OBJECTIVE:** Given the responsibility to perform the duties of a new job, with a new employer, demonstrate knowledge of how to adapt to change.

**ENABLING OBJECTIVES:**

- Recognize the need to change.
- Demonstrate a willingness to learn.
- Demonstrate flexibility.
- Participate in continuing education.
- Seek challenge in the work place.
- Adjust goals and plans when necessary.

**CURRICULUM STANDARDS FOR PRECISION MACHINING**

**MODULE 2**

**PREREQUISITE MACHINING**

## MODULE 2 - PREREQUISITE MACHINING

This is one of a series of modules which comprise the Idaho Curriculum Guide for Precision Machining. Each module contains a listing of the tasks, performance objectives, and enabling objectives required to enable a student to achieve competency in a specific system or field of study within the basic machining technician occupational field. The numbering of these modules is not intended to dictate an order of instruction or scheduling. The order in which these modules may be taught is determined by each institution and its instructors.

Each task describes an occupational activity which will result in a finished process or product. The tasks listed in each module represent the basic activities required of each student to demonstrate entry level competence for that specific system or field of study within the machining occupation. Individual records of student performance in completing the tasks listed within each module should be maintained.

Although some provision is made for basic mathematics and communication skills within these standards, they may not be adequate to meet the needs of individual students. Counseling, guidance, and diagnostic test results may indicate a need for further preparation in these areas. In such cases, instructors are encouraged to utilize the resources and personnel within the institution to improve or complement the instructional process.

The benefits to students and institutions derived from these curriculum standards should be considerable. Articulation of students from secondary to post-secondary programs will be aided through the use of a single set of curriculum standards. The curriculum standards provide a tool for evaluation of local curricula and programs. The curriculum standards may be used in a flexible manner to assure that Precision Machining programs meet the needs of local business and industry.

It is the goal of this program curriculum guide to provide a level of instruction which will impart entry level employment skills. Students should be carefully counseled on the importance of attaining competency in the tasks assigned. As in virtually all occupations today, machining technicians will require periodic up-dating and review in the future. It is important that each student understand that meeting the program curriculum standards is essential not only to obtain employment today but also to have a base upon which to retain employment in the future.

## MODULE 2 - PREREQUISITE MACHINING SKILLS

**TASK: Demonstrate Proficiency in Maintaining Immediate Work Area**

**Level III**

**PERFORMANCE OBJECTIVE:** Given appropriate materials and supplies the student will be able to demonstrate proficiency to maintain work areas in a machine shop.

**ENABLING OBJECTIVES:**

Demonstrate the knowledge of shop safety rules and practices.

Describe procedures for the proper disposal of scrap metal chips, shavings, oil, and coolant.

List shop operating rules and practices.

Demonstrate procedures to clean and maintain work areas affected by operations of work and shop areas.

Demonstrate knowledge of maintaining a clean and orderly shop.

Demonstrate knowledge of leaving work and shop area in a safe condition.

**TASK: Perform Mathematical Calculation's**

**Level III**

**PERFORMANCE OBJECTIVE:** Given the appropriate tools, equipment and resource material, the student will demonstrate the ability to perform accurate mathematical calculations relating to machine set up, material, and machine shop environment.

**ENABLING OBJECTIVES:**

Accurately perform job related decimal and fraction calculations.

Demonstrate proficiency solving job-related problems using basic formulas.

Demonstrate proficiency solving job-related problems using basic geometry.

Demonstrate proficiency measuring a work piece and compare measurements with blueprint specifications.

Demonstrate proficiency calculating the amount of material that should be removed to obtain correct limits for secondary operations.

Demonstrate proficiency in solving job-related problems using mathematical handbooks, charts, and tables.

Demonstrate proficiency in converting measurements from English to metric and from metric to English units.

Demonstrate proficiency in determining the clearance, relief, and rake of cutting tools.

Demonstrate proficiency in calculating machine speeds and feeds using appropriate formulas.

**TASK: Demonstrate Proficiency in Blueprint Reading and Machine Planning**

**Level III**

**PERFORMANCE OBJECTIVE:** Given the appropriate tools, materials, and prints, the student will demonstrate proficiency in reading blueprints to layout and prepare stock for machining operations.

**ENABLING OBJECTIVES:**

- Interpret view concepts.
- Read lines.
- Read and interpret title blocks.
- Read and interpret change orders on working and assembly prints.
- Read and interpret abbreviations.
- Make shop sketches.
- Read and interpret blueprints, including geometric tolerancing.
- Determine and interpret reference information used in performing machine work.
- Perform layout for precision machine work by using layout instruments.
- Lay out radial and bolt hole circles.
- Select the most productive tool and tooling for a given operation.

**TASK: Perform Measuring Operations**

**Level III**

**PERFORMANCE OBJECTIVE:** Given the appropriate tools and operation pieces, the student will accurately measure work pieces using the proper measuring instruments.

**ENABLING OBJECTIVES:**

- Read and measure with rules and calipers.
- Read and measure with micrometers.
- Read and measure with vernier tools.
- Read and measure with dial indicators.
- Measure using as surface plate.
- Read and interpret surface finish (ANSI Y14)

**TASK: Perform Maintenance on Machines and Tools**

**Level III**

**PERFORMANCE OBJECTIVE:** Given the appropriate tools, equipment, and supplies, the student will be able to perform maintenance functions on machining equipment and tools to restore the equipment to full operating condition.

**ENABLING OBJECTIVES:**

- Inspect work areas to assure a safe working environment.
- Lubricate equipment parts.
- Clean and store hand tools, cutters, fixtures, jigs, and attachments.
- Inspect and repair hand tools.
- Inspect drive pulleys or belts.
- Select lubricants for machining operations.
- Inspect equipment for safe operational conditions.
- Store grinding wheels and precision tools

# **CURRICULUM STANDARDS FOR PRECISION MACHINING**

## **MODULE 3**

### **BENCH WORK**

## MODULE 3 - BENCH WORK

This is one of a series of modules which comprise the Idaho Curriculum Guide for Precision Machining. Each module contains a listing of the tasks, performance objectives, and enabling objectives required to enable a student to achieve competency in a specific system or field of study within the basic machining technician occupational field. The numbering of these modules is not intended to dictate an order of instruction or scheduling. The order in which these modules may be taught is determined by each institution and its instructors.

Each task describes an occupational activity which will result in a finished process or product. The tasks listed in each module represent the basic activities required of each student to demonstrate entry level competence for that specific system or field of study within the machining occupation. Individual records of student performance in completing the tasks listed within each module should be maintained.

Although some provision is made for basic mathematics and communication skills within these standards, they may not be adequate to meet the needs of individual students. Counseling, guidance, and diagnostic test results may indicate a need for further preparation in these areas. In such cases, instructors are encouraged to utilize the resources and personnel within the institution to improve or complement the instructional process.

The benefits to students and institutions derived from these curriculum standards should be considerable. Articulation of students from secondary to post-secondary programs will be aided through the use of a single set of curriculum standards. The curriculum standards provide a tool for evaluation of local curricula and programs. The curriculum standards may be used in a flexible manner to assure that Precision Machining programs meet the needs of local business and industry.

It is the goal of this program curriculum guide to provide a level of instruction which will impart entry level employment skills. Students should be carefully counseled on the importance of attaining competency in the tasks assigned. As in virtually all occupations today, machining technicians will require periodic up-dating and review in the future. It is important that each student understand that meeting the program curriculum standards is essential not only to obtain employment today but also to have a base upon which to retain employment in the future.

## MODULE 3 - PERFORM BENCH WORK SKILLS

**TASK:** Cut materials by using hand hacksaws

Level III

**PERFORMANCE OBJECTIVE:** Given a dimensioned blueprint of a work piece, raw material, and a hand hacksaw, the student will be able to:

**ENABLING OBJECTIVES:**

Explain the safety precautions/procedures for use of a hand hacksaw.

