Penn Foster's Mechanical Maintenance program

Course Title	Course Number	PF Price	Course Duration
Year 1:			
Trades Safety: Getting Started	186104	$75.00	5 hours
Working Safely with Chemicals	186105	$75.00	5 hours
Fire Safety	186106	$75.00	5 hours
Material Handling Safety	186109	$75.00	5 hours
Working Safely with Electricity	4400	$75.00	10 hours
Basic Industrial Math	Block X31	$450.00	30 hours
Addition and Subtraction	186303	($75.00)	(5 hours)
Multiplication and Division	186304	($75.00)	(5 hours)
Fractions, Percents, Proportions, and Angles	186305	($75.00)	(5 hours)
Metric System	186306	($75.00)	(5 hours)
Formulas	186307	($75.00)	(5 hours)
Introduction to Algebra	186308	($75.00)	(5 hours)
Practical Measurements	Block X32	$375.00	25 hours
Linear and Distance Measurement	186125	($75.00)	(5 hours)
Bulk Measurement	186126	($75.00)	(5 hours)
Temperature Measurement	186127	($75.00)	(5 hours)
Energy, Force, and Power	186128	($75.00)	(5 hours)
Fluid Measurement	186129	($75.00)	(5 hours)
Jobs, Companies, and the Economy: Basic Concepts for Employees	186191	$75.00	5 hours
Quality Concepts: Tools and Applications	186036	$75.00	5 hours
Applied Geometry	186085	$75.00	6 hours
Practical Trigonometry	186086	$75.00	6 hours
Reading Prints and Schematics	Block X45	$900.00	96 hours
Introduction to Print Reading	186325	($75.00)	(8 hours)
Print Reading Symbols and Abbreviations	186326	($75.00)	(8 hours)
Dimensioning and Tolerancing	186327	($75.00)	(8 hours)
Print Reading Applications	186328	($75.00)	(8 hours)
Building Drawings	186181	($75.00)	(8 hours)
Electrical Drawings and Circuits	186044	($75.00)	(8 hours)
Electronic Drawings	186045	($75.00)	(8 hours)
Year 2:			
Hydraulic and Pneumatic Drawings	186046	($75.00)	(8 hours)
Piping: Drawings, Materials, and Parts	186047	($75.00)	(8 hours)
Welding Symbols	186048	($75.00)	(8 hours)
Sheet Metal Basics	186182	($75.00)	(8 hours)
Sketching	186050	($75.00)	(8 hours)
Hand and Power Tools	Block X34	$900.00	70 hours
Common Hand Tools, Part 1	186164	($75.00)	(5 hours)
Common Hand Tools, Part 2	186165	($75.00)	(5 hours)
Precision Measuring Instruments, Part 1	186188	($75.00)	(10 hours)
Electric Drilling and Grinding Tools	186166	($75.00)	(5 hours)
Power Cutting Tools	186167	($75.00)	(5 hours)
Pneumatic Hand Tools	186056	($75.00)	(5 hours)
Plumbing and Pipefitting Tools	286113	($75.00)	(5 hours)
Electricians' Tools	006026	($75.00)	(10 hours)
Tool Grinding and Sharpening	186057	($75.00)	(5 hours)

Woodworking Hand Tools	186169	($75.00)	(5 hours)
Woodworking Power Tools	186170	($75.00)	(5 hours)
Lifting Equipment	186168	($75.00)	(5 hours)
Bench Work, Part 3	5004C	$75.00	10 hours
Mechanical Calculations	5608	$75.00	10 hours
Industrial DC Motors	086051	$75.00	10 hours
Industrial AC Motors	086052	$75.00	10 hours
Controlling Industrial Motors	086053	$75.00	10 hours

Year 3:

Transformers	4040	$75.00	10 hours
Industrial Motor Applications	086092	$75.00	10 hours
Motor Control Fundamentals (for PLC's)	006010	$75.00	10 hours
Industrial Motor Control (for PLC's), Part 1	006011	$75.00	10 hours
Industrial Motor Control (for PLC's), Part 2	006012	$75.00	10 hours
Hydraulic Power Basics	286060	$75.00	10 hours
Hydraulic Components: Actuators, Pumps, and Motors	286061	$75.00	10 hours
Hydraulic Components: Conductors, Conditioners, and Fluids	286062	$75.00	10 hours
Hydraulic Power System Control	286063	$75.00	10 hours
Interpreting Hydraulic System Schematics	286064	$75.00	10 hours
Hydraulic Power System Troubleshooting	286065	$75.00	10 hours
Pneumatics	6623	$75.00	10 hours
Pneumatic Instrumentation for the Technician	286M01	$275.00	35 hours

Year 4:

Air Compressors, Part 1	286096	$75.00	10 hours
Air Compressors, Part 2	286097	$75.00	10 hours
Lubrication, Part 1	286091	$75.00	10 hours
Lubrication, Part 2	286092	$75.00	10 hours
Mechanical Power Transmission, Part 1	286101	$75.00	10 hours
Mechanical Power Transmission, Part 2	286102	$75.00	10 hours
Mechanical Power Transmission, Part 3	286103	$75.00	10 hours
Belt Power Transmission	2607A-B	$150.00	20 hours
Bearings and Seals, Part 1	286093	$75.00	10 hours
Bearings and Seals, Part 2	286094	$75.00	10 hours
Transfer Devices for Machine Tools	6569A-B	$150.00	20 hours
Preventive Maintenance	286085	$75.00	5 hours
Preventive Maintenance Techniques	286086	$75.00	5 hours
Predictive Maintenance	286087	$75.00	5 hours
Predictive Maintenance: Vibration Analysis	286088	$75.00	5 hours
Predictive Maintenance: Advanced Topics	286089	$75.00	5 hours

Estimated Curriculum Duration: 633 hours (Yr 1 = 163 hours; Yr 2 = 160 hours; Yr 3 = 155 hours; Yr 4 = 155 hours)
Number of Exams: 87

***SEE FULL COURSE DESCRIPTIONS BELOW

186104
Trades Safety: Getting Started

Duration:
5 hours (includes 1 test)

What Students Learn:
Preview
A thorough knowledge of safe practices is an important part of working in any industrial setting. Every industrial worker should be familiar with accident prevention techniques, fire safety mehods, and the use of personal protective equipment. Injuries in the workplace cost many millions of dollars in medical costs, lost wages, and production losses each year. Many injuries can be prevented by understanding how accidents and injuries can occur. This study unit is designed to help trainees understand why safety is so important, and to present students with information about safety that goes beyond common sense.

Objectives
When a student completes this study unit, he and she will be able to:

- Name the agencies that make and enforce safety regulations and explain an employee's responsibilities under those regulations.
- List the physical hazards associated with chemicals and describe how to avoid those hazards.
- Name several electrical shock hazards and the techniques used to prevent shocks.
- List the steps in a lock-out / tag-out procedure.
- Explain the importance of machine guarding and name several types of machine guards.
- Name the four classes of fire and how to extinguish each of them.
- Describe the proper technique used to 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 the science of ergonomics are used to improve the workplace.
- Explain the importance of personal protective equipment and name several types of PPE.

Contents
Introduction; Safety Regulations; Key safety Issues; Protecting Yourself and Your Co-workers.

186105
Working Safely with Chemicals

Duration:
5 hours (includes 1 test)

What Students Learn:
Preview
This study unit deals with the safe use of chemicals in the workplace. The two primary causes of chemical accidents are the misuse of chemicals and the improper disposal of chemical wastes. Understanding the hazards that chemicals can create is the first step in protecting people from harm.
The main goal of this study unit is to provide students with sound, practical knowledge about chemical use and disposal, both in the workplace and at home. You will learn how to recognize common chemical hazards and how to deal with them. Trainees will learn how to perform a job analysis to look for potential chemical dangers in your daily taks. Finally, people will learn how to take precautions to avoid chemical accidents and make all jobs as safe as possible.

Objectives
When a student completes this study unit, he and she will be able to:

- Recognize the six different ways in which a chemical can cause physical injury.
- Name the routes or paths of entry by which chemicals can enter the body.
- Describe the types of injuries caused by chemicals.
- Identify potential chemical dangers in your 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 and worn when handling chemicals.
- Explain the role of governmental agencies in enforcing chemical regulations.

