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# Machinist with CNC

## Trades Safety: Getting Started

### Objectives:

- List the physical hazards associated with chemicals and describe how to avoid them
- Name several electrical shock hazards and the techniques used to prevent shocks
- List the steps in a lockout/tagout procedure
- Explain the importance of machine guarding, and name several types of machine guards
- Name the five classes of fire and how to extinguish each of them
- Describe the proper technique used to manually lift a heavy load
- Explain how to avoid hand injuries when using hand and power tools
- List some of the hazards involved in welding and hot cutting operations and how to prevent them
- Explain how job analysis and ergonomics are used to improve the workplace
- Explain the importance of using personal protective equipment (PPE)
- Name the agencies and organizations that make and enforce safety

## Working Safely with Chemicals

### Objectives:

- Recognize the different ways in which a chemical can cause you physical injury
- Name the paths of entry along which chemicals enter your body
- Describe the basic types of injuries caused by chemicals
- Identify potential chemical hazards in the workplace
- Describe how to identify, store, and label hazardous chemicals
- List several methods used to prevent chemical accidents
- Explain why proper training is important to chemical handling
- Describe the types of personal protective equipment used when handling chemicals
- Explain the role of government agencies in enforcing chemical regulations

## Fire Safety

### Objectives:

- Describe the types of property losses and injuries associated with fires
- Explain how fires are ignited
- Identify the five classes of fire
- Describe the primary fire hazards found in the workplace
- Explain the various ways in which fires can be prevented
- Describe the operation of several different fixed fire protection systems
- Identify the proper type of portable fire extinguisher to use on a fire
- Describe the operation of several different types of fire extinguishers
- Explain how to defend yourself and others in a fire situation
- Describe how to evacuate a burning building in a safe manner

## Safe Handling of Pressurized Gases and Welding

### Objectives:

- Identify common welding gases and the hazards associated with each of them
- Safely handle and store different types of gas cylinders
- Recognize the safety considerations involved in the setup and operation of electric arc-welding equipment
- Explain how to safely set up and operate a basic gas welding rig
- Identify welding equipment malfunctions and take corrective action
- Utilize fire prevention and protection methods specific to welding operations
- Discuss the importance of the hot-work-permit program in your facility
- Explain the correct use of protective clothing and equipment for welding
- Understand the importance of proper ventilation when welding
- Describe how to effectively deal with confined spaces when performing welding operations

## Advanced Electrical Safety

### Objectives:

- Explain how electricity can harm you and property
- Discuss the importance of using quality electrical components
- Describe why it's important to properly ground electrical installations
- Understand the type of equipment used in hazardous locations
- List the safety practices required when performing electrical work
- Discuss the importance of workspace clearance around electrical enclosures

## Material-Handling Safety

### Objectives:

- Recognize the hazards associated with handling materials
- Know the types of injuries that can be caused by these hazards
- Understand how to effectively use safe material-handling practices
- Know how to avoid physical injury when handling loads
- Identify the parts of a powered lift truck and similar mechanized material-handling equipment
- Explain how to operate various types of mechanized material-handling equipment safely
- Know and follow the rules for safe operation of powered industrial material-handling equipment
- Understand and respect the limits and restrictions placed on powered material handling mechanisms

## Machine Safety

### Objectives:

- Recognize the basic machine motions that can present a hazard to you
- Recognize the types of machinery most likely to be hazardous to you
- Understand the types of injuries caused by accidents commonly associated with unsafe machine-operating procedures
- Discuss the importance of machine guarding and how to incorporate methods of guarding to avoid physical injury
- Recognize the types of machine guards commonly used in industry
- Control various forms of hazardous machine energy through the use of lockout/ tagout procedures
- Understand how and why to properly use personal protective equipment for added protection when operating industrial equipment

## Addition and Subtraction

### Objectives:

- Define the following terms: whole number, numeral, digit, decimal, place value, addend, sum, minuend, subtrahend, and difference
- Properly place commas in large numbers
- Explain the significance of the digit zero in a number
- Differentiate between concrete and abstract numbers
- Properly prepare numbers for addition and subtraction
- Perform addition and subtraction on numbers
- Check your answers to both addition and subtraction problems
- Use a calculator to add and subtract numbers

## Multiplication and Division

### Objectives:

- Define the following terms: factor, multiplicand, multiplier, partial product, product, dividend, divisor, quotient, and remainder
- Recognize the various signs used for multiplication and division
- Properly prepare numbers for multiplication and division
- Perform multiplication and division on whole numbers, decimal numbers, and mixed decimal numbers
- Check your answers to both multiplication and division problems
- Find the average of a group of numbers
- Use a calculator to multiply and divide numbers