Determine teeth per inch on various hacksaw blades.

Describe the applications for saw blades with different ratios of tooth pitch.

Demonstrate the correct method of sawing materials with a hand hacksaw.

**TASK:** Cut threads by using hand taps and dies

Level III

**PERFORMANCE OBJECTIVE:** Given a dimensioned blueprint, work piece, tap, die, tap wrench, die stock, cutting fluids and measuring instruments, cut internal and external threads to a class #2 fit.

**ENABLING OBJECTIVES:**

Explain safety precautions/procedures for threading with taps and dies.

Identify and explain the use of the three taps used for threading a blind hole.

Select cutting fluids.

Describe the procedure for cutting internal and external threads with a tap or die.

Explain the correct procedure to align a tap with the hole.

**TASK:** Ream holes by using hand reamers

Level III

**PERFORMANCE OBJECTIVE:** Given a hand reamer, ream a series of previously drilled holes to a tolerance of  $\pm .001$ .

**ENABLING OBJECTIVES:**

Demonstrate the proper method of hand reaming holes using both adjustable and non-adjustable reamers.

Explain the types of lubricants and their applications to reaming.

Explain the correct drill sizes as they relate to the various sizes of reamers.

**TASK:** Hand sharpen cutting tools by using abrasive stones

Level III

**PERFORMANCE OBJECTIVE:** Given a bench stone and a variety of cutting tools, hone the cutting edges to remove burrs and smooth the surfaces.

**ENABLING OBJECTIVES:**

Determine and demonstrate how to correctly hold various cutting tools to the angles characteristic to that tool.

Explain why bench stones require lubricants.

**TASK:** Remove damaged screws and other hardware

**Level III**

**PERFORMANCE OBJECTIVE:** Given a set of easy outs, a broken bolt in a piece of material, tap extractor and broken tap, remove these broken items from a variety of materials with a minimum of damage to the work piece.

**ENABLING OBJECTIVES:**

Explain the safety precautions/procedures for using easy outs and tap extractors.

Explain the purpose of easy outs and tap extractors.

Determine the correct drill sizes used with various easy outs.

Determine the correct tap extractor for various taps.

Describe the procedures for using easy outs and tap extractors.

Remove damaged screws.

**TASK:** Set up and use arbor press broaches

**Level III**

**PERFORMANCE OBJECTIVE:** Given an arbor press, broaches and lubricant, cut internal spline and keyways to a tolerance of  $\pm.002$ .

**ENABLING OBJECTIVES:**

Explain why broaches have to be shimmed.

Explain why lubricant is required.

Cut splines and keyways utilizing broaches, bushings, shims and arbor presses.

**TASK:** Deburr work pieces

**Level III**

**PERFORMANCE OBJECTIVE:** Given a variety of internal and external geometries, files and scrapers, completely deburr these work pieces to required tolerances.

**ENABLING OBJECTIVES:**

Demonstrate how to properly hold files and three corner scrapers.

Demonstrate how to sharpen a three corner scraper.

Deburr work pieces to required tolerances.

**CURRICULUM STANDARDS FOR PRECISION MACHINING**

**MODULE 7**

**LATHES**

## **MODULE 7 - DEMONSTRATE PROFICIENCY IN SETTING UP AND OPERATING LATHES**

This is one of a series of modules which comprise the Idaho Curriculum Guide for Precision Machining. Each module contains a listing of the tasks, performance objectives, and enabling objectives required to enable a student to achieve competency in a specific system or field of study within the basic machining technician occupational field. The numbering of these modules is not intended to dictate an order of instruction or scheduling. The order in which these modules may be taught is determined by each institution and its instructors.

Each task describes an occupational activity which will result in a finished process or product. The tasks listed in each module represent the basic activities required of each student to demonstrate entry level competence for that specific system or field of study within the machining occupation. Individual records of student performance in completing the tasks listed within each module should be maintained.

Although some provision is made for basic mathematics and communication skills within these standards, they may not be adequate to meet the needs of individual students. Counseling, guidance, and diagnostic test results may indicate a need for further preparation in these areas. In such cases, instructors are encouraged to utilize the resources and personnel within the institution to improve or complement the instructional process.

The benefits to students and institutions derived from these curriculum standards should be considerable. Articulation of students from secondary to post-secondary programs will be aided through the use of a single set of curriculum standards. The curriculum standards provide a tool for evaluation of local curricula and programs. The curriculum standards may be used in a flexible manner to assure that Precision Machining programs meet the needs of local business and industry.

It is the goal of this program curriculum guide to provide a level of instruction which will impart entry level employment skills. Students should be carefully counseled on the importance of attaining competency in the tasks assigned. As in virtually all occupations today, machining technicians will require periodic up-dating and review in the future. It is important that each student understand that meeting the program curriculum standards is essential not only to obtain employment today but also to have a base upon which to retain employment in the future.

## MODULE 7 - DEMONSTRATE PROFICIENCY IN SETTING UP AND OPERATING LATHES

**TASK:** Identify the parts of the lathe.

Level III

**PERFORMANCE OBJECTIVE:** Given a parts breakdown sheet, identify the main parts of the lathe.

**ENABLING OBJECTIVES:**

Explain the major parts of the lathe.

Explain the function of the bed.

Explain the function of the carriage and the parts therein.

Explain the function of the head stock and the parts therein.

Explain the function of the tail stock and the parts therein.

**TASK:** Comply with general safe and efficient work practices.

Level III

**PERFORMANCE OBJECTIVE:** Given an engine lathe, identify the major safety hazards characteristic to rotating work pieces.

**ENABLING OBJECTIVES:**

Explain the need for safety glasses.

Explain the hazards of chip handling.

Explain the set up hazards.

Explain the chuck removal and installation hazards.

Explain the hazards of work piece burrs.

Explain the proper housekeeping and tool hazards.

Demonstrate knowledge of safety by completing a written safety test

**TASK:** Measure stock

Level III

**PERFORMANCE OBJECTIVE:** Given a cylindrical work piece with external threads and a counterbored hole and a corresponding uni-dimensioned blueprint, outside, inside, and depth micrometers, telescope work piece, small hole gauge, vernier caliper, and surface plate, precision measure the work piece. Measure the external diameters, pitch diameters, internal bores, hole depths, and linear measurements of a work piece to a tolerance of  $\pm .002$  inches. Transpose dimensions onto blueprint in accordance with machine drafting procedures.

**ENABLING OBJECTIVES:**

Explain correct drafting standards for dimensioning blueprints.

Demonstrate the proper care, use, and calibrations of precision measuring instruments.

List accepted drafting abbreviations and/or symbols for the following terms:

Outside diameter

Inside diameter

Threads per inch

Inch

Millimeter

Counterbore

Depth

Measure a cylindrical work piece.

**TASK:** Set up an engine lathe

Level III

**PERFORMANCE OBJECTIVE:** Given independent, universal and collect chucks, lathe operation manual and dial indicator, mount chucks on lathe in accordance with operation manual so that there is no horizontal or vertical movement of the chuck. Set up a lathe using follower and steady rests.

**ENABLING OBJECTIVES:**

Explain the relevant safety precautions/procedures for mounting chucks on lathes.

Explain the operation of lathe.

Describe the use of wood blocks as cradles between bedways and chuck.

Discuss the applications for independent, universal, and collect chucks.

Describe the procedures for mounting chucks on lathe.

Describe the procedures for mounting face plates.

Describe the procedures for mounting and using follower and steady rests.

**TASK:** Secure tools, tool-holders, and fixtures or attachments

Level III

**PERFORMANCE OBJECTIVE:** Given independent, universal and collet chucks, lathe operation manual, and dial indicator, mount chucks on lathe in accordance with operation manual so that there is no horizontal or vertical movement of the chuck. Mount tool bits, fixtures or attachments on lathe.