Contents
Introduction: Living with Chemicals; Chemical Injuries; Accident Prevention; Handling Hazardous Wastes.

186106
Fire Safety

Duration:
5 hours (includes 1 test)

What Students Learn:
Preview
Fires are the most destructive and expensive of all accidents. However, fires can be effectvely prevented through the combined use of technology and common sense. By understanding how fires get started and how to extinguish them, students will have much of the knowledge needed to protect people from fire. This study unit will introduce trainees to the information you need to practice fire safety and prevention in the workplace.

Objectives
When a student completes this study unit, he and she will be able to:

- Describe the types of property losses and injuries associated with fires.
- Explain how fires are ignited.
- Identify the four 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 safely evacuate a burning building.

Contents
Introduction to Fire; Fire Hazards in the Workplace; Preventing Fires; Fixed Fire Protection Equipment; Portable Fire Extinguishers; Fire Protection Techniques.

186109
Material Handling Safety

Duration:
5 hours (includes 1 test)

What Students Learn:
Preview
This study unit introduces the safe techniques and work practices commonly used when handling manufacturing and industrial materials. Trainees will learn the procedures necessary to avoid physical injury to yourself and those working with you, for both manual handling methods and mechanical handling methods. You will also learn procedures that minimize damage to the materials being moved and to facility property. Knowing the proper procedures will also give you the insight to decide when mechanical handling is necessary, or preferred, over traditional physical handling.

Objectives
When a student completes this study unit, he and she will be able to:

- 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.
- 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.

Contents
Introduction to Material Handling; Housekeeping and Storage; Material Handling Equipment; Hoists and Cranes.

4400
Working Safely with Electricity

Duration:
10 hours (includes 1 test)

What Students Learn:
Electrician Categories and Classifications; Electrical Safety Standards and Codes, including OSHA, NEC, and NESC; Materials Standards; Listing and Labeling by Testing Laboratories; Electric Shock; Safety Precautions; First Aid for Electric Shock; Protective Clothing.

Block X31
Basic Industrial Math

Duration:
30 hours (includes 6 tests)

What Students Learn:
This module of six study units offers the trainee arithmetic and basic mathematics, metric measurement, and calculator fundamentals. The Metric System is an introductory unit which includes metric conversions. Problem exercises and examples in this module are presented in on-the-job scenarios with applications drawn from the industrial context.

Special Notes:
This updated course replaces lessons contained within Practical Math and Measurements, Block X01. Each study unit contains a progress examination.

Components:
Addition and Subtraction (186303)
Multiplication and Division (186304)
Fractions, Percents, Proportions, and Angles (186305)
Metric System (186306)
Formulas (186307)
Introduction to Algebra (186308)

186303
Addition and Subtraction

Objectives:

- Define the terms: whole number, numeral, digit, decimal, place value, addend, sum, minuend, subtrahend, and difference.

- 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.
- How to check your answers to both addition and subtraction problems.
- How to use a calculator to add and subtract numbers.

186304
Multiplication and Division

Objectives:
- Define the terms: factor, multiplicand, multiplier, partial 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 and decimals.
- How to check your answers to both multiplication and division problems.
- How to find the average of a group of numbers.
- How to use a calculator to multiply and divide numbers.

186305
Fractions, Percents, Proportions, and Angles

Objectives:
- Define the terms: fraction, proper fraction, improper fraction, lowest common denominator, percent, ratio, and proportion.
- How to add, subtract, multiply, and divide fractions and decimals.
- How to change fractions to decimals and decimals to fractions.
- Solve problems involving percent.
- How to use a protractor to measure angles.
- Lay out templates for checking angles.
- How to use a calculator to solve percent problems and to convert fractions to decimals.

186306
Metric System

Objectives:
- Name the base units most commonly used in the metric system.
- Identify metric prefixes and their values.
- Apply conversion factors to increase or decrease metric base units.
- Estimate lengths in metric units.
- Express temperature in degrees Celsius.
- Define the terms: mass, density, force, torque, and pressure. Identify the metric units used to measure each one.
- How to use a calculator to convert one metric unit to another.

186307
Formulas

Objectives:
- Explain the use of letters in formulas.
- Prepare and use formulas to solve problems.
- The use of formulas to calculate the perimeter of a triangle and rectangle, distance, area of a triangle, rectangle, and circle, volume of a pyramid, current in a circuit, and volume of a sphere.
- How to use a calculator to find square root and solve formulas.
- Transform and solve an equation.
- Perform basic arithmetic operations with signed terms.
- Substitute given numerical values for letters in a formula and find the unknown quantity.

186308
Introduction to Algebra

Objectives:
- Define the terms: term, constant, coefficient, exponent, monomial, trinomial, and polynomial.
- Identify and combine like terms in an expression.
- Multiply and divide terms containing exponents.
- Remove parentheses from an expression and simplify the expression.
- Perform basic arithmetic operations with signed terms.

Block X32
Practical Measurements

Duration:
25 hours (includes 5 tests)

What Students Learn:
The five lessons in this block present the trainee with a broad overview of measurements found in an industrial setting. In addition to the basic measurements of length, temperature, energy, force, and power, the trainee will learn how materials are measured and handled in bulk quantities. Fluid measurements include the measuring of fluid flow, fluid pressure, and fluid level. All lessons include the metric conversions in addition to the English units.

Special Notes:
This updated course replaces the X0105 to X0109 lessons found in Practical Math and Measurements, Block X01. Each study unit contains a progress examination.

Components:
Linear and Distance Measurement (186125)
Bulk Measurement (186126)
Temperature Measurement (186127)
Energy, Force, and Power (186128)
Fluid Measurement (186129)

186125
Linear and Distance Measurement

Objectives:
- Recognize the difference between English and metric units of length.
- Find the perimeter of rectangular, square, or triangular areas or objects, such as rooms or machine bases, after measuring the sides.
- Calculate the circumference of circular objects like pipes of tanks after measuring the diameter.
- Measure lengths with the aid of rigid and flexible rules, thickness gauges and screw pitch gauges.
- Read a typical vernier scale and micrometer to take precise measurements.

186126
Bulk Measurement

Objectives:
- Measure an angle by degrees.
- Find the areas of rectangles, triangles, and circles.
- Find the volumes of prisms, cylinders, and cones.
- Find the weight of material stored in a container.
- Determine the amount of material that can be stored or handled.
- Discuss the types and uses of conveyors and weighing systems.

186127
Temperature Measurement

Objectives:
- Change temperature units from one system to another.
- Discuss the use of the various types of thermometers.
- Select the type of thermometer to be used at certain temperatures.

186128
Energy, Force, and Power

Objectives:
- Distinguish between the concepts of energy, force, and power.
- Explain what the term "work" means, and how it is measured.
- Know by sight the basic machines, lever, inclined plane, wedge, wheel and axle, and screw.
- Solve simple problems that involve levers, mechanical advantage, and machine efficiency.
- List the forms of energy that have important industrial applications, and the instruments used for measuring energy.

186129
Fluid Measurement

Objectives:
- Understand the properties of fluids.
- Determine the density, specific gravity, and viscosity of fluids.
- Express pressure in three different units.
- Measure the pressure of fluids using manometers and Bourdon tubs pressure gages.
- Measure the flow rate of fluids using different types of flowmeters.

186191
Jobs, Companies, and the Economy: Basic Concepts for Employees

Duration:
5 hours (includes 1 test)

What Students Learn:
- Recognition of how the economy affects the actions of companies, employees, consumers, and investors.
- The concept of capitalism and the principles of supply and demand.
- How government policies affect the amounts of saving, spending, and investing by companies and individuals.
- Understand economic measuring tools such as the inflation rate, the unemployment rate and Gross Domestic Product (GDP).
- How labor is divided into three employment sectors and how wages are set, including the influence of labor unions and the benefits of a multi-functional workforce.
- Recognition of how both the employee and the company must compete in an increasingly international marketplace.

Special Notes:
This updated course replaces How Our Economic System Works, study unit 6606, and Economics Today, study unit 186034.