## Fractions, Percents, Proportions, and Angles

### Objectives:

- Define the following terms: fraction, proper fraction, improper fraction, lowest common denominator, percent, ratio, and proportion
- Add, subtract, multiply, and divide fractions
- Change fractions to decimals and decimals to fractions
- Solve problems involving percent
- Work with ratios and equivalent ratios
- Solve proportion problems
- Use a protractor to measure angles
- Lay out templates for checking angles
- Use a calculator to solve percent problems, to convert fractions to decimals, and to calculate missing terms in proportions

## Metric System

### Objectives:

- Name the base units most commonly used in the metric system and identify what they're used to measure
- Identify metric prefixes and their values
- Apply conversion factors to create a unit that's larger or smaller than the base unit
- Estimate lengths in metric units
- Express temperature in degrees Celsius
- Define the terms mass, density, force, torque, and pressure, and identify the metric units used to measure each one
- Use a conversion table to convert metric units to English units and English units to metric units
- Use a calculator to perform metric conversions

## Formulas

### Objectives:

- Explain the use of variables in formulas
- Prepare and use formulas to solve problems
- Use formulas to calculate the perimeter of a triangle and a rectangle, and the area of a triangle, a rectangle, and a circle
- Use formulas to calculate distance, current in a circuit, and the volume of a pyramid and a sphere
- Use a calculator to find square roots and solve formulas
- Substitute given numerical values for letters in a formula and find the unknown quantity
- Transform and solve equations and formulas

## Introduction to Algebra

### Objectives:

- Explain the difference between positive and negative numbers and their uses
- Perform basic arithmetic operations with signed numbers
- Raise a number to any power
- Use the order of operations for solving problems involving multiple operations
- Define the following words: term, constant, coefficient, exponent, monomial, trinomial, and polynomial
- Identify and combine like terms in an expression
- Perform basic arithmetic operations with signed terms
- Multiply and divide terms containing exponents  $n$
- Remove parentheses from an expression and simplify the expression

## Applied Geometry

### Objectives:

- Identify properties and types of angles and figures
- Distinguish between common geometric solids
- Use the Pythagorean theorem to solve triangles
- Calculate the perimeter and area of polygons, circles, and ellipses
- Determine the surface area and volume of commonly encountered geometric solids

## Practical Trigonometry

### Objectives:

- Define and compute the value of trigonometric functions such as cosine, sine, tangent, and others
- Use trigonometric functions to find the lengths of sides and angles in right and oblique triangles
- Understand trigonometric functions as they relate to waves
- Solve practical problems using trigonometry

## Introduction to Print Reading

### Objectives:

- Identify the various kinds of lines used on drawings
- Compare and contrast the various types of drawings
- Relate the information given in the title block and bill of material to the drawing
- Define different types of scales used on drawings
- Identify the different views used on drawings

## Reading Shop Prints, Part 1

### Objectives:

- Properly interpret working drawings (including dimensions and tolerances)
- Interpret symbols, notes, and specification
- Identify material requirements
- Interpret drawings to determine the proper procedure to make the part

## Reading Shop Prints, Part 2

### Objectives:

- Read and properly interpret various shop prints
- Interpret and use cam prints
- Interpret and use gear prints
- Read and understand an assembly drawing and bill of materials
- Read simple sheet metal drawings

## Dimensioning

### Objectives:

- Identify the height, width, and length dimensions of a drawing
- Interpret dimensions on angles, arcs, fillets, rounds, holes, and chamfers
- Interpret the surface finish symbols for roughness, waviness, and lay

## Tolerancing and Symbols

### Objectives:

- Tell the position method from the bracket method of dual dimensioning
- Identify the three general classes of fit
- Interpret unilateral and bilateral tolerances
- Interpret the various symbols and notations used on drawings

## Sectional Views and Simplified Drafting

### Objectives:

- Tell one type of section from another
- Interpret the various types of sections
- Interpret drawings using simplified drafting methods

## Bench Work Part 1

### Objectives:

- Familiarize yourself with the nature of bench work
- Familiarize yourself with wrenches, hammers, pliers, and screwdrivers
- Familiarize yourself with punches, twist drills, reamers, and broaches
- Familiarize yourself with saws, chisels, and snips
- Familiarize yourself with finishing and grinding tools