**ENABLING OBJECTIVES:**

Explain the relevant safety precautions/procedures for mounting chucks on lathes.

Explain the operation of lathe.

Describe the use of tool holders, fixtures and attachments.

Determine and discuss the applications for independent, universal and collect chucks.

Describe the mounting of tool bits.

Demonstrate mounting and use of steady and follower rests.

**TASK:** Select and set feeds and speeds

Level III

**PERFORMANCE OBJECTIVE:** Given work sheet with check list, set assigned machines for each specified lathe spindle speed and feed.

**ENABLING OBJECTIVES:**

Explain lathe safety.

Locate, speed and feed chart on each machine.

List spindle speed formula and calculate RPM as per work sheet.

Identify lathe parts as listed on worksheet.

Adjust speed and feed settings for specified work sheet.

**TASK:** Set up lathes and face work pieces held in chucks

Level III

**PERFORMANCE OBJECTIVE:** Given blueprint, work piece, tool blanks, cutting fluids, and precision measuring instruments face the work piece holding a tolerance of  $\pm .005$  inch and to a surface finish of 125 micro inches.

**ENABLING OBJECTIVES:**

- Explain the safety precautions/procedures for facing.
- Describe the uses of carbide, high speed, and cutting tools as applied to facing operations.
- Define micro-inch.
- Calculate cutting speeds and feeds for facing operations.
- Describe the procedures for facing.
- Identify the correct cutting fluids for facing.
- Face a work piece to specifications.

**TASK:** Rough-cut and finish-cut with lathes

Level III

**PERFORMANCE OBJECTIVE:** Given bar stock and drawing, cutter bits, cutting fluids, measuring tools, make the required rough and finish cuts to required specifications.

**ENABLING OBJECTIVES:**

- Explain safety for lathe operation.
- Explain lathe feeds and describe the guideline
- Select speeds and feeds and mount stock in work holding devices.
- Explain tool position and tool geometry (angles).
- Define trial cuts.
- Make required trial cuts.
- Using appropriate measuring tools, measure work piece.
- Perform required rough and finish cuts to specifications.

**TASK:** Perform lathe filing to deburr parts

Level III

**PERFORMANCE OBJECTIVE:** Given work piece and work sheet; file, polish and deburr the work piece.

**ENABLING OBJECTIVES:**

- Explain lathe safety.
- Select spindle speed and mount project in lathe.
- Define micro-inch finishes.
- List names of different deburr tools.
- Explain grit size of abrasive clothes.
- List and identify shape, cut and size of files as required by worksheet.
- List other tools needed.
- File, polish and deburr a work piece.

**TASK:** Align lathe centers using accurate methods.

**Level III**

**PERFORMANCE OBJECTIVE:** Given a live and dead center, show methods of aligning lathe centers.

**ENABLING OBJECTIVES:**

- Describe the geometry of alignment of centers.
- Align centers using the point to point method.
- Align centers using a precision ground centered shaft.
- Align centers using the cut and measuring method.

**TASK:** Drill holes with lathes.

**Level III**

**PERFORMANCE OBJECTIVE:** Given blueprint, work piece, drill, lathe attachments, and cutting fluid, drill hole in work piece to a tolerance of  $\pm .005$  inch,  $-.000$  for diameter.

**ENABLING OBJECTIVES:**

- Explain the safety precautions/procedures for drilling operations.
- Calculate speeds for drilling operations.
- Describe the procedures for drilling on a lathe.
- Identify the correct cutting fluid for drilling operations.
- Drill a hole in a work piece.

**TASK:** Countersink holes with lathes

**Level III**

**PERFORMANCE OBJECTIVES:** Given blueprint, countersink tool, work piece, lathe attachments, cutting fluid, and measuring instruments, countersink hole in work piece to a tolerance of  $+ .010$  inch,  $-.000$  for diameter.

**ENABLING OBJECTIVES:**

- Explain the safety precautions/procedures for countersinking operations.
- Calculate speeds for countersinking operations.
- Describe the procedures for countersinking on a lathe.
- Identify the correct cutting fluid for countersinking.
- Countersink a hole in a work piece.

**TASK:** Ream holes with lathes

**Level III**

**PERFORMANCE OBJECTIVE:** Given a blueprint, work piece, reamer, lathe attachments, cutting fluid, and inside measuring instruments, ream hole in work piece to a tolerance of  $+ .002$ ,  $-.000$  for diameter.

**ENABLING OBJECTIVES:**

- Explain the safety precautions/procedures for reaming operations.
- Calculate speeds for reaming operations.
- Describe the procedures for reaming.
- Identify the correct cutting fluid for reaming.
- Ream a hole in a work piece.

**TASK: Tap threads with lathes**

**Level III**

**PERFORMANCE OBJECTIVE:** Given blueprint, work piece, tap, tap wrench, lathe attachments, cutting fluid, and thread plug gauge, tap hole in work piece to a class 2 fit.

**ENABLING OBJECTIVE:**

- Explain the safety precautions/procedures for tapping operations.
- Determine tap drill size using the charts and formulas.
- Describe the procedures for tapping on a lathe.
- Identify the correct cutting fluid for tapping.
- Describe the proper use of a plug gauge.
- Tap threads in a work piece.

**TASK: Die-cut threads with lathes**

**Level III**

**PERFORMANCE OBJECTIVE:** Given blueprint, work piece and threading die and die stock, die cut external threads using a lathe.

**ENABLING OBJECTIVES:**

- Explain safety requirements for cutting external threads.
- Calculate lathe RPM.
- Set up work piece in chuck.
- Remove tail stock center and explain how to follow the die with the tailstock spindle.
- Describe procedures for cutting external threads.
- Identify the proper cutting fluid.
- Die cut external threads on a work piece.

**TASK: Counterbore holes with lathes**

**Level III**

**PERFORMANCE OBJECTIVE:** Given blueprint, work piece, lathe attachments, boring bar, cutting fluid, and precision measuring instruments, counterbore hole in work piece to a tolerance of  $\pm .001$  inch for diameter and depth.

**ENABLING OBJECTIVES:**

- Explain the safety precautions/procedures for counter-boring operations.
- Calculate speeds for counter-boring operations.
- Describe the procedures for counter-boring.
- Identify the correct cutting fluid for counter-boring operations.
- Counterbore a hole in a work piece.

**TASK: Bore holes with lathes**

**Level III**

**PERFORMANCE OBJECTIVES:** Given blueprint, work piece, boring bar, tool blank, boring bar holder, cutting fluid, and precision measuring instruments, bore hole with lathe to a tolerance of  $\pm .001$  inch for location, diameter, depth, and to print surface finish specifications.

**ENABLING OBJECTIVES:**

- Explain the safety precautions/procedures for boring holes with a lathe.
- Calculate speeds for boring operations on lathes.
- Describe the procedures for boring holes.
- Identify the correct cutting fluids for boring.
- Bore a hole in a work piece.

**TASK: Knurl parts with lathes**

**Level III**

**PERFORMANCE OBJECTIVE:** Given blueprint, work piece, diamond and/or straight knurling tools, cutting fluid, knurl work piece in accordance with Machinery's Handbook specifications for knurling.

**ENABLING OBJECTIVES:**

- Explain the safety precautions/procedures for knurling a work piece.
- Explain the proper use of knurling tools.
- Calculate speeds and feeds for knurling operations.
- Describe the procedures for knurling a work piece.
- Identify the correct cutting fluid for knurling.
- Knurl a work piece.

**TASK: Cut external threads with lathes**

**Level III**

**PERFORMANCE OBJECTIVE:** Given blueprint, work piece, tool holder, tool blank, center gauge, cutting fluids, and precision measuring instruments, cut external threads on work piece to tolerances for class 2 fit for external threads and in accordance with Machinery's Handbook. Use thread micrometer and/or three-wire system for checking threads.