186036

Quality Concepts: Tools and Applications

Duration:
5 hours (includes 1 test)

What Students Learn:
- Describe how job roles change as a company evolves in its quality consciousness.
- Explain several ways in which you can support TQM.
- Identify approaches, practices and skills associated with positive organizational change.
- Differentiate between the "change process" at the company level and the manufacturing processes that require improvement.
- Describe major causes of process variation and give examples of how they may affect you in your job.
- Explain why and how the reduction of variability is a key factor in process improvement.
- Describe why and how quality and process improvement depend on data-driven decision making.
- Identify seven quality tools and explain their uses.

186085
Applied Geometry

Duration:
6 hours

Course Prerequisites:
Basic Industrial Math (Block X21)
Practical Measurements (Block X22)

What Students Learn:
- Recognize characteristics of angles and closed plane figures.
- Distinguish between common geometric solids.
- Apply the Pythagorean theorem.
- Calculate perimeters and areas of a polygon, circle, and ellipse.
- Apply the formula for area and volume of geometric solids.

186086
Practical Trigonometry

Duration:
6 hours

Course Prerequisites:
Basic Industrial Math (Block X21)
Practical Measurements (Block X22)

What Students Learn:
- Define trigonometric functions.
- Use trigonometric tables and apply interpolation.
- Solve right triangles.
- Apply the laws of sines and cosines in solving oblique triangles.

Block X45
Reading Prints and Schematics

Duration:
96 hours (includes 12 tests)

Course Prerequisites:
Basic Industrial Math (Block X31)

What Students Learn:
This block introduces the trainee to the various types of prints, drawings, and schematics used in an industrial environment. The trainee will learn how to read and interpret the different types of standard symbols and abbreviations found on these drawings. This block will benefit trainees entering any industrial trade. Each study unit contains a progress examination.

Special Notes:
This updated course replaces Reading prints and Schematics, Block X25. Each study unit contains a progress examination.

Components:
Introduction to Print Reading (186325)
Print Reading Symbols and Abbreviations (186326)
Dimensioning and Tolerancing (186327)
Print Reading Applications (186328)
Building Drawings (186181)
Electrical Drawings and Circuits (186044)
Electronic Drawings (186045)
Hydraulic and Pneumatic Drawings (186046)
Piping: Drawings, Materials, and Parts (186047)
Welding Symbols (186048)
Sheet Metal Basics (186182)
Sketching (186050)

186325
Introduction to Print Reading

What Students Learn:
• Describe the basic format for conveying technical information in a
drawing
• Interpret the various drawing views used in technical drawings
• Extract information from notes and title blocks
• Recognize and interpret the different line types used in drawings
• Understand the concept of drawing scale and how it affects information shown in the drawing
• Identify various types of building, electrical, and mechanical drawings

186326
Print Reading Symbols and Abbreviations

Course Prerequisite:
Introduction to Print Reading (186325)

What Students Learn:
• Recognize, understand, and interpret the most common abbreviations
used on a wide range of drawing types used in construction and maintenance trades
• Understand and interpret the various symbols and notations used on drawings for electrical, architectural, mechanical, welding, fluid power, and other types of applications
• Explain how symbols are used to show standard materials, parts, and assemblies.

186327
Dimensioning and Tolerancing

Course Prerequisite:
Introduction to Print Reading (186325)
Print Reading Symbols and Abbreviations (186326)

What Students Learn:
• Recognize the international standards and conventions that apply to
drawings
• Explain how different numbering systems were developed and how
they are applied to prints
• Read and interpret various systems of dimensions and tolerances on
drawings
• Recognize and interpret common symbols and nomenclature used in
geometric dimensioning and tolerancing (GD&T) systems

186328
Print Reading Applications

Course Prerequisite:
Introduction to Print Reading (186325)
Print Reading Symbols and Abbreviations (186326)
Dimensioning and Tolerancing (186327)

What Students Learn:
• Work with standard drawing formats to obtain information such as
part titles, part numbers, dimensional standards, revisions, and materials
• Explain how various components shown on prints are connected or
related to each other
• Obtain information from a drawing about quantities, materials, assembly processes, or dimensions
• Visualize the three-dimensional parts and assemblies represented by
two-dimensional drawings
• Effectively interpret electrical, architectural, mechanical, fluid power,
and other types of prints.

186181
Building Drawings

Course Prerequisite:
Introduction to Print Reading (186325)
Print Reading Symbols and Abbreviations (186326)
Dimensioning and Tolerancing (186327)

What Students Learn:
• Work with standard drawing formats to obtain information such as
part titles, part numbers, dimensional standards, revisions, and materials
• Explain how various components shown on prints are connected or
related to each other
• Obtain information from a drawing about quantities, materials, assembly processes, or dimensions
• Visualize the three-dimensional parts and assemblies represented by
two-dimensional drawings
• Effectively interpret electrical, architectural, mechanical, fluid power,
and other types of prints.

186044
Electrical Drawings and Circuits

Objectives:
- Identify electrical construction drawings, schematics, and wiring diagrams.
- Interpret various electrical symbols.
- Read standard abbreviations used in electrical diagrams.
- Tell if a diagram is a block diagram, a schematic diagram, or a wiring diagram.
- Compare closed circuits, open circuits, grounded circuits, and short circuits.

186045
Electronic Drawings

Objectives:
- Identify and interpret the various electronics symbols used on drawings.
- Identify and interpret the various types of drawings used in the electronics field.

186046
Hydraulic and Pneumatic Drawings

Objectives:
- Graphic symbols for lines, flows, and reservoirs.
- Pump and valve symbols.
- Fluid circuit and air circuit components.

- Graphical, circuit, cutaway, pictorial, and combined diagrams.

186047
Piping: Drawings, Materials, and Parts

Objectives:
- Define the term "piping drawings."
- Recognize plans, elevations, and sectional views.
- Identify a view by its placement on a drawing.
- List what working drawings include.
- Evaluate whether or not a freehand sketch serves its intended purpose.
- Interpret the standard symbols and abbreviations and "read" the color coding on piping in industrial and power plants.
- Interpret dimensions marked on piping drawings.

186048
Welding Symbols

Objectives:
- Identify by name the welding processes commonly used in plant maintenance work.
- Name the best welding processes for a given welding job.
- Identify by sight, the basic joint and groove designs used in welding.
- Identify by sight the basic types of welds and describe their uses.
- Interpret the weld symbols most often found in the drawings used in plant maintenance work.

186182
Sheet Metal Basics

Objectives:
- Identify sheet metal of known material and thickness by page and weight.
- Figure allowances for bends, circumferences, seams, locks, and edges.
- Know when and where to cut relief radi.
- Catalog and identify by sight the various seams, locks, and edges.
- Name and describe the major tools and machines used in sheet metal working.
- Explain how large fittings can be constructed.
- List the characteristics of PVC and PVF sheet and laminates.

186050
Sketching

Objectives:
- Use the right techniques for sketching straight and curved lines, and circles and arcs.
- Draw, with practice, multiview sketches of simple objects that accurately show all the details of the objects.
- Draw dimension sketches of simple machine parts with enough detail that parts can be made.
- Draw, with practice, realistic sketches of objects that have simple rectangular and circular shapes.

Block X34
Hand and Power Tools

Duration:
70 hours (includes 12 tests)

Course Prerequisites:
Electrical Wiring Practices (086E02)
Basic Industrial Math (Block X31)
Practical Measurements (Block X32)
Trades Safety: Getting Started (186001)

What Students Learn:
In all industrial trades, a trainee will often have to several and various tools to get the task done properly. This block introduces commonly used hand and power tools. Safety is stressed while the maintenance worker is learning what tools to use, what tasks the tool can effectively accomplish, and how to use the tools correctly.

Special Notes:
This course replaces Hand and Power Tools, Block X24.
Each study unit contains a progress exam.