## Bench Work Part 2

### Objectives:

- Identify threaded fasteners
- Describe thread systems
- Describe hole preparation for threaded fasteners
- Identify mechanical fasteners
- Describe rivets
- Describe keys
- Describe pins
- Familiarize yourself with threading with hand tools

## Bench Work Part 3

### Objectives:

- Describe tolerance, allowance, clearance, and fit
- Describe installation of machine components
- Describe babbitting
- Familiarize yourself with cutoff saws
- Familiarize yourself with soldering
- Familiarize yourself with brazing

## Precision Measuring Instruments Part 1

### Objectives:

- Explain the difference between accuracy and precision
- Define standard, the Rule of 10, and traceability
- Describe Abbe's error
- Describe how to use a number of tools for measuring dimensions
- Read a vernier scale
- Demonstrate the skill to work with both English and metric dimensions and with their abbreviations
- Convert between millimeters and inches

## Precision Measuring Instruments, Part 2

### Objectives:

- Properly read standard and metric micrometers
- Read a vernier micrometer
- Choose special micrometers appropriately for various measuring tasks
- Recognize five kinds of depth and height gages and demonstrate the ability to read a depth gage
- Read the scale on a vernier bevel protractor
- Explain the uses of many kinds of indicators and gages in shopwork
- Describe how to minimize cosine error when using dial test indicators

## Precision Measuring Instruments, Part 3

### Objectives:

- Explain the use of optical comparators and toolmaker's microscopes
- Recognize the setup and operation of an optical alignment system—including laser and alignment telescopes
- Understand the use of digital readout gauges, and the use of both absolute and incremental measuring
- Recognize the uses for in-process and post-process gauging, including video inspection and CNC tool presetters
- Understand the use of hardness testers and video material testing
- Recognize the uses for modern nondestructive material testing, including magnetic particle inspection and ultrasonic testing

## Linear Distance and Measurement

### Objectives:

- Measure using both English and metric units of length
- Calculate the perimeters of rectangles, squares, and triangles
- Calculate the areas of objects such as rooms or machine bases
- Calculate the circumference of circular objects such as pipes or tanks
- Measure distances using rigid and flexible rules, thickness gages, and screw pitch gages
- Make precise measurements using vernier calipers and micrometers

## Jobs, Companies, and the Economy—Basic Concepts for the Employee

### Objectives:

- Conclude how the economy will affect you as a consumer and as an employee
- Explain the concept of competition and how a business must react to market demands
- Evaluate how government policies affect the amount of saving and investing within an economy
- Defend the use of a flexible and empowered workforce in making a business more competitive
- Explain various economic measuring tools such as the inflation rate, the unemployment rate, and the GDP
- Appraise the current status of American labor in general and the status of American labor unions in particular
- Recognize how you as an employee or as an employer must compete in an increasingly international marketplace

## Quality Concepts: Terminology

### Objectives:

- Define quality and total quality management, using examples
- Describe how quality has evolved to where it is today
- Explain several motivations for quality improvement
- Describe how quality-conscious organizations have changed for the better
- Assess quality-consciousness in individuals and organizations
- Explain how some familiar business practices have led to TQM and how certain other common practices have gotten in the way of TQM
- Name some successful results of TQM programs

## Metal Processing

### Objectives:

- Identify industrial metals by their names and chemical symbols
- Define in basic terms the characteristics and properties of metals
- Explain the various metal-processing methods used in producing industrial metals
- Explain how metals are extracted from their ores found in the earth and then refined

## Ferrous Metals

### Objectives:

- Identify the features of a blast furnace
- Recognize cast irons by their fractures and other properties
- Describe the major steelmaking processes
- Discuss the hot-working and cold-working methods used to shape steel
- Classify the types of steel, according to both processing method and carbon content
- Relate certain grade numbers to the types of steel they identify

## Nonferrous Metals

### Objectives:

- Explain how the various metals are extracted from their ores
- Describe how the addition of certain elements affects the mechanical properties of the base metals
- Select the metal alloy most suitable for a given job
- Recognize whether a copper alloy is a brass or a bronze

## Identification of Metals

### Objectives:

- Identify a metal by making a file test, magnetic test, temperature test, chip test, or spark test
- Find the hardness of a metal, by using a Brinell, Rockwell, monotron, Vickers, Herbert-pendulum, or scleroscope hardness-testing machine