**ENABLING OBJECTIVES:**

- Explain the safety precautions/procedures for cutting external threads.
- Explain the formulas used in the three wire system for measuring external threads.
- Calculate proper speeds for cutting external threads.
- Describe the procedures for cutting external threads.
- Select the correct cutting fluid for threading operations.
- Calculate thread depth.
- Calculate total in feed of compound.
- Determine depth per pass.
- Determine compound off-set angle (right or left hand threads).
- Cut external threads on a work piece.

**TASK:** Re-chase threads with lathes

Level III

**PERFORMANCE OBJECTIVE:** Given a damaged thread, set up and catch thread to repair it.

**ENABLING OBJECTIVES:**

- Explain safety precautions for re-chasing threads.
- Describe procedure for setting up a lathe to re-chase threads.
- Identify tools needed to re-chase threads.
- Select correct cutting fluid for re-chasing threads.
- Re-chase threads on a work piece.

**TASK:** Cut internal threads with lathes

Level III

**PERFORMANCE OBJECTIVE:** Given blueprint, work piece, tool holder, tool blank, thread center gauge, cutting fluids and precision measuring instruments, cut internal threads on work pieces to tolerances for class 2 fit for internal threads in accordance with Machinery's Handbook. Use threaded part or plug gauge for checking threads.

**ENABLING OBJECTIVES:**

- Explain the safety precautions/procedures for chasing internal threads.
- Calculate total in feed of compound for unified threading.
- Calculate proper speeds and hole size for cutting internal threads.
- Describe the procedures for cutting internal threads.
- Select the correct cutting fluid for threading.
- Determine depth of cut per pass.
- Determine compound off-set angle.
- Cut internal threads on a work piece.

**TASK:** Set up and perform taper turning with taper attachments

Level III

**PERFORMANCE OBJECTIVE:** Given blueprint, work piece, turning tool, tool holder, dial indicator, micrometer carriage stop, cutting fluids, and precision measuring instruments, machine external taper on work piece holding a tolerance of .001 per 4 inches in length and a surface finish as specified by the blueprint.

**ENABLING OBJECTIVES:**

- Explain the safety precautions/procedures for machining an external taper.
- Explain the use of taper attachments.
- Describe the procedures for cutting external tapers.
- Calculate speeds and feeds for external tapering operations.
- Explain how to check taper over a 4.000 inch length.
- Identify the correct cutting fluids for external tapering operations.
- Turn an external taper on a work piece.

**TASK:** Set up and perform taper turning with compound.

Level III

**PERFORMANCE OBJECTIVE:** Given blueprint, work piece, tool holder, cutting tool, cutting fluid, and precision measuring instruments, cut external angle with compound on work piece holding a tolerance of  $\pm 30$  minutes for the angle, and a surface finish to print requirements.

**ENABLING OBJECTIVES:**

- Explain the safety precautions/procedures.
- Calculate cutting speed for cutting external angle with compound.
- Describe the procedures for cutting external angles.
- Identify the correct cutting fluid for cutting external angles.
- Cut an external taper with a compound on a work piece.

**TASK:** Cut internal tapered surfaces

Level III

**PERFORMANCE OBJECTIVE:** Given blueprint, work piece, boring bar, tool blank, boring bar holder, cutting fluid, and precision measuring instruments, cut internal tapered surface on work piece using taper attachment to a tolerance of  $\pm .002$  inch on the diameter, and  $\pm .005$  on the length, and to print surface finish requirements.

**ENABLING OBJECTIVES:**

- Explain the safety precautions/procedures for cutting internal tapered surface.
- Calculate speeds and feeds for internal tapering operations.
- Describe the procedures for boring internal tapers with taper attachment.
- Identify the correct cutting fluids for boring internal tapers.
- Cut an internal taper on a work piece.

**TASK:** Perform contour, angular, or radial cuts with lathes

Level III

**PERFORMANCE OBJECTIVE:** Given blueprints, work piece, tool blanks, tool holder, cutting fluid, radius work piece, and precision measuring instruments, free hand form work piece to concave and convex radii and angular into per blueprint and visual inspection.

**ENABLING OBJECTIVES:**

- Explain the safety precautions/procedures for free hand forming a work piece.
- Describe the procedures for angular concave or contour cuts with lathes.
- Explain the proper use of radius gauges.
- Calculate speeds for free hand forming operations.
- Describe the procedures for free hand forming concave and convex radii.
- Identify the correct cutting fluids.
- Cut contour, concave and angular surfaces on a work piece.

**TASK: Set up and use follower and steady-rests**

**Level III**

**PERFORMANCE OBJECTIVE: Given blueprint, face plate, dog, steady rest and follower rest, turn long shaft between centers.**

**ENABLING OBJECTIVES:**

**Explain safety precautions for using follow and steady rests.**

**Install face plate.**

**Describe the procedure to install work using a lathe dog and faceplate.**

**Install steady rest or follower rest and adjust to part.**

**Turn work to size with proper follow and steady rest setup.**

**TASK: Set up face plates and lathe dogs**

**Level III**

**PERFORMANCE OBJECTIVE: Given blueprint, face plate, clamping tools, tool blanks, center drill, drill, boring bar, and work piece, face, drill and bore work piece holding a tolerance of  $\pm .005$  on all dimensions and to a surface finish as specified on print.**

**ENABLING OBJECTIVES:**

**Explain the safety precautions/procedures for facing, drilling, and boring operations.**

**Describe the use of the face plate and the importance of counter-balancing the work piece.**

**Describe the procedure for clamping and aligning part to face plate.**

**Calculate cutting speeds for facing, drilling and boring.**

**Identify the correct fluid for facing, drilling and boring operations.**

**CURRICULUM STANDARDS FOR PRECISION MACHINING**

**MODULE 8**

**MILLING MACHINES**

## MODULE 8 - MILLING MACHINES

This is one of a series of modules which comprise the Idaho Curriculum Guide for Precision Machining. Each module contains a listing of the tasks, performance objectives, and enabling objectives required to enable a student to achieve competency in a specific system or field of study within the basic machining technician occupational field. The numbering of these modules is not intended to dictate an order of instruction or scheduling. The order in which these modules may be taught is determined by each institution and its instructors.

Each task describes an occupational activity which will result in a finished process or product. The tasks listed in each module represent the basic activities required of each student to demonstrate entry level competence for that specific system or field of study within the machining occupation. Individual records of student performance in completing the tasks listed within each module should be maintained.

Although some provision is made for basic mathematics and communication skills within these standards, they may not be adequate to meet the needs of individual students. Counseling, guidance, and diagnostic test results may indicate a need for further preparation in these areas. In such cases, instructors are encouraged to utilize the resources and personnel within the institution to improve or complement the instructional process.

The benefits to students and institutions derived from these curriculum standards should be considerable. Articulation of students from secondary to post-secondary programs will be aided through the use of a single set of curriculum standards. The curriculum standards provide a tool for evaluation of local curricula and programs. The curriculum standards may be used in a flexible manner to assure that Precision Machining programs meet the needs of local business and industry.

It is the goal of this program curriculum guide to provide a level of instruction which will impart entry level employment skills. Students should be carefully counseled on the importance of attaining competency in the tasks assigned. As in virtually all occupations today, machining technicians will require periodic up-dating and review in the future. It is important that each student understand that meeting the program curriculum standards is essential not only to obtain employment today but also to have a base upon which to retain employment in the future.

## **MODULE 8 - DEMONSTRATE PROFICIENCY IN SETTING UP AND OPERATING MILLING MACHINES**

**TASK: Identify the parts of the Horizontal and Vertical Milling Machine**

**Level III**

**PERFORMANCE OBJECTIVE:** Given a milling machine and service manual, identify major parts and their function.

**ENABLING OBJECTIVES:**

Identify types of milling machines.