Components:
Common Hand Tools, Part 1 (18164)
Common Hand Tools, Part 2 (186165)
Precision Measuring Instruments, Part 1 (186188)
Electric Drilling and Grinding Tools (186166)
Power Cutting Tools (186167)
Pneumatic Hand Tools (186056)
Plumbing and Pipefitting Tools (286113)
Electricians' Tools (006026)
Tool Grinding and Sharpening (186057)
Woodworking Hand Tools (186169)
Woodworking Power Tools(186170)
Lifting Equipment (186168)

186164
Common Hand Tools, Part 1

Objectives:

Preview

In the first part of a students introduction to hand tools, you'll learn about various types of tools as well as how to use them safely. You'll also learn how workpieces are held in place, the manner in which workpieces are marked prior to actually starting a given job, and how to make the most of a workbench's many useful features.

Next, students will be introduced to a group of hand tools which most technicians use on a daily basis -- wrenches, pliers, screwdrivers, and hammers. Again, you'll learn the correct ways to safely use and take care of these tools. Equally important, students will learn how not to use these tools and the results of their improper use.

Objectives

When a student completes this study unit, he and she will be able to:

- Identify common hand tools and their function.
- Explain how to safely use common hand tools.
- Maintain most types of hand tools.
- Describe the benefits of several special features available for some hand tools.

Contents

Working with Hand Tools; Wrenches; Pliers; Screwdrivers; Striking Tools; Tool Storage and Benchwork.

186165
Common Hand Tools, Part 2

Objectives:

Preview

In this study unit, we'll continue the discussion of hand tools commonly used by technicians. While a broad range of technicians use many of the tools discussed here, such as chisels and punches, many others are more specialized and are commonly used by maintenance and machine trades technicians.

Students will learn how to choose the correct chisel or punch for the job, how to care for it, and use it safely.

Next, you'll learn about the variety of different cutting tools such as snips, knives, and hacksaws. Another important group of tools is shaping tools, such as files. Students will learn the different types of files, and again, how to care for them, and use them safely.

Also discussed in this unit are various specialized maintenance tools. These are tools used for specific types of maintenance jobs such as pulling or prying objects from machines, safely inspecting machines, and retrieving objects in areas that aren't easily accessible to the technician.

Objectives

When a student completes this study unit, he and she will be able to:

- Identify and use various chisels and punches safely.
- Use and care for cutting tools.
- Understand the need for specialized maintenance tools.
- Correctly use threading and other precision tools.

Contents

Struck Tools; Cutting Tools; Sheet Metal Tools; Shaping Hand Tools; Hand Tools for Threading and other Precision Work; Specialized Maintenance Hand Tools.

186188
Precision Measuring Instruments, Part 1

Objectives:

Purpose and Language of Measurement; Scale Instruments and Accessories; Vernier Caliper; Micrometers, Gages, and Protractors.

186166
Electric Drilling and Grinding Tools

Objectives:

Preview

The electric drill is one of the most widely used power tools. It has many uses and is simple to operate. Electric drills can be found in a variety of shapes and sizes, from a light household duty to the heavy-duty industrial grade hand drill and drill press. One variation of the electric drill is the hammer drill or rotary hammer. The hammer drill is a tool used for making holes in concrete and masonry.

Grinders are commonly used for shaping and finishing metal and other materials. Hand grinders are available in sizes ranging from those designed to do the intricate work of the die grinder to that of the 7-inch heavy-duty disc grinder. Bench grinders are standard equipment in most shops, ranging from a 6-inch bench model to the heavy-duty 12-inch pedestal grinder.

Objectives

When a student completes this study unit, he and she will be able to:

- Safely set up and operate a portable electric drill, electric drill press, and electric hammer.
- Choose the proper drill bit for many drilling applications.
- Set up and use a variety of hand and bench grinders.
- Safely use the proper grinder for various jobs.
- Follow the necessary steps for proper tool maintenance.
- Purchase the proper drilling tool for your application.

Contents
Electric Drills; Drill Presses; Drill Bits; Hammer Drills and Rotary Hammers; Electric Grinders; Abrasives.

186167
Power Cutting Tools

Objectives:

Preview
Power cutting tools fall into two categories: portable and stationary. Portable and stationary cutting tools perform many similar operations, but portable tools, carried easily by hand, are used most often at the job site. Stationary tools are used in workshops and on plant tools. Stationary saws range in size from small shop jigsaws to huge band saws used in paper mills to saw large trees into lumber. This unit introduces students to the most common portable power saws used in construction and repair work, namely circular, saber, jig-, and reciprocating saws, and the stationary cutting tools found in most maintenance and fabrication shops.

Objectives
When a student completes this study unit, he and she will be able to:

- Identify the most common portable and stationary power saws.
- Identify the various parts of a saw and explain how they work.
- Discuss the types of cuts made by each type of saw.
- Choose the most appropriate saw and blade for the type of work being done.
- Recognize a portable circular saw, name its parts, and (with practice) operate it safely.
- Select and (with practice) use the proper saw; saber saw, portable band saw, reciprocating saw, cut-out saw, cut-off saw, for a given application.
- Operate (with practice) the stationary circular, radial, band and scroll saws safely.
- Observe the various safety precautions when using power saws and stationary power tools.

Contents
Power Saw Safety; Portable Power Saws; Stationary Circular Power Saws; Other Stationary Power Saws.

186056
Pneumatic Hand Tools

Objectives:

Preview
Pneumatic tools are used in many areas of maintenance, construction, and production work. These tools harness the power of compressed air and convert this power to useful work. Compressed air can be a very powerful energy source. However, due to this power, you must be extremely careful when using these tools.

Pneumatic tools are normally made much heavier than standard-duty hand and power tools. You will notice this fact as soon as you lift an impact wrench or framing nailer. The cases of the tools are made intentionally heavy to contain the stresses of the impact hammers or piston and to absorb the normal day-to-day abuse that the tool takes. You have probably seen someone remove a tire's lug nuts with a pneumatic impact wrench. The operator picks up the wrench and blasts off four or five bolts. Next, the wrench is dropped the six inches or so to the floor while the operator's hands move to quickly grab the wheel and rim. Come back to this same shop a year later, and you will probably see the same wrench being used after thousands of tires have come and gone. The tool's case may be nicked and grooved, but if properly cleaned and lubricated, the tool could last for many thousand more tires.

This text discusses the selection, use and safe practices of using different types of pneumatic tools.

Objectives
When a student completes this study unit, he and she will be able to:

- Describe the various pneumatic tools used for plant maintenance.
- Identify and describe the safe use of impact, cutting, and grinding tools.
- Explain how pneumatic hammers, nailers, and staplers are selected and used in a safe manner.
- Describe the use of pneumatic assembly tools such as grinders, sanders, screwdrivers, and drills and how other types of production tools are selected and used.
- Identify the proper procedures for pneumatic tool and system care.
- Identify safe tool use procedures and how vibration and excess noise can cause bodily injury.

Contents
Pneumatic Tools for Maintenance; Pneumatic Tools for Construction; Pneumatic Tools for Production and Assemble; Pneumatic Tool Care; Using Pneumatic Tools Safely.

286113
Plumbing and Pipefitting Tools

Objectives:

- Identify the various tools available for various tasks by appearance.
- Demonstrate your knowledge of job safety and tool safety.
- Identify the tools required to join and assemble pipes of different material composition.
- Determine when and how to use pipe-joint assembly tools.
- Identify the tools required to perform layout, cutting, and boring tasks.

- Identify the tools needed for testing and maintaining piping systems.
- Determine when and how to use finishing, testing, and maintenance tools for piping systems.

006026
Electricians' Tools

Objectives:
Electricians' Equipment: Basic Hand Tools; Wire-Working Tools; Conduit-Working Tools; Power Tools; Knowledge as a Tool with Basic Introduction to the Metric System; Units of Electricity; Static Electricity; Electric Current, Measuring Instruments, and the Symbols and Terminology Used by Electricians.

186057
Tool Grinding and Sharpening

Objectives:
Preview
Trades people must keep their hand tools in good working condition. They must follow a regular maintenance schedule for servicing them. Tools with cutting edges must have the edges sharpened. Other tools must be trued and shaped for their special uses. Screwdrivers, chisels, punches, snips, and twist drills are shaped or sharpened on a grinding machine.