## Practical Shop Math (Part I)

### Objectives:

- Add, subtract, multiply, and divide fractions and decimal values of whole units such as inches and feet Derive the square root of fractions and decimals
- Compute a machine drive ratio for a given speed
- Make calculations using the metric, or SI, system of measurement

## Practical Shop Math (Part II)

### Objectives:

- Compute the areas of rectangles, triangles, circles, parallelograms, and other common shapes
- Compute the volumes of solid figures such as cubes, cylinders, cones, rectangles, and combinations of these
- Use the principles of geometry and trigonometry to lay out and solve various kinds of triangles and their parts
- Plot coordinates of a point using both the rectangular (Cartesian) and the polar systems

## Practical Shop Measurement

### Objectives:

- Use a steel rule to measure the length of a part in inches or millimeters
- Measure the sizes of parts to 1/1000 inch using a vernier caliper
- Use a micrometer to measure diameters and thicknesses of workpieces
- Make angular measurements using various instruments

## Safe Shop Practices

### Objectives:

- List the proper safety equipment to be worn when performing machine shop tasks
- State the environmental hazards most commonly encountered in a machine shop
- State the method used to remove stock from a workpiece mounted in a lathe, milling machine, and drill press
- Name at least one method used to protect the worker from harmful fumes when cutting fluids are used

## Properties and Classifications of Metals

### Objectives:

- Understand the four basic methods of manufacturing iron and steel
- Discuss the fundamental properties of metals
- Recognize standard identification of various steels and alloys
- Know the characteristics and applications of particular steels and alloys
- Realize the effects and limitations of heat treatment
- Be familiar with materials testing methods
- Differentiate between hot-working and cold-working metal processes

## Using Shop Drawings and Process and Routing Sheets (Part I)

### Objectives:

- Understand the uses of industrial blueprints
- Recognize surfaces, object lines, and object points on a blueprint
- Recognize front, top, and right-side views of an object
- Identify lines on a drawing and explain their use
- Read and understand sectional views and apply information from them to other views
- Identify and read auxiliary and double auxiliary lines
- Understand tolerances and apply them to dimensions, and read different tolerancing systems

## Using Shop Drawings and Process and Routing Sheets (Part II)

### Objectives:

- Recognize and read a geometric drawing
- Understand variations used on geometric drawings
- Locate and correctly read a drawing block, and apply its information to a drawing
- Recognize and read a process sheet, and use the information it contains
- Understand the baseline dimensioning system
- Understand the Cartesian coordinate system
- Understand the fixed or floating zero system

## Layout

### Objectives:

- Prepare a work surface and know the types and uses of layout compounds
- Identify and use common layout tools
- Identify and use measuring instruments used in a layout
- Identify and use precision layout tools
- Perform basic layout operations and construct various geometric shapes

## Metal Cutting and Machine Tooling (Part I)

### Objectives:

- Identify a variety of cutting tools
- Understand how a cutting tool cuts and separates material by using the three kinds of cutting edges
- Identify the three major types of chips a cutting tool produces
- Know the key parts of a twist drill
- Describe the applications of a counterbore, countersink, and combination countersink/centerdrill
- Understand the differences between reamers for machine and hand use
- Explain the differences between taps used for hand tapping and machine tapping methods
- Describe the dies used to produce threads by both hand and machine methods
- Identify the different machine attachments and tooling components needed for tap and die threading on production machinery

## Metal Cutting and Machine Tooling (Part II)

### Objectives:

- Define the major parts of a lathe tool bit
- Identify numerous turning, boring, and milling tools shown in this module
- Describe the different styles of end mills available
- Identify the different horizontal end mills
- Explain the difference between the mounting methods used for horizontal and end mill style cutters
- Understand the differences among the various cutting tool materials used
- Describe the reasons for using a tool coating on a cutting tool or cutting insert
- Describe the effects that coolants have on the cutting point
- Identify the major methods of applying cutting fluids

## Metal Cutting Machinery (Part I)

### Objectives:

- Identify numerous machine tools described in this module and identify their important operating parts
- Describe the major accessories and work holders used on drilling machines
- Explain the difference between horizontal and vertical milling machines
- Describe the different types of horizontal and vertical milling machines available
- Understand numerical control and computer numerical control of machine tools and differentiate between the two methods
- Distinguish a machining center from an ordinary milling machine
- Understand the differences among the four designs of automatic tool changers