Identify major parts of milling machines.

Describe the function of major parts.

**TASK: Lubricate Milling Machines**

**Level III**

**PERFORMANCE OBJECTIVES:** Given service manual and/or lubrication chart, lubricants and tools, clean, inspect and lubricate the milling machine in accordance with charts in operation manual. All lubrication points will be supplied with the correct amount and type of lubricant.

**ENABLING OBJECTIVES:**

Explain the safety precautions/procedures for cleaning, lubricating and inspecting the milling machine.

Explain the reasons for performing routine cleaning, inspection, and lubrication of milling machines.

Determine the proper lubricants to be used for milling machines.

Explain the meaning of the terms (a) climb; (b) conventional milling.

Describe the procedures for cleaning, lubricating and inspecting the milling machine.

Lubricate a milling machine.

**TASK: True up the Head and Align Milling Machine Fixtures**

**Level III**

**PERFORMANCE OBJECTIVE:** Given a milling machine with a swivel type head and dial indicator with attachments, align the table and must be aligned to within .001 inch T.I.R. at a 4 inch radius and align vise on milling machine table to within .001 inch T.I.R.

**ENABLING OBJECTIVES:**

Explain the safety precautions/procedures in alignment of heads.

Explain the operation of a swivel head on a mill.

Explain the use of dial indicator for aligning swivel heads.

Describe the procedures for aligning the head of a milling machine.

Describe the procedures for aligning a vise on a milling table.

Align a vise on a milling table.

Align a head of a milling machine.

**TASK: Select and Set Feeds and Speeds for Milling Work**

**Level III**

**PERFORMANCE OBJECTIVE:** Given a known hardness of a variety of materials, determine the correct speeds and feeds for milling using handbook.

**ENABLING OBJECTIVES:**

List the correct cutting speed and feed for the following materials:

cold rolled steel, with 1/2" end mill.

aluminum, with 1/4" end mill.

tool steel, with 3/8" end mill.

Set correct feeds and speeds on a milling machine for selected material.

**TASK: Square up Work pieces with a Table Vise**

**Level III**

**PERFORMANCE OBJECTIVES:** Given a blueprint, work piece, end mill or face mill, cutting fluids, milling machine vise, parallels, soft face hammer, and precision measuring instruments, mill a block of metal square holding a tolerance of  $\pm .001$  inch for linear dimensions.

**ENABLING OBJECTIVES:**

Explain the safety precautions/procedures for milling operations.

Calculate the correct speed and feed for various cutters.

Describe the procedures for setting-up and machining a work piece parallel and square.

Identify the correct cutting fluids for milling.

Mill a block of metal to square within required tolerances.

**TASK: Perform End Milling**

**Level III**

**PERFORMANCE OBJECTIVES:** Given blueprint, work piece holding device, end mill, cutting fluid, and precision measuring instrument, mill a flat surface to .001 T.I.R.

**ENABLING OBJECTIVE:**

Explain the safety precautions/procedures for end milling.

Calculate proper speeds, feeds and depth of cut with end milling.

Describe the procedures for setting up and end milling a flat surface.

Identify the correct cutting fluids for milling.

End mill a flat surface to .001 T.I.R.

**TASK: Perform Fly-Cutting Operations**

**Level III**

**PERFORMANCE OBJECTIVE:** Given a blueprint, work piece, fly-cutter, cutting tool blank, and precision measuring instruments, fly-cut work piece surface to print requirements.

**ENABLING OBJECTIVES:**

- Explain the safety precautions/procedures for fly-cutting a work piece surface.
- Define surface roughness, waviness, lay and identify their symbols.
- Explain the purpose of fly-cutters.
- Calculate speeds, feeds, and determine depth of cut for fly-cutting surfaces.
- Describe the procedures for fly-cutting surfaces.
- Fly-cut a work piece surface to required tolerances.

**TASK: Drill Holes with a Milling Machine**

**Level III**

**PERFORMANCE OBJECTIVE:** Given a blueprint, work piece, center drill and drill, layout materials, and precision measuring instruments, drill equally spaced holes in work piece holding a tolerance of  $\pm .002$  inch for location and diameter, and  $\pm 1$  degree for perpendicularity.

**ENABLING OBJECTIVES:**

- Explain safety precautions/procedure for drilling holes.
- Describe the procedures for using milling machine dials for accurate table positioning.
- Calculate the amount of table movement for each position.
- Describe the procedures for compensating for backlash out the lead screws.
- Calculate the correct speed and feed.
- Drill holes in a work piece to specified tolerances using a milling machine.

**TASK: Perform Reaming Operations**

**Level III**

**PERFORMANCE OBJECTIVES:** Given blueprint, work piece, holding device, centerdrill, drill, reamer, cutting fluid, and precision measuring instruments, centerdrill, drill and ream a hole holding a tolerance of  $+ .002$ ,  $- .000$  for diameter, and  $.002$  for the hole's true position according to print specifications.

**ENABLING OBJECTIVES:**

- Explain the safety precautions/procedures for centerdrilling and reaming a hole.
- Explain the uses of centerdrills, drills, and reamers.
- Calculate proper speeds and feeds for centerdrilling, drilling, and reaming operations.
- Describe the procedures for centerdrilling, drilling, and reaming on a milling machine.
- Identify the correct cutting fluids for centerdrilling, drilling and reaming.
- Determine the proper drill size for reaming.
- Ream a hole in a work piece holding required tolerances.

**TASK: Cut External Keyways**

**Level III**

**PERFORMANCE OBJECTIVE:** Given blueprint, work piece holding device, end mill, cutting fluid, and precision measuring instruments, end mill keyseat in the work piece holding a tolerance of + .001, - .000 inch for width, + .005, - .000 depth,  $\pm$  1/64 inch for length.

**ENABLING OBJECTIVES:**

- Explain the safety precautions/procedures for end milling keyseats.
- Calculating proper speeds, feeds, and depth of cut when milling keyseats.
- Describe the procedures for setting up and milling keyseats.
- Identify the correct cutting fluids for milling keyseats.
- Determine keyway depth.
- End mill a keyseat in a work piece holding required tolerances.

**TASK: Bore Hole with Milling Machines**

**Level III**

**PERFORMANCE OBJECTIVE:** Given a blueprint with bore specifications, work piece, work holding device, boring head, cutting fluid and precision measuring instruments, bore hole in work piece with boring head holding print tolerances.

**ENABLING OBJECTIVES:**

- Explain the safety precautions/procedures for boring and counterboring holes.
- Explain the procedures for accurately adjusting a boring head.
- Calculate speeds and feeds for boring operations.
- Describe the procedures for setting up and completing boring operations.
- Identify the correct cutting fluids for boring and counterboring.
- Bore a hole in a work piece using a boring head on a milling machine to required tolerances.

**TASK: Perform Form Milling**

**Level III**

**PERFORMANCE OBJECTIVE:** Given a blueprint, work piece, form cutter, cutting fluids, and precision measuring instruments, form mill work piece holding print tolerances.

**ENABLING OBJECTIVES:**

- Explain the safety precautions/procedures for form milling.
- Define the terms concave and convex as they pertain to milling cutters.
- Calculate speeds, feeds, and depth of cut for milling cutter.
- Describe the procedures for form milling.
- Identify the correct cutting fluids.
- Form mill a work piece to required tolerances.

**TASK: Perform Indexing Operations Using a Dividing Head**

**Level III**

**PERFORMANCE OBJECTIVE:** Given blueprint, milling machine with an indexing head, Machinery's Handbook, change gears, cutting tools, cutting fluids, and precision measuring instruments, machine work piece using differential indexing locating odd numbers of divisions over 40.