Objectives
When a student completes this study unit, he and she will be able to:
- Use a grinding machine, following all safety procedures.
- Hone or whet tools with an oilstone.
- Explain the procedures for grinding metal stock.
- Compare the methods used in grinding screwdrivers, snips, chisels, plane irons, and twist drills.

Contents
Tool Sharpening Equipment; Grinding and Sharpening Procedures.

186169
Woodworking Hand Tools

Objectives:
Preview
A person who does not really know the workings of industry might think that hand tools are not used that much any more. That is not so; in a maintenance job, trades people will use hand tools to do many different tasks. Hand tools are necessary for superior craftsmanship, and ideal for many maintenance operations. With hand tools, you supply the power and guide the tool.

This study unit focuses on the basic hand tools used when working with wood. Which woodworking hand tool you use will depend on the work you are doing. Often the same job can be done equally well with different tools.

Objectives
When a student completes this study unit, he and she will be able to:
- Distinguish between the types of hand saws and use them correctly.
- Bore and drill holes in wood.
- Explain the differences between planes and use planes effectively.
- Use abrasive tools correctly.

Contents
Layout Tools, Saws, and Hammers; Wood Boring and Removal Tools.

186170
Woodworking Power Tools

Objectives:
Preview
The correct use of routers, power planers, and sanders will be important to trades people in your maintenance job. You will cut contours and irregular shapes on both edges and surfaces with the portable router; or you will plane doors, lumber, and assembled work accurately with the portable power planer. Trades people will also finish wood, metal, and plastic, and prepare surfaces for painting with power sanders.

Objectives
When a student completes this study unit, he and she will be able to:
- Operate (with practice) the portable router.
- Outline the procedures for using a portable power planer.
- Recognize by sight the common stationary power sanders and compare their operation.
- Choose the right portable sander for a given job, and operate (with practice) the portable belt sander.

Contents
Routers; The Portable Power Planner; Power Sanders and Sanding Operations.

186168
Lifting Equipment

Objectives:
Preview

Maintenance work involves hoisting or lifting and moving machines, and other heavy loads. A new machine may have to be moved in, and installed on its foundation; a broken machine may have to be hoisted and taken to the maintenance area for repair. For such work, trades people will need hoisting equipment, plus certain accessories, such as rope and chain slings. Therefore, it is important for trainees to be familiar with the common types of hoisting equipment and slings.

In maintenance work, you will often have to remove parts, such as gears and bearings, from an assembly. Pullers are very useful tools for such purposes. The commonly used pullers are of the jaw and push types.

Objectives
When a student completes this study unit, he and she will be able to:

- Identify the many forms of jacks and hoists.
- Safely operate jacks and hoists.
- Understand the construction details of fiber ropes, wire ropes, and chains.
- Properly use and maintain fiber-rope, wire-rope, and chain slings.
- Properly use jaw and push pullers.

Contents
Jacks; Hoists; Fiber Ropes; Wire Ropes; Hoisting Chains; Pullers.

5004C
Bench Work, Part 3

Duration:
10 hours (includes 1 test)

What Students Learn:
Fitting Practice; Tolerance, Allowance, Clearance, and Fit; Babbitting; Hack Saw; Band Saw Machine; Clamping Work for Sawing; Soldering; Soft Solder; Soldering Copper; Sweat Soldering; Brazing; Hand Solders and Fluxes; Torch Brazing; Induction Brazing; Furnace Brazing.

5608
Mechanical Calculations

Duration:
10 hours (includes 1 test)

Course Prerequisites:
Basic Industrial Math (Block X21)
Practical Measurements (Block X22)

What Students Learn:
Power Transmission; Pulleys; Flat Belts; V Belts; Gears; Cams and Levers; Calculations; Slide Rule, Relative Speeds of Pulleys and Gears, Sizes of Pulleys and Gears; Textile Motors; Adjustable-Speed Drives; Calculation of Constants; Calculations for Levers; Accuracy in Calculations.

286085
Preventive Maintenance

Duration:
5 hours (includes 1 test)

Course Prerequisites:
Basic Industrial Math (Block X21)
Practical Measurements (Block X22)
Trades Safety: Getting Started (186001)

What Students Learn:
Preview
The purpose of a preventive maintenance program is to locate possible machine or equipment faults before the machine fails.

Objectives
When a student completes this study unit, he and she will be able to:

- Describe the function of inspection and scheduled maintenance as the basis of preventive maintenance.
- Explain why preventive maintenance is performed and how it's scheduled.
- Identify those within industry who should be part of preventive maintenance planning and execution.
- Discuss the causes, effects, and goals of a successful preventive maintenance program.
- Explain how a computerized preventive maintenance program can be developed and implemented.

Contents
Introduction To Preventive Maintenance; Why Perform Preventive Maintenance?; Scheduling Preventive Maintenance; PM Program Personnel; PM Program Goals; Computerized PM Programs.

286086
Preventive Maintenance Techniques

Objectives:
Preview
How to implement a preventive maintenance (PM) program is just as important as the why and when of such a program. It doesn't pay to create a well thought out and scheduled PM program only to have the lubrication, inspection, or repair tasks performed improperly. The objective of this unit is to show you how to perform these tasks safely and properly. This will include showing you typical PM tasks as they are performed on common industrial equipment.

Objectives
When a student completes this study unit, he and she will be able to:

- Explain how to inspect and properly maintain a belt, chain, and gearbox power transmission system.
- Discuss why proper alignment is necessary when operating a power transmission system.
- List the steps needed to properly maintain an AC or DC motor.
- Explain how to perform a start-up or bump test of a motor.
- Describe how to perform PM tasks on pneumatic systems.
- Describe how to maintain both floor and elevated conveyor systems.
- Identify the types of elevators and vertical lifts in your plant and the proper PM procedures for this equipment.
- Explain how to maintain liquid and vacuum pump systems.
- Describe how to perform a basic alignment of in-line shafts.
- List the proper PM procedures for electronic controllers and robot systems.

Contents
PM Of Power Transmission Systems; PM Of Electric Motors And Controllers; PM Of Pneumatic Systems; PM Of Conveyors; PM Of Vertical Lifts; PM Of Vacuum And Fluid Pumps; PM Of Electronic Controllers; PM Of Robots.

286087
Predictive Maintenance

Objectives:
Preview
Predictive technologies measure one or more characteristics of machine operation, calculate the expected life of the monitored system, and then estimate the condition of equipment and, therefore, the need for maintenance on that equipment. With this information passed along to a good preventive maintenance program, the preventive maintenance team can make informed decisions on task scheduling and make the most of its maintenance and inspection tasks.

Vibration analysis programs are the most commonly conducted PDM efforts. By performing inspection and repairs during downtime, uptime failures of the analyzed components are all but eliminated. PDM is more than vibration analysis, however; multiple technologies, such as infrared thermography, balance, alignment, and electrical signature analysis are part of many PDM programs. Because of these technologies, plants run better and are more competitive. PDM allows maintenance departments to predict when a unit will fail and plan its maintenance during a scheduled downtime, usually when the unit is cooler, cleaner, and not needed for the manufacturing process.

Objectives
When a student completes this study unit, he and she will be able to:

- Define what PDM is and how it can be used in industry.
- Identify the various types of technologies used in PDM.
- Explain what goals should be considered for a new and a maturing PDM program.
- Discuss the scope of basic mechanical PDM.
- Explain how a time waveform and a frequency spectrum can be used to identify machine faults.

Contents
What Is Predictive Maintenance?; Predictive Maintenance Program Goals; Basic Mechanical Predictive Maintenance; Forms Of PDM Data.

286088
Predictive Maintenance: Vibration Analysis

Objectives:
Preview
When a company decides to begin a predictive maintenance (PDM) program, the first technology usually embraced is vibration analysis. Vibration analysis allows the technicians or other specially trained personnel to perform condition monitoring of equipment. Condition monitoring is used at first as a coarse comb to pull out those programs that will imminently cause downtime. Then the program can progress beyond condition monitoring to provide scheduling services for preventive maintenance and identification of redesigns that address repetitive faults.

This study unit will show you the basics of vibration analysis as performed with a data collector and a computer software program. These devices will be used to collect vibration measurement data and to store and display the results.