## Metal Cutting Machinery (Part II)

### Objectives:

- Be familiar with basic lathe construction
- Describe the manual and automated turning machines used by industry
- Recognize the uses of turning centers for mass-production applications
- Differentiate between the bar and chucking types of automatic screw machines
- Identify some of the accessories and workholders used with turning machines
- Know the differences between the horizontal and vertical band saw configurations
- Interpret the different tooth styles of band saws and the applications for each style
- Understand conventional and vertical band saw cutting operations
- Explain the circular cold sawing, abrasive cutting, and friction sawing techniques

## Fundamentals of Grinding

### Objectives:

- Explain the differences among the types of abrasives and bonds
- Define structure in terms of how it applies to the grinding process
- Recognize Standard Marking System symbols to choose the correct grinding wheel
- Know the major wheel types by shape and list specific applications for each
- Describe how to put a grinding wheel into operation and keep it in good working order
- Be familiar with the various types of grinding fluids, what they're used for, and the different methods of applying them
- List uses and nomenclature associated with utility grinders, surface grinders, and cylindrical grinders
- Know various safe practices when using grinders

## CNC Machine Tool Features and Advantages

### Objectives:

- List the most common machines adapted to computer numerical control
- Describe how CNC machines operate and what processes they're capable of performing
- List advantages of CNC over manual control
- Name various CNC components and describe what each does
- Explain the function of a feedback device
- Understand the Cartesian coordinate system of measurement
- Define tool length compensation and describe the process of zeroing a CNC machine
- Know safe practices when operating CNC machines
- Be familiar with the job responsibilities of people involved in CNC operations

## Drilling, Part 1

### Objectives:

- Recognize and use basic drilling equipment and components
- Identify and use various types of drill tools
- Explain how to set up various workpieces on a drill press
- Understand how to recondition drilling tools and maintain equipment

## Drilling, Part 2

### Objectives:

- Explain how to set up more complex drilling equipment
- Select and use various types of auxiliary tools with drill equipment
- Set up more advanced work on a drill press
- Select and modify drills for different materials and cutting conditions
- Determine the correct speeds, feeds, and coolant for a given operation
- Diagnose quality, tolerance, and tool-life problems, and find solutions for them

## Lubrication, Part 1

### Objectives:

- Describe the various types of friction
- Discuss how materials wear
- List the various functions lubricants perform in industry
- Explain how lubricants reduce friction
- Classify lubricants depending upon their composition, properties, and additives
- Understand why certain lubricants are chosen for certain tasks
- Explain how to safely handle and store lubricants

## Lubrication, Part 2

### Objectives:

- Explain how to manually apply various types of lubricants in an industrial environment
- Describe total-loss lubrication
- Identify a nonloss lubrication system's components and describe their operation
- Explain how to maintain a nonloss lubrication system
- Identify the proper lubrication procedures to use for special industrial applications including sealed bearings, oil-impregnated bearings, and food-processing plants
- Explain how lubricant-conditioning systems work and how to maintain them
- Describe how automatic lubrication systems work and how to maintain them
- List the tasks involved in preventive and predictive lubrication maintenance

## Milling Machines Part 1

### Objectives:

- Define the milling operation and the types of uses for cutters
- Identify the classifications and differences of milling machines
- Describe the construction, sizes, and the basic components of milling machines
- Describe some of the types and features of knee milling machines
- Describe the manual feed process of milling machines
- Identify the different power feed processes
- Identify the functions of overarms, arbors, braces, and supports
- Identify some of the controls and cycles used on milling machines
- Describe how the horizontal milling machine operates
- Calculate and select the proper spindle speed, cutting speed, and feed rate for a horizontal machine

## Milling Machine Fundamentals

### Objectives:

- Understand the application of a Cartesian coordinate system to the milling operation
- Describe the construction, sizes, and the basic components of milling machines
- Identify the classifications, characteristics, and functions of different milling machines
- Describe how knee, horizontal, and vertical milling machines operate
- Discuss the numerous attachments and accessories that increase the effectiveness of milling machines • Explain the application of CNC to milling machines

## Milling Machine Cutting Tools

### Objectives:

- Discuss the primary function of different types of milling cutters
- Describe the heat treatment process for making tool steels
- Explain how cemented carbide cutting tools are made
- Interpret the standardized lettering/numbering system for carbide cutters
- Understand the geometry of carbide inserts and toolholders and the methods used to attach inserts to tools
- Explain what causes tool wear and methods for extending tool life
- Recognize basic milling econometric concepts