**ENABLING OBJECTIVES:**

- Explain the safety precautions/procedures for machining using the differential indexing method.
- Explain the calculations for the indexing head when performing differential indexing.
- Explain the proper technique for assembling gears in gear train.
- Define simple gearing and compound gearing.
- Explain the use of an idler gear.
- Describe the procedures for machining a work piece using differential indexing.
- Identify the correct cutting fluids.
- Explain the use of wide range indexing.
- Machine a work piece with differential indexing using a dividing head.

**TASK: Set Up and Operate Rotary Tables**

**Level III**

**PERFORMANCE OBJECTIVE:** Given blueprint, work piece, milling machine with rotary table, end mills, cutting fluids, and precision measuring instruments, machine an outside radius holding print tolerances.

**ENABLING OBJECTIVES:**

- Explain the safety precautions/procedures for milling radii using a rotary table.
- Describe set up and clamping procedures for a rotary table.
- List the applications for a rotary table.
- Explain the procedures for avoiding backlash of rotary table and milling machine screws.
- Calculate the correct speeds for machining outside radius.
- Describe the procedure for milling outside radius using a rotary table.
- Identify the correct cutting fluids.
- Describe the procedures for centering spindle with rotary table.
- Mill an outside radius using a rotary table on a machining machine.

**TASK: Mill an External Radius**

**Level III**

**PERFORMANCE OBJECTIVE:** Given blueprint, work piece, milling machine with rotary table, end mills, cutting fluids, and precision measuring instruments, machine an inside radius holding print tolerances.

**ENABLING OBJECTIVES:**

Explain the safety precautions/procedures for cutting radii using a rotary table.

Calculate the correct speeds for milling inside radius.

Describe the procedures for machining inside radii using a rotary table.

Identify the correct cutting fluids.

Machine an internal radius using a rotary table on a milling machine.

**TASK: Mill an Angle**

**Level III**

**PERFORMANCE OBJECTIVE:** Give blueprint, milling machine, with an indexing head, drills, Machinery's Handbook, work piece, cutting fluids, and precision measuring instruments, drill holes in work piece to specified angles using the indexing head.

**ENABLING OBJECTIVES:**

Explain the safety precautions/procedures for milling holes using angular indexing.

Explain the calculations required for the indexing head when performing angular indexing.

Calculate speeds and feeds for angular indexing operations.

Describe the procedures for milling holes using angular indexing.

Identify the correct cutting fluids.

Drill holes in a work piece to specified angles using an indexing head.

**TASK: Align Milling Machine Attachments**

**Level III**

**PERFORMANCE OBJECTIVE:** Given a milling machine and a dial indicator with attachments, align milling machine attachments to within .001 inch T.I.R.

**ENABLING OBJECTIVES:**

Explain the safety precautions/procedures in alignment of attachment.

Explain the use of dial indicator for aligning attachment.

Describe the procedures for aligning the milling attachment.

Align various milling machine attachments to within .001 T.I.R.

**TASK: Mill Internal Slots with a slotting attachment**

**Level III**

**PERFORMANCE OBJECTIVE:** Given a blueprint, work piece, milling machine with slotting attachment, cutting fluids, precision measuring instruments, and tool blanks, machine internal slots and keyway holding a tolerance as specified on blueprint.

**ENABLING OBJECTIVES:**

Explain the safety precautions/procedures for cutting internal slots and keyways.

Explain the ability to grind and sharpen cutting tools.

Determine the correct cutters for various applications.

Calculate depth and size of keyways and slots.

Describe set up procedures for the length of stroke.

Calculate speed in strokes per minute.

Describe procedures for machining internal slots and keyways.

**TASK: Perform Cutting-Off Operation**

**Level III**

**PERFORMANCE OBJECTIVE:** Given a milling machine, arbor and slitting saw, cut multiple work pieces to precision lengths and slot various shapes of work pieces.

**ENABLING OBJECTIVES:**

Explain how to calculate depths, speeds and feeds for slitting saws.

Explain how to set up work pieces with kickers to cut precision lengths.

Cut work pieces to precision lengths.

Slot various shapes of work pieces.

**TASK: Set Up and Perform Slab Mill Operations**

**Level III**

**PERFORMANCE OBJECTIVE:** Given blueprint, work piece, horizontal milling machine, slab milling cutter, arbor with spacers, work holding device, cutting fluids, and precision measuring instruments, mill the work piece. After rough and finish cut, parallelism must be within .002 inch per 6 inches of length.

**ENABLING OBJECTIVES:**

Explain the safety precautions/procedures for slab milling.

Explain the importance of maintaining a clean milling machine.

Describe procedures for mounting cutter and arbor in the milling machine.

Explain why the cutter should always be mounted on the arbor as close to the column of the milling machine as possible.

Describe the procedures for slab milling operations.

Identify the correct cutting fluid.

Explain the purpose of the applications for using climb milling and conventional milling.

Mill, rough and finish cut a work piece to required tolerances.

**TASK: Use an Edge Finder and Wiggler**

**Level III**

**PERFORMANCE OBJECTIVE:** Given a work piece and an edge finder or wiggler locate the center of the work piece to within  $\pm .001$  inch.

**ENABLING OBJECTIVES:**

Explain the safety precautions/procedures.

Explain the correct care and use of an edge finder or wiggler.

Describe the procedures for touching off with an edge finder and a wiggler.

Mark the center of a work piece after locating it with a wiggler or edge finder.

**TASK: Use Digital Readouts**

**Level III**

**PERFORMANCE OBJECTIVE:** Given a blueprint, work piece, center drill and drill, layout materials, digital read out, and precision measuring instruments, drill equally spaced holes in work piece holding a tolerance of  $\pm .0005$  non-cumulative location.

**ENABLING OBJECTIVES:**

Explain the safety cutting precautions/procedures for drilling holes.

Describe the procedures for using digital read out for accurate table positioning.

Calculate the amount of table movement for each position.

Describe the procedures for keeping backlash out of lead screws.

Calculate the correct cutting speed and feed.

Describe the procedures for drilling equally spaced holes.

Identify the correct cutting fluids for drilling.

Drill equally spaced holes in a work piece using digital read outs to locate centers.

**TASK: Perform Straddle Milling Operations on the Horizontal Mill**

**Level III**

**PERFORMANCE OBJECTIVE:** Given a blueprint, work piece, work holding device, milling cutter, arbor spacer, cutting fluids, and precision measuring instruments, gang mill work pieces holding a tolerance of  $\pm .005$  on depth, width and spacing.

**ENABLING OBJECTIVES:**

Explain the safety precautions/procedures.

Explain the purpose of and applications for gang milling operations.

Describe the procedures for mounting cutters and arbor in machine.

Explain why a key is needed in the arbor.

Calculate speed, feed, and depth of cut for gang milling operations.

Describe the procedures for gang milling.

**TASK: Set Up and Use a Sine Vise**

**Level III**

**PERFORMANCE OBJECTIVE:** Given a milling sine vise, work piece, parallels, soft face hammer, and precision measuring instruments, seat work piece in vise to within .003 T.I.R. per 4 inches.

**ENABLING OBJECTIVES:**

Explain the safety precautions/procedures.

Describe the care and use of parallels.

Describe the procedures for seating a part in a milling sine vise.

Set up and seat a work piece in a sine vise.

**CURRICULUM STANDARDS FOR PRECISION MACHINING**

**MODULE 9**

**SURFACE GRINDING MACHINING**

## MODULE 9 - SURFACE GRINDING MACHINING

This is one of a series of modules which comprise the Idaho Curriculum Guides for Precision Machining. Each module contains a listing of the tasks, performance objectives, and enabling objectives required to enable a student to achieve competency in a specific system or field of study within the basic machining technician occupational field. The numbering of these modules is not intended to dictate an order of instruction or scheduling. The order in which these modules may be taught is determined by each institution and its instructors.

Each task describes an occupational activity which will result in a finished process or product. The tasks listed in each module represent the basic activities required of each student to demonstrate entry level competence for that specific system or field of study within the machining occupation. Individual records of student performance in completing the tasks listed within each module should be maintained.