Objectives
When a student completes this study unit, he and she will be able to:

- Explain how vibration measurements are taken and the systems used to identify measurement points.
- Identify balance, looseness, and misalignment problems.
- Discuss the techniques used to diagnose rolling-element bearing faults.
- Explain how journal bearing condition monitoring and fault analysis is performed.
- Identify speed reducer faults that occur in the gear sets or the internal bearings.
- Describe how resonance can affect the operation of equipment.

Contents

Vibration Measurements; Analyzing Balance And Looseness Problems; Misalignment Of Inline And Overhung Drive Systems; Analyzing Rolling-Element Bearing Systems; Condition Monitoring Of Journal Bearings; Condition Monitoring Of Speed Reducers; Resonance.

286089
Predictive Maintenance: Advanced Topics

Objectives:
Preview
Vibration analysis alone cannot perform sufficient condition monitoring to meet the needs of today's industry. Vibration analysis cannot easily find electrical faults, air leaks, electrical discharges, metal particles or contamination and breakdown of lubricants, or other important monitoring processes. Other technologies are needed for these tasks. This study unit will introduce you to these other technologies.
In this study unit, we will investigate many different technologies that can and should often be part of a good predictive maintenance program (PDM). This course is designed to discuss these technologies at a basic level. If you're considering working with one of these technologies, it's very important to understand how to operate the equipment involved and to gain additional equipment training from the manufacturer. These actions will provide you with a safe and profitable expanded PDM program.

Objectives
When a student complete this study unit, he and she will be able to:
- Explain the steps involved in performing balance and alignment on industrial machines.
- Discuss the use and operation of ultrasonic equipment to find problems such as electrical arcing, bearing faults, and internal and external air leaks in pneumatic systems.
- Describe the procedures used in electrical signature analysis (ESA) and how this inspection system can find motor problems.
- Explain how oil analysis can find lubricant problems and contamination.
- Describe how thermography can be used in a PDM environment.

Contents
Modern Balance And Alignment; Ultrasonic Testing; Electrical Signature Analysis; Oil Analysis; Infrared Thermography.

086051
Industrial DC Motors

Duration:
10 hours (includes 1 test)

Course Prerequisites:
Basic Industrial Math (Block X21)
DC Principles (Block A21)

What Students Learn:
Advantages and Operating Characteristics of DC Motors that make them widely used in industrial applications; Function of each component of a DC Motor; Operation of a Single-Coil Armature Motor; Troubleshooting DC Motors; How a DC Motor Controller Operates; Identify and list applications for various types of DC Motors including Universal, Stepper, PM, Servo and Brushless Motors.

Special Notes:
This new course replaces, DC Generators and Motors, course 6687.

086052
Industrial AC Motors

Duration:
10 hours (includes 1 test)

Course Prerequisites:
Basic Industrial Math (Block X21)
AC Principles (Block A22)

What Students Learn:
Construction and Operation of Single- and Three-Phase AC Motors; Principles of Electromagnetic Induction; Identify and work with Starter Systems for Single- and Ploy-Phase Motors including Shaded-Pole, Split-Phase Capacitor, and Repulsion-Induction Motors; Troubleshoot Polyphase Motor Systems.

Special Notes:
This new course replaces, AC Motors, Generators and Rectifiers, course 6698.

086053
Controlling Industrial Motors

Duration:
10 hours (includes 1 test)

Course Prerequisites:
Basic Industrial Math (Block X21)
AC Principles (Block A22)
Industrial DC Motors (086051)
Industrial AC Motors (086052)

What Students Learn:

How Stepper Motors are Electronically Controlled; Steps to follow when Troubleshooting Stepper Motor Controls; Explain how AC Line Frequency sets Motor Speed; How Frequency Inverters Control Motor Speed in Three-Phase Installations; Describe how Servo Motors are Controlled; Explain how Brushless Motors Work and how their Shafts are precisely Positioned: List the steps to follow when Troubleshooting Brushless Motor Controller Systems.

Special Notes:
This new course, in conjunction with courses 006010, 006011 and 006012 covering Industrial Motor Control for PLCs, replaces Industrial Motor Control, course 6699A-C.

4040
Transformers

Duration:
10 hours (includes 1 test)

Course Prerequisites:
AC Principles (Block A22)

What Students Learn:
Essential Transformer Properties; Operation Under Load and Without Load; Losses; Voltage Regulation; Rating; Types of Core and Windings; Insulation; Bushings; Tap Changers; Polarity; Single-Phase and Polyphase Transformers; Delta, Star, Open-Delta, and Scott Connections; Special Transformers, Autotransformers, Reactors, Step-Voltage Regulators; Instrument Transformers; Maintenance of Transformers; Design of Small Low-Voltage Transformers.

4341
Industrial Motor Applications

Duration:
10 hours (includes 1 test)

Course Prerequisites:
AC Principles (Block A22)
Industrial DC Motors (086051)
Industrial AC Motors (086052)

What Students Learn:
Motor Torque; Inertia of Loads; Motor Types and Characteristics; Power-Supply Factors; Types of Drives; Braking of Motors; Intermittent Service; Mechanical Connecting Devices; Motor-Driven Power Pumps; Fans and Blowers; Reciprocating, Rotary, and Centrifugal Compressors.

006010
Motor Control Fundamentals (for Programmable Logic Controllers)

Duration:
10 hours (includes 1 test)

Course Prerequisites:
Basic Industrial Math (Block X21)
AC Principles (Block A22)
Industrial AC Motors (086052)

What Students Learn:
Motor Control Standards; Operating Characteristics of Motors motor starters, NEMA and IEC Starters, reversing and multi-speed starters; Motor Control Fundamentals; Interpreting Control Devices and Circuits using Control Diagrams automatic and manual signaling devices, capacitive and inductive switches; Enclosures.

Special Notes:
This new series of Motor Control texts (006010-11-12) provides current electronics technology not covered in Industrial Motor Control (6699A-C).

006011
Industrial Motor Control (for Programmable Logic Controllers), Part 1

Duration:
10 hours (includes 1 test)

Course Prerequisites:
Motor Control Fundamentals (for Programmable Logic Controllers) (006010)

What Students Learn:
History and concepts of programmable logic controllers (PLC's); number systems, The Central Processing Unit (CPU); CPU scan, analog and discrete signals, types of PLC memory; The Input/Output System (I/O); Special Function I/O; Elements of a Relay Ladder Logic Program; Operation of Timers and Counters.

Special Notes:
This new series of Motor Control texts (006010-11-12) provides current electronics technology not covered in Industrial Motor Control (6699A-C).

006012

Industrial Motor Control (for Programmable Logic Controllers), Part 2

Duration:
10 hours (includes 1 test)

Course Prerequisites:
Industrial Motor Control (for Programmable Logic Controllers), Part 1 (006011)

What Students Learn:
Programmable Logic Controllers (PLC's) Fundamentals; contacts, coils, ladder logic terminology and symbology, scanning and solving ladder logic programs, application/troubleshooting exercise one; The Pick and Place Robot, application/troubleshooting exercise two; The Mixing Vat; application/troubleshooting exercise three, The Paper Roll Stand, troubleshooting skills using LED indicators and programming console procedures; PLC's in Motor Speed Control; PLC System Troubleshooting and Repair.

Special Notes:
This new series of Motor Control texts (006010-11-12) provides current electronics technology not covered in Industrial Motor Control (6699A-C)

286060
Hydraulic Power Basics

Duration:
10 hours (includes 1 test)

Course Prerequisites:
Introduction to Algebra, Geometry, and Trigonometry (Block X02)
Introduction to Fluid Power (Block Y01)

What Students Learn:
Introduction to Hydraulic Power; Physical Principles of Hydraulic Power and Energy; Pascal's Law; Bernoulli's Principle; Work and Power; Horsepower and Loss; Hydraulic Power Systems; Basic Components of Hydraulic Systems; Basic Hydraulic System Accessories; Fittings and Couplings; Characteristics of Hydraulic Systems; Comparing Power Systems; Requirements for Hydraulic Systems; Properties of Hydraulic Fluid; Fluid Storage, Handling, and Maintenance; Filters and Strainers; Heat Exchangers; Eliminating Air; Examples of Hydraulic Systems; Proportional Displacement; Hydraulic System Operation; Working Safely with Hydraulic Systems.