## Milling Machine Practice and Operation, Part 1

### Objectives:

- Explain the function of layout tools
- Perform basic layout operations
- Understand machine setup guidelines
- Use a variety of vises, clamps, and fixtures to securely hold workpieces
- Square up work holders on a milling machine table
- Select machine speeds and feeds
- Plan a sequence of milling operations

## Lathes, Part 1

### Objectives:

- Describe the modern lathe
- Explain the differences among various types of modern lathes
- Interpret the size ratings of a lathe
- Describe common work-holding devices
- Explain the range of operations of the lathe
- Describe various tool styles, materials, and holders
- Understand turning parameters and their effects on the machining process

## Lathes, Part 2

### Objectives:

- Set up a lathe using various work holders and auxiliary equipment
- Choose the correct tool material, type, and geometry for a particular operation
- Set the correct feed, speed, and depth of cut for external machining operations
- Explain facing, diameter turning, and shoulder turning
- Describe forming operations, including the fillet radius and chamfer forming
- Explain necking and groove cutting, parting, and knurling
- Discuss finishing operations, including filing and polishing

## Lathes, Part 3

### Objectives:

- Machine boring operations, internal shoulders, internal grooves, and recesses
- Machine offset bushings, eccentrics, and other off-center milling operations
- Improve workpiece finish and reduce chatter
- Measure inside forms, including bored holes and internal grooves
- Understand tailstock operations, including drilling, reaming, and tapping
- Describe the functions of different types of drills

## Lathes, Part 4

### Objectives:

- Identify various types of tapers and state their uses
- Describe methods of producing tapers
- Calculate the dimensions required to machine tapers
- Explain how to set up and machine tapers using various techniques
- Calculate tapers measured in inches per foot and their corresponding taper angles
- Describe techniques for measuring and inspecting tapers

## Lathes, Part 5

### Objectives:

- Describe the functions of various thread types
- Understand the differences among thread standards
- Calculate the required dimensions and setups for machining threads
- Explain common methods of producing threads
- List the steps required to set up, machine, measure, and inspect threads

## Fasteners

### Objectives:

- Describe the various types of fasteners
- Identify the different types of thread form systems
- Recognize various nonthreaded fasteners and discuss their uses
- Explain how to install and uninstall fasteners
- Understand the terminology used in measuring fasteners
- Explain how adhesives are used as fasteners

## Turret Lathes Part 1

### Objectives:

- Familiarize yourself with turret lathe design
- Describe ram-type turret lathes
- Describe saddle-type turret lathes
- Describe electronically controlled turret lathes
- Describe turret lathe basic maintenance
- Familiarize yourself with work-holding and work-feeding devices

## Turret Lathes Part 2

### Objectives:

- Describe toolholding provisions
- Familiarize yourself with bar tools
- Familiarize yourself with chucking tools
- Familiarize yourself with threading devices
- Familiarize yourself with cross slide tools
- Familiarize yourself with tooling principles
- Familiarize yourself with examples of setups

## Cylindrical Grinding Part 1

### Objectives:

- List the various types of cylindrical grinders
- Describe the fundamentals of cylindrical grinding
- Identify the significant components of center-type grinders
- Describe the various functions of center-type grinder parts
- List the types of controls grinding machines use
- Describe the functions of the various grinding machine controls
- List the factors that impact the characteristics of a grinding wheel, and identify the use of the wheels
- Identify the terms and procedures used in dressing the grinding wheel
- Describe the processes that must take place in the inspection, mounting, and balancing of a grinding wheel
- List the important reasons and applications for coolants when precision grinding

## Cylindrical Grinding Part 2

### Objectives:

- Describe some of the safety measures that should be applied when using grinding machines
- Calculate the revolutions per minute by using the formula and the manufacturer's grinding wheel speed as indicated by the surface feet per minute
- Identify the procedures and calculations necessary in preparing the grinding machine
- Describe the methods and machines used in obtaining the required workpiece size
- Identify the various components that are used in production grinding
- Describe automatic wheel balancing and gage sizing
- Identify the requirements and characteristics that occur in roll grinding
- List some of the types of roll grinders and their functions
- Describe some of the applications and procedures used in grinding, such as taper grinding and rotary surface grinding
- Identify some of the sources of grinding faults, as they pertain to a poor finish on a workpiece
- Describe some of the causes that leave a workpiece out of round or with unwanted taper
- Identify the causes and remedies for chatter marks, feed lines, and scratches
- Describe some of the reasons for problems and the corrective actions to be taken with grinding machines and wheels