Although some provision is made for basic mathematics and communication skills within these standards, they may not be adequate to meet the needs of individual students. Counseling, guidance, and diagnostic test results may indicate a need for further preparation in these areas. In such cases, instructors are encouraged to utilize the resources and personnel within the institution to improve or complement the instructional process.

The benefits to students and institutions derived from these curriculum standards should be considerable. Articulation of students from secondary to post-secondary programs will be aided through the use of a single set of curriculum standards. The curriculum standards provide a tool for evaluation of local curricula and programs. The curriculum standards may be used in a flexible manner to assure that Precision Machining programs meet the needs of local business and industry.

It is the goal of this program curriculum guide to provide a level of instruction which will impart entry level employment skills. Students should be carefully counseled on the importance of attaining competency in the tasks assigned. As in virtually all occupations today, machining technicians will require periodic up-dating and review in the future. It is important that each student understand that meeting the program curriculum standards is essential not only to obtain employment today but also to have a base upon which to retain employment in the future.

## MODULE 9 - SETTING UP AND OPERATING SURFACE GRINDERS

**TASK:** Identify the parts of the Machine and explain their use

Level III

**PERFORMANCE OBJECTIVES:** Given a surface grinder, service manual, identify major parts and function.

**ENABLING OBJECTIVES:**

Identify types of surface grinders.

Identify major parts.

Describe the function of major parts.

**TASK:** Comply with Safe and Efficient Work Practices

Level III

**PERFORMANCE OBJECTIVE:** Given a tool and cutter grinder and a selection of grinding wheels, explain the safety hazards associated with grinders and grinding wheels.

**ENABLING OBJECTIVES:**

Explain the safety precautions/procedures for mounting grinding wheels.

Explain how to determine if a wheel is cracked before mounting.

Explain the importance of cleanliness when mounting a wheel.

Explain the importance of the blotters on the wheel.

Describe the procedure for determining how tight the flanges should be.

**TASK:** Clean, inspect, and lubricate surface grinding machine

Level III

**PERFORMANCE OBJECTIVE:** Given service manual and/or lubrication charts, and access to cleaning fluid, lubricants, and lubrication tools for the surface grinder, clean, inspect, and lubricate the grinder in accordance with service manual and lubrication charts. All lubrication points will be supplied with the required type and amount of lubricant.

**ENABLING OBJECTIVES:**

Explain the safety precautions/procedures for cleaning, inspecting, and lubricating.

Explain the reasons for performing routine cleaning, inspection, and lubrication.

List the applications for lubricants used.

Locate the lubrication points on the grinder using the manual.

Describe the inspection procedures.

Identify the materials and describe the procedures used for cleaning surface grinders.

Lubricate a surface grinding machine.

**TASK: Select the Proper Wheel**

**Level III**

**PERFORMANCE OBJECTIVE:** Given grinder, grinding wheel and access to necessary tools and precision measuring instruments, select, inspect, and mount wheel to meet requirements found in operator's manual and the Machinery's Handbook.

**ENABLING OBJECTIVES:**

Explain the safety precautions/procedures for mounting grinding wheels. State type of grit, structure, grade, bond, and grit size for grinding the following materials: a) machine steel, b) hardened tool steel, c) carbide, d) cast iron.

Explain how to determine if a wheel is cracked before mounting.

Explain the importance of cleanliness when mounting a wheel.

Explain the importance of the blotters on the wheel.

Explain the reasons for the manufacturer printing the operating wheel speed on grinding wheels.

Explain the relevant safety precautions/procedures in regard to the diameter of the flanges in relationship to the diameter of the wheel.

Describe the procedures for mounting and balancing a grinding wheel.

Mount and balance a grinding wheel.

**TASK: Inspect, Balance, Dress, and True, Grinding Wheel**

**Level III**

**PERFORMANCE OBJECTIVE:** Given grinder and diamond dresser, true and dress the grinding wheel in accordance with the procedures stated in the Machinery's Handbook and so that the wheel runs true and the grinding surface is neither loaded nor glazed.

**ENABLING OBJECTIVES:**

Explain the safety precautions/procedures for truing and dressing a grinding wheel.

Identify the different types of wheel dresser.

Determine the types of dresser to be used on different grinding wheels.

Explain the reasons for truing and dressing grinding wheels.

Describe procedures for truing, dressing, and balancing a grinding wheel.

Explain the safety precautions/procedures for using a diamond wheel dresser.

True and dress a grinding wheel using a diamond wheel dresser.

**TASK: Attach and Align Work pieces for Grinding Operations**

**Level III**

**PERFORMANCE OBJECTIVE:** Given a surface grinder and a dial indicator with attachments, align surface grinding attachments to within .0005 inch T.I.R.

**ENABLING OBJECTIVES:**

Explain the safety precautions/procedures in alignment or attachment.

Explain the use of dial indicator for aligning attachment.

Describe the procedures for aligning the grinding attachment.

Align grinding attachments to required tolerances.

**TASK: Set Up and Grind Parallel Flat Surfaces**

**Level III**

**PERFORMANCE OBJECTIVE:** Given grinding specifications, work piece, diamond wheel dresser, coolant, and precision measuring instruments, grind flat surface holding a tolerance of  $\pm .0005$  inch without warpage or distortion.

**ENABLING OBJECTIVES:**

- Explain the safety precautions/procedures for surface grinding flat surfaces.
- Describe the dressing procedures for grinding flat surfaces.
- Explain the reason for using a coolant.
- Describe the procedures for grinding flat surfaces.
- Identify the correct coolant.
- Discuss safe wheel mounting procedures.
- Grind parallel flat surfaces to required tolerances.

**TASK: Set Up and Grind Four Sides Square**

**Level III**

**PERFORMANCE OBJECTIVE:** Given grinding specifications, work piece, diamond wheel dresser, angle plate, clamps, coolant, and precision measuring instruments, grind work piece square holding a tolerance for squareness as specified on blueprint.

**ENABLING OBJECTIVES:**

- Explain the safety precautions/procedures for grinding square.
- Define square in relation to surface grinding.
- Describe the procedures for grinding square.
- Grind four sides of a work piece square.

**TASK: Set Up and Use Angle Plates**

**Level III**

**PERFORMANCE OBJECTIVE:** Given grinding specifications, grinder, three work pieces, diamond wheel dresser, angle vise, coolant, sine plate, and precision measuring instruments, grind angular surfaces holding a tolerance of  $\pm 3$  minutes for angle vise grinding and  $\pm 2$  minutes for sine plate grinding.

**ENABLING OBJECTIVES:**

- Explain the safety precautions/procedures for grinding angular surfaces.
- Define the term "wringing" in relation to the use of gage blocks.
- Describe the correct care and use of gauge blocks.
- Describe the use of gauge blocks for setting up angles.
- Describe the correct care and use of angle vises and sine plates.
- Describe the procedures for grinding angular surfaces, using dressed angular wheels, angle vise, and sine plate.
- Grind angular surfaces on three work pieces to required tolerances.

**TASK: Measure, inspect and rework work pieces on grinding machines**  
**Level III**

**A PERFORMANCE OBJECTIVE: Given a grinder, flat work piece, outside micrometer, vernier caliper, and surface plate, precision measure the work piece.**

**ENABLING OBJECTIVES:**

**Explain correct drafting standards for dimensioning blueprints.**

**Demonstrate the proper care, use, and calibration of precision measuring instruments.**

**List accepted drafting abbreviations and/or symbols for the following terms:**

**outside diameter**

**inside diameter**

**threads per inch**

**inch**

**millimeter**

**counterbore**

**depth**

**Measure and grind a work piece to blueprint specification.**

**CURRICULUM STANDARDS FOR PRECISION MACHINING**

**MODULE 10**

**COMPUTERIZED NUMERICAL CONTROL**

## MODULE 10 - COMPUTERIZED NUMERICAL CONTROL

This is one of a series of modules which comprise the Idaho Curriculum Guide for Precision Machining. Each module contains a listing of the tasks, performance objectives, and enabling objectives required to enable a student to achieve competency in a specific system or field of study within the basic machining technician occupational field. The numbering of these modules is not intended to dictate an order of instruction or scheduling. The order in which these modules may be taught is determined by each institution and its instructors.