Special Notes:
The entire course consists of study units 286060, 286061, 286062, 286063, 286064 and 286065.

286061
Hydraulic Components: Actuators, Pumps, and Motors

Duration:
10 hours (includes 1 test)

Course Prerequisites:
Introduction to Algebra, Geometry, and Trigonometry (Block X02)
Introduction to Fluid Power (Block Y01)

What Students Learn:
Actuator Design, Detail, and Operation; Linear Actuators; Hydraulic Actuator Components; Rotary Actuators; Pumping Principles; Slippage; Pump Classifications; Gear Pumps; Vane Pumps; Double Pumps; Gear and Vane Pump Lubrication and Capabilities; Piston Pumps; Screw-type Pumps; Supercharging Pumps; Variable-displacement Pump Control Fundamentals; Hydraulic Motors; Comparing Pumps and Motors; Gear Motors; Screw Motors; Vane Motors; Piston Motors; Abutment-type Motors; Losses through Fluid Motors; Deceleration and Braking.

Special Notes:
The entire course consists of study units 286060, 286061, 286062, 286063, 286064 and 286065.

286062
Hydraulic Components: Conductors, Conditioners, and Fluids

Duration:
10 hours (includes 1 test)

Course Prerequisites:
Introduction to Algebra, Geometry, and Trigonometry (Block X02)
Introduction to Fluid Power (Block Y01)

What Students Learn:
Reservoirs and System Components; Types of Reservoirs; Reservoir Volume; Reservoir Components; Reservoir Interior Care and Auxiliary Tanks; Reservoir in Use; Practical Tips for Reservoir Selection and Maintenance; Conductors, Fittings, and Seals; Maintenance Tips for Conductors, Fittings, and Seals; Choice of Conductor Size and Materials; Types of Heat Exchangers; Automatic Temperature Control; Effective System Cooling Tips; Accumulators; Circuits Using Accumulators; Accumulator Safety; Hydraulic Fluids; Petroleum-based Fluids; Viscosity; Demulsibility; Oxidation Stability; Lubricating Value; Corrosion and Rust Prevention; Fire-resistant Fluids.

Special Notes:

The entire course consists of study units 286060, 286061, 286062, 286063, 286064 and 286065.

286063
Hydraulic Power System Control

Duration:
10 hours (includes 1 test)

Course Prerequisites:
Introduction to Algebra, Geometry, and Trigonometry (Block X02)
Introduction to Fluid Power (Block Y01)

What Students Learn:
Explain the Function of Control Components in a Typical Hydraulic System; Identify Control Valves by Pressure, Flow, or Directional Type; Explain the Operating Principles and Typical Internal Parts of Pressure, Flow, and Directional Valves; Interpret Schematic Symbols which represent Control Valve Configurations.

Special Notes:
The entire course consists of study units 286060, 286061, 286062, 286063, 286064 and 286065.

286064
Interpreting Hydraulic System Schematics

Duration:
10 hours (includes 1 test)

Course Prerequisites:
Introduction to Algebra, Geometry, and Trigonometry (Block X02)
Introduction to Fluid Power (Block Y01)

What Students Learn:
Typical Schematic Layout; Recognizing Standard Schematic Symbols; Interpreting Control Configuration from Schematic Symbols; Evaluating System Operating Characteristics from Schematics.

Special Notes:
The entire course consists of study units 286060, 286061, 286062, 286063, 286064 and 286065.

286065
Hydraulic Power System Troubleshooting

Duration:
10 hours (includes 1 test)

Course Prerequisites:
Introduction to Algebra, Geometry, and Trigonometry (Block X02)
Introduction to Fluid Power (Block Y01)

What Students Learn:
Sizing Components to meet Requirements; Measuring and Evaluating System Operation; Assessing Motor and Pump Capacity and Performance; Special System Control including Servos and Pressure, Temperature, and Limit Switches; Performing Periodic Maintenance and Analyzing Inspection Information; Troubleshooting System Faults; Typical Hydraulic System Faults and Failures.

Special Notes:
The entire course consists of study units 286060, 286061, 286062, 286063, 286064 and 286065.

6623
Pneumatics

Duration:
10 hours (includes 1 test)

What Students Learn:
Atmospheric Pressure; Barometers; Properties of Gases; Relative Unit Pressure; Laws Relating to Change of State; Boyle's Law; Gay-Lussac's Laws; Combination of Boyle's and Gay-Lussac's Laws; Mixtures of Gases; Pneumatic Machines and Devices; The Air Pump; Apparatus Showing Weight and Pressure of Atmosphere; Siphon; Air Compressors.

286M01
Pneumatic Instrumentation for the Technician

Duration:
35 hours (includes 7 tests)

Course Prerequisites:
Basic Industrial Math (Block X21)

What Students Learn:
Lesson 1 - Pneumatic Instrumentation for Industry:
- Instrument Systems; How Fluid Power Works; Pneumatic Instruments; Link Mechanisms: Components and Adjustments; Calibration Standards, Procedures and Programs.

Lesson 2 - Pressure and Liquid Level Measuring Instruments:
- Principles of Pressure; Sensing Pressure; Bourbon Elements; Compensation and Calibration; Liquid-Level Instruments; Differential Pressure Instruments: Manometers, Bellows and Diaphragm Instruments, Displaces.

Lesson 3 - Flow-Measuring Instruments:

- Principles of Operation; Orifice Flow; Meter Types and Mechanisms; The Square-Root Problem; Integrators.

Lesson 4 - System Components, Part 1:
- Self-Balancing Instruments; Error Detectors; Pilot Valves; Relay Functions and Variations; Moment-Balance Pressure, Temperature and Differential-Pressure Transmitters; Moment Balance Positioners.

Lesson 5 - System Components, Part 2:
- True Force-Balance Instruments, Transmitters and Positioners; Motion-Balance Principle and Applications; Angle Motion-Balance Positioners; Linear Motion-Balance Instruments.

Lesson 6 - Pneumatic System Control, Part 1:
- Control Valve Maintenance; Control Theory and Fundamental Controllers; Gain, Feedback and Response.

Lesson 7 - Pneumatic System Control, Part 2:
- Controller Functions, Types and Components; Range and Gain Mechanisms; Foxboro, Honeywell, Taylor, and Fisher and Porter Controllers; Universal Controllers; Process Control.

Special Notes:
This course consists of a textbook and supplemental study guide.

286096
Air Compressors, Part 1

Duration:
10 hours (includes 1 test)

What Students Learn:
Preview

Most, if not all, manufacturing and industrial facilities use some application of compressed air. Many personnel in these industries refer to compressed air as the "fourth utility," in line with electricity, gas, and water. Because compressed air is considered a major utility in most manufacturing and industrial settings, its operational functions demand understanding, as well as continuous monitoring and maintenance.

Just as the unintentional loss of electricity, gas, or water can shut down processes, so can the loss of compressed air. It is common for major facilities that depend on compressed air in production and control, to have at least one backup compressor for every main line compressor. These backup compressors are usually not allowed to sit idle while the main line compressor or compressors do all the work. In fact, most systems or facilities are set up to either exercise these backup machines on a regularly scheduled basis, or to alternate their operation with the main line compressor or compressors. This way, operational and environmental wear is divided equally between all machines in the system.

Compressor outlet piping systems are often designed so that the flow of compressed air can be shifted from one compressor to another automatically. Alternately, in some less-complex systems, the shifting of flow may be accomplished manually by opening and closing specific valves to redirect the flow.

This study unit will discuss the fundamentals of compressed air systems, types of air compressors, and the proper methods of selecting a compressor for specific compressed air requirements. It will cover determining the cost efficiency associated with operating compressed air systems, and the major auxiliary equipment used with compressed air systems. This study unit should provide a good introduction and background knowledge that will be required to complete the study unit, Air Compressors, Part 2. The second study unit will cover installation, preventative maintenance, and major repairs on reciprocating air compressor systems.