## Surface Grinding Part 1

### Objectives:

- Identify the types of surface grinders and explain their uses
- Identify the purpose and characteristics of surface grinders, magnetic chuck, horse power, and work speed
- Identify the differences between grinding done on a small and large scale
- Identify the differences between grinders
- Identify the characteristics of vertical spindle surface grinders
- List the other important grinders and their characteristics that are used in surface finishing
- Identify design considerations and work supporting mechanisms as they relate to surface grinding
- Compare the types of work holders and other accessory items used in surface grinding
- Define how controls are important when using surface grinders
- Identify attachments used with grinders

## Surface Grinding Part 2

### Objectives:

- Describe how to select, mount, and balance a grinding wheel
- Describe the procedures used in the dressing and truing of the wheel
- Explain the procedures used in surface grinding
- Describe the processes used in form grinding and crush forming
- Identify the methods used in finishing surfaces
- Identify the causes of imperfections and the procedures used to correct them
- List the types of grinding accessories available and how they assist in the grinding process

## Milling Machine Practice and Operation, Part 2

### Objectives:

- Set the cutter exactly on the workpiece surface
- Square the workpiece
- Mill shoulders, steps, slots, angled surfaces, dovetails, keyseats, and pockets
- Perform sawing and slitting work on the mill
- Maintain and troubleshoot mills

## Fundamentals of Metal Cutting

### Objectives:

- Describe the metal-cutting process and cutting tool requirements
- Explain the role of feed, speed, and depth-of-cut in machining
- List the advantages and limitations of carbon steel and carbide cutting tools
- Describe the principles of single-point cutting tools and the factors governing tool wear
- Explain multiple-point cutting tools and their uses
- Describe the difference between lathe turning and milling operations
- Explain tapping, threading, reaming, and broaching
- Understand the role of cutting fluids in machining operations

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- Describe the principles of single-point cutting tools and the factors governing tool wear
- Explain multiple-point cutting tools and their uses
- Describe the difference between lathe turning and milling operations
- Explain tapping, threading, reaming, and broaching
- Understand the role of cutting fluids in machining operations

## Automatic Screw Machines Part 1

### Objectives:

- Identify types of automatic screw machines
- Identify single-spindle chucking lathes
- Identify multiple-spindle chucking lathes
- Identify bar-type lathes

## Automatic Screw Machines Part 2

### Objectives:

- Identify operations performed with various single-spindle chucking lathe setups
- Identify attachments for the multiple-spindle chucking lathe
- Identify the vertical slide and many types of blades used on the single-spindle bar machine
- Identify Swiss-type automatic lathes
- Identify single-spindle bar lathes
- Identify multiple-spindle bar lathes

## Fundamentals of Grinding

### Objectives:

- List the types of abrasives and their classifications
- Identify the basic grinding machines and how they work
- Describe the types of abrasives and how they are used in grinding wheels
- Define the terms grain size, bond, and structure and explain their effect in the grinding action
- Explain what types of grinding machines there are and how they work
- Describe the types of grinding fluids, how they are selected, and how they are applied
- Explain the differences between coated abrasives and grinding wheels
- Compare the roles of coated abrasives and their characteristics and uses on grinding machines
- Describe what the terms stock-removal and surface finish mean
- Apply the factors that influence stock removal and finish
- Identify the major hazards you must be aware of when working with grinding wheels and machines
- Describe how to properly mount and use grinding wheels

## Inspection of Shop Products

### Objectives:

- Identify inspection practices
- Identify inspection procedures
- Identify inspection methods
- Identify other types of inspection
- Identify screw threads, dovetails, tapers, and gears
- Describe care of equipment and instruments

## Boring Mills Part 1

### Objectives:

- Identify boring mill fundamentals
- Identify vertical boring mills
- Identify horizontal boring mills
- Identify special boring mills
- Identify boring mill motions
- Identify boring mill supports, tools, and operations

## Planers

### Objectives:

- Identify the nature and classification of planers
- Identify planers' construction and lubrication system
- Identify automatic features and convertible planers
- Identify cutters, feeds, and speeds
- Identify clamping equipment and procedures
- Identify additional planer information

## Broaching

### Objectives:

- Identify broaching principles
- Identify types of broaches
- Identify broaching machines
- Identify broaching fixtures
- Identify broaching practice
- Identify troubleshooting in broaching
- Identify supplementary broaching information