Each task describes an occupational activity which will result in a finished process or product. The tasks listed in each module represent the basic activities required of each student to demonstrate entry level competence for that specific system or field of study within the machining occupation. Individual records of student performance in completing the tasks listed within each module should be maintained.

Although some provision is made for basic mathematics and communication skills within these standards, they may not be adequate to meet the needs of individual students. Counseling, guidance, and diagnostic test results may indicate a need for further preparation in these areas. In such cases, instructors are encouraged to utilize the resources and personnel within the institution to improve or complement the instructional process.

The benefits to students and institutions derived from these curriculum standards should be considerable. Articulation of students from secondary to post-secondary programs will be aided through the use of a single set of curriculum standards. The curriculum standards provide a tool for evaluation of local curricula and programs. The curriculum standards may be used in a flexible manner to assure that Precision Machining programs meet the needs of local business and industry.

It is the goal of this program curriculum guide to provide a level of instruction which will impart entry level employment skills. Students should be carefully counseled on the importance of attaining competency in the tasks assigned. As in virtually all occupations today, machining technicians will require periodic up-dating and review in the future. It is important that each student understand that meeting the program curriculum standards is essential not only to obtain employment today but also to have a base upon which to retain employment in the future.

## MODULE 10 - COMPUTERIZED NUMERICAL CONTROL

**TASK: Perform Preventive Maintenance on NC/CNC Machines**

Level III

**PERFORMANCE OBJECTIVE:** The student will perform preventive maintenance on NC/CNC Machines as required by the manufacturers' lubrication charts and procedures and complete assignments and tests with a minimum score of eighty-five percent (85%).

**ENABLING OBJECTIVES:**

Match terms associated with preventive maintenance to their correct definitions.

Match types of lubricants used in machines to their correct descriptions.

Determine required lubricants and coolants.

Demonstrate the ability to perform routine inspection and maintenance.

Make appropriate adjustments to machine components.

**TASK: Identify the Parts of the Machine and Explain their use**

Level III

**PERFORMANCE OBJECTIVE:** The student will identify and apply CNC safety requirements on assignments, quizzes and daily operations with 100% accuracy, and identify CNC development parts, functions, axes and coordinates with 85% accuracy.

**ENABLING OBJECTIVES:**

Select from a list, facts concerning numerical control.

Label work areas of CNC Machines.

Label major parts of CNC Machines.

Select from a list, facts concerning the Cartesian coordinate System.

Label the axes on a CNC Machine.

Label coordinate points.

**TASK: Identify and Select Proper Machine Controls**

Level III

**PERFORMANCE OBJECTIVE:** The student will be able to bring the machine from an inactive to an active mode. The student will show this knowledge by completing an assignment sheet and the unit test on machine powering up with a minimum score of 85 percent, and a safety test with a minimum score of 100 percent. Further, evidence of this knowledge will be indicated by accurately and completely powering up and shutting down a CNC machine.

**ENABLING OBJECTIVES:**

Complete a CNC safety test.

Match terms associated with machine and control power-up to their correct definitions.

Identify controls and indicators used to power up, check, and shut down the machine.

Match controls and indicators used to power up, check, and shut down the machine to their correct functions.

State functions of mode select switch positions used to power up, check, and shut down the machine.

Describe the types of programming used in a CNC Machine.

Match letter addresses to their correct meanings.

Match selected G codes to their correct functions.

Match selected M codes to their correct functions.

Identify types of CRT displays.

State meanings of status display codes.

Match alarm codes to their correct descriptions.

Complete statements about the operation of the joystick/axes controls.

Describe the purpose of emergency stops and power switches.

Troubleshoot alarm indicators during power up.

Demonstrate the ability to:

power up, check, and shut down CNC Machines

perform axes accuracy checks.

**TASK:** Write a Program and Apply Basic Programming Skills to a Turning Operation  
Level III and/or a Milling Machine

**PERFORMANCE OBJECTIVE:** The students will be able to write a program. The student will show this knowledge by completing program, tooling, coordinated dimensions, and written set up procedures to produce parts to print specifications on the CNC Lathe Machine.

**ENABLING OBJECTIVES:**

Match terms associated with writing a program to their correct definitions.

State purpose of the program.

Match program letters to their basic functions.

Match G codes to their modes of operation.

Match M codes to their functions.

Modify blueprint dimensions to fit CNC Program Planning.

Calculate axes values using absolute method.

Calculate axes values using incremental method.

Calculate axes values using tool radius compensation.

Calculate I, J and K values.

Write a lathe program for turning, contouring and threading.

Write a mill program for drilling, milling and continuous path contouring.

From a list select the steps to determine threading passes.

From a list select the factors to consider when selecting tooling required for turning, milling, and drilling procedures.

From a list select the guidelines for planning procedures.

Calculate speeds and feeds.

Arrange in order, steps in writing a program utilizing appropriate canned cycles.

From a list select the steps in writing a program to set dwell.

Plan procedure.

Complete a setup sheet.

Write a program to set dwell.

**TASK: Select Proper Work Holders for a Production Run**

**Level III**

**PERFORMANCE OBJECTIVE:** The student will be able to perform a production run. The student will show this knowledge by completing assignment sheets and a unit test with a minimum score of 85 percent and by performing a production run with a minimum of a 90 percent efficiency rating and a maximum rejection rate of 5 percent.

**ENABLING OBJECTIVES:**

Match terms associated with production runs to their correct definitions.

Calculate efficiency.

Calculate productivity.

State guidelines to follow in monitoring tool life.

From a list select the guidelines to follow when monitoring dimensional accuracy

during a production run.

Demonstrate the ability to perform production run to required efficiency and productivity standards.

monitor dimensional accuracy and change offsets as required.

monitor tool life and change tools as required.

**TASK: Select Proper Cutting Tools**

**Level III**

**PERFORMANCE OBJECTIVE:** The student will determine the correct type of cutter suitable to the operation performed.

**ENABLING OBJECTIVES:**

Select the best cutter geometry from the cutter inventory available.

Describe why this cutter is the best for the many operations these machines can perform.

**TASK: Machine Parts to Blueprint Tolerances**

**Level III**

**PERFORMANCE OBJECTIVE:** The student will be able to evaluate a NC/CNC produced part in terms of design requirements. The student will show this knowledge by completing assignment sheets and a unit test with a minimum score of 85 percent and by producing a part within all tolerances on the second run.

**ENABLING OBJECTIVES:**

Match terms associated with machining evaluation to their correct definitions.

From a list select the items to check during a visual inspection of first run.

Match blueprint symbols to their correct meanings.

Match inspection equipment to their correct descriptions.

From a list select the items to check during a dimensional inspection of first run.

Identify three indications that program editing may be necessary.  
List actions to take for setup flaws.  
Compare finished part to blueprint.  
Calculate revised offset values.  
Determine required program and setup changes.  
Demonstrate the ability to:  
    run first part.  
    evaluate first run.  
    edit program and change setup as required.  
    run and evaluate second part.

**TASK: Demonstrate the Use of CAD/CAM Systems for Part Program Development**

**Level III**

**PERFORMANCE OBJECTIVE:** Each student will complete the exercises assigned under projects and submit the assigned, completed projects for evaluation.

**ENABLING OBJECTIVES:**

1. Develop an understanding of computer aided drafting.
2. Develop a beginning level of AUCAM competency.
3. Post process a simple CMC program.