## Shapers, Slotters, and Keyseaters

### Objectives:

- Identify the principle and construction of shapers
- Identify attachments, work-holding devices, and cutters
- Identify shaper practice and operations
- Identify vertical shapers and slotters
- Identify keyseaters

## Tool Dressing

### Objectives:

- Identify tool steels
- Identify forging chisels and machine cutting tools
- Identify tipping forged tools
- Identify forging rock chisels and drills
- Identify annealing, hardening, and tempering

## Gear Calculations

### Objectives:

- Identify spur gears
- Identify helical and bevel gears
- Identify worm and spiral gearing
- Identify strength of gear-teeth

## Nontraditional Machining Technologies

### Objectives:

- Explain how electrical discharge machining works
- Describe the difference between wire and ram electrical discharge machining
- Explain how laser light is produced and how lasers are used in industrial settings
- Explain why a plasma cutting torch is so much hotter than other types of cutting torches
- Describe the difference between chemical and electrochemical machining
- Explain how water can be made to cut steel
- Identify the common rapid-prototyping manufacturing processes

## Hardening and Tempering

### Objectives:

- Identify methods and equipment used for hardening and tempering
- Identify heat treating operations
- Identify examples of heat treatment
- Identify the theory of heat treatment

## Tool Grinding

### Objectives:

- Identify the requirements needed, and the types of tools used, in the grinding of tools
- Describe the methods used when grinding carbide tools
- Describe how, and why, chip breaking is done
- Identify the procedures and rules used in obtaining and adjusting cutter clearance
- Describe the procedures used in cylindrical and helical grinding
- Identify the various grinding cutters and compare their characteristics
- Describe the procedures that take place when sharpening a reamer
- Explain the process of tap sharpening
- Explain how to sharpen chasers
- List the ways cutters can be straightened and reconditioned

## Toolholding Systems

### Objectives:

- Understand the fundamental characteristics of toolholders used in various machine tools
- Describe how a toolholder affects the quality of the machining operation
- Interpret national standards for tool and toolholder identification systems
- Recognize the differences in toolholder tapers and the proper applications for each type of taper
- Explain the effects of toolholder concentricity and imbalance
- Access information from manufacturers about toolholder selection

## Gear Making Part 1

### Objectives:

- Identify milling methods
- Identify templet planning
- Identify generating spur and helical gears
- Identify backlash

## Gear Making Part 1

### Objectives:

- Identify gear hobbing
- Identify generating straight- and spiral-toothed bevel gears
- Identify gear finishing
- Familiarize yourself with gear inspection
- Identify gear materials and their heat treatment

## Manufacturing Processes, Part 1

### Objectives:

- Understand and describe the evolution of modern manufacturing before and since the industrial revolution of the 1800s
- Understand and describe the importance of developments in manufacturing such as standardization and mass production
- Understand the importance of and advances in typical manufacturing materials and their effect on manufacturing locations and techniques
- Understand and describe the role of quality assurance in manufacturing operations
- Describe and categorize the basic types of manufacturing organizational structure

## Manufacturing Processes, Part 2

### Objectives:

- Describe the four basic classifications of materials used for manufacturing processes
- Understand the essential metallurgical characteristics of steel and ferrous alloys, and types of steel for different applications
- List the important properties of nonferrous alloys
- Explain the effect material choices have on the subsequent manufacturing processes and the performance of the end product
- Describe the manufacturing processes for ceramics, polymers, and composite materials especially as they relate to metal and alloy replacement applications

## Manufacturing Processes, Part 3

### Objectives:

- Identify and describe the general classifications of manufacturing systems that provide us with product
- Identify important processes used to manufacture parts from different materials, and select appropriate techniques to produce finished parts
- Understand and describe the fundamental cutting and forming processes used to make products or parts
- Understand and describe the basic technical aspects of new manufacturing processes for high-tech applications
- List the advantages and disadvantages of manufacturing methods used to process various materials and understand why each of these processes may be used in different applications
- Identify and describe the most important methods of joining components or subassemblies to make completed parts
- Understand and select appropriate finishing methods for manufactured parts
- Understand and describe the basic manufacturing systems used to assemble parts into finished products

## Manufacturing Processes, Part 4

### Objectives:

- Understand and describe the basic functions of management and the principles on which work is organized in a manufacturing business
- Understand and describe various types of production control systems
- Describe the basic concepts behind modern production systems
- Explain how modern QA systems affect the manufacturing processes and product and process quality
- Understand how modern network-based communications technologies will affect the manufacturing process now and in the future