Objectives

When a student completes this study unit, he and she will be able to:
- Define the terms and concepts related to the delivery of compressed air to industrial systems.
- Describe the two major classifications of air compressors.
- Identify the types of air compressors used in industry.
- Apply a checklist in the process of selecting an air compressor for a specific industrial application.
- Identify the auxiliary equipment associated with compressed air systems and list the functions of this equipment.

Contents

Compressor Fundamentals: What Is Compressed Air?; Types of Compressed Air Services; General Terminology; Pressure; Temperature; Converting Fahrenheit to Celsius; Converting Celsius to Fahrenheit; Volume or Capacity; Loading and Unloading; Stages / Single and Multiple; Types of Compressors: Dynamic Air Compressors; Centrifugal Compressors; Surging; Applications; Axial Compressors; Positive Displacement Air Compressors; Rotary Compressors; Rotary Sliding Vane; Liquid Piston; Reciprocating Compressors; Single- and Multiple-Stage; Single- and Double-Acting; Cooling Methods; Cooling Water Treatment and Flow; Selecting and Efficiently Operating an Air Compressor: Factors in Selecting an Air Compressor; Operating Efficiency and Cost; Auxiliary Equipment: Intake Filters; Silencers; Separators and Traps; Receivers; Dryers.

286097
Air Compressors, Part 2

Duration:
10 hours (includes 1 test)

What Students Learn:

Preview
Air Compressors, Part 1 discussed what compressed air is, types of air compressors, basic rules for selecting the right air compressor for a particular application, and the auxiliary equipment sometimes installed in compressed air systems.

New technology now offers oil-free reciprocating air compressors in which the internal parts are protected from wear by using sealed crankshaft and rod bearings, and pistons that move on alloyed heat-resistant filled Teflon guide and compression rings. However, many of the new and existing single-acting compressors are still of the lubricated, air-cooled, crankcase style.

Air Compressors, Part 2 focuses on the installation, design and operating fundamentals, major components, maintenance, and troubleshooting of small- to medium-sized single-acting, lubricated reciprocating air compressors.

Objectives
When a student completes this study unit, he and she will be able to:

- Identify the factors that must be considered before installing a single-acting reciprocating air compressor.
- Describe the reciprocating air compressor cycle and the functions of the major components.
- Understand lubrication systems of single-acting, air-cooled, lubricated reciprocating air compressors.
- Follow specific guidelines and procedures in the startup, operation, maintenance, and troubleshooting of single-acting, air-cooled, lubricated reciprocating air compressors.

Contents
Installation: Location; Ambient Temperature; Ventilation; Foundation; Compressor Room; Piping And Distribution Layout; Design And Operating Fundamentals: Compressor Classifications; The Compression Cycle; Main Components – Design And Repair; Housing Or Crankcase; Crankshaft; Main Bearings; Connecting Rod And Rod Bearings; Piston And Piston Rings; Cylinder; Valves And Cylinder Heads; Lubricating System; Compressor Startup, Operation, Maintenance, And Troubleshooting: Prestart and Startup; Operation; Extended Shutdown; Maintenance; Scheduled Inspections; Alignment; Troubleshooting.

286091
Lubrication, Part 1

Duration:
10 hours (includes 1 test)

What Students Learn:
Preview
Since the development of machinery, there has been a war against friction. Friction causes machinery to vibrate excessively, sound louder, use more energy to do a given job, and, most importantly, wear out faster. To counter friction, lubricants have been developed.

Lubricants were once basic animal fats and plant oils used on simple machines. Today's lubricants are chemical compositions specially designed for specific types of machines and their work environment. There are now hundreds of types of oils and grease to select from, each tailored specifically for the machine or an individual component of any given machine.

This study unit is designed to give students the information they need to understand how lubricants are blended into these very special compounds and how they are selected for various applications.

Objectives
When a student completes this study unit, he and she will be able to:

- 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.

Contents
Friction and Wear; The Purpose of Lubricants; How Lubricants are Classified; How Lubricants Work; Proper Lubricant Selection; Handling and Storing Lubricants Safely.

Special Notes:
This updated course replaces 2531A.

286092
Lubrication, Part 2

Duration:
10 hours (includes 1 test)

What Students Learn:
Preview
Lubricating equipment is one of the most important industrial maintenance activities performed. Lubricants reduce friction, which saves on energy costs. They reduce wear, which saves on equipment maintenance costs. Proper lubrication significantly reduces machine downtime resulting from broken or worn out components. In addition, proper lubricating practices help keep a machine in tolerance for a longer period of time.

In today's world of twenty-four-hour-a-day, seven-days-a-week, plant operation, the role of lubrication takes on even greater importance. Equipment must be lubricated on a timely schedule, in the proper amounts, and with the correct lubricants to sustain long work cycles between planned shutdowns. This study unit will show you how to properly apply lubrication and maintain lubrication systems.

Objectives
When a student completes this study unit, he and she will be able to:

- 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.

Contents
Manual Methods of Lubrication; Lubricating Total-Loss Systems; Nonloss Lubrication Systems; Lubrication in Special Environments; Lubrication Conditioning; Automatic Lubrication Systems; Preventive and Predictive Lubrication Maintenance.

Special Notes:
This updated course replaces 2531B.

286101
Mechanical Power Transmission, Part 1

Duration:
10 hours (includes 1 test)

What Students Learn:

- Physical principles that govern mechanical power transmissions
- Identify type of shaft misalignment and select coupling to compensate for it
- Coupling types, including resilient and metallic, components, and their functions
- Belt-drive system configurations, components, and applications
- Computing speed ratios
- Installing, servicing, and troubleshooting various types of belt drives

This three-study-unit course replaces and expands on 286015

286102
Mechanical Power Transmission, Part 2

Duration:
10 hours (includes 1 test)

What Students Learn:

- Various chain drive configurations and their unique operating characteristics
- Install chain coupling links and setting chain tension
- Interpret chain drive system ratings
- Servicing and lubricating Chain Drives
- Brake and clutch types, applications, and rating systems
- Selecting multimedia drives
- Predictive-maintenance for mechanical power transmission systems

This three-study-unit course replaces and expands on 286015

286103
Mechanical Power Transmission, Part 3

Duration:
10 hours (includes 1 test)

What Students Learn:

- Gear types and their operating characteristics
- Removing or mounting a gear from its shaft
- General dimensions in gearing and gear-drive systems
- Interpret gear and gearbox ratings
- Recognize different types of gearboxes and explain the applications for which each suited
- Selecting lubricants and lubricating gearboxes

This three-study-unit course replaces and expands on 286015

2607A-B
Belt Power Transmission

Duration:

20 hours (includes 2 tests)

Course Prerequisites:
Introduction to Algebra, Geometry, and Trigonometry (Block X02)

What Students Learn:
PART 1 (2607A). General Considerations on Belt Drives; Basic Theory of Belt Power Transmission; Types of Belt Drives; Application of V-Belt Drives; Application of Flat Belt Drives; Belt Drive Installation and Maintenance; Appendix.
PART 2 (2607B). Application of Special Belt Drives; Additional Considerations in Belt Drive Applications; New Developments in Belt Drives.

286093
Bearings and Seals, Part 1

Duration:
10 hours (includes 1 test)

What Students Learn:
Preview
Bearings of one type or another have been used since the invention of the most primitive machines. Bearings support rotating machine shafts as well as translating movement in machine components, and bearings keep the components in correct alignment.

This study unit, will primarily discuss plain bearings. However, so that students understand the fundamental differences, it will briefly cover antifriction bearing operation. Students will get a basic understanding of the differences between plain bearings and antifriction bearings. The study unit will then discuss the various types of plain bearings and their uses in greater detail.

Because bearings are used in such a wide range of applications, there are many factors to consider when selecting a bearing for a specific need. It is important that students understand these factors and the process for choosing the correct bearing and lubrication method for an intended application. In this study unit, students will also learn about the different techniques and tools used to properly install, lubricate, and remove bearings.

Objectives
When a student completes this study unit, he and she will be able to:
- Understand what friction is and how bearings help reduce it.
- Explain the difference between plain and antifriction bearings.
- List the different types of plain bearings.
- Understand the characteristics of plain bearings.
- Know the importance of proper handling and installation of bearings.
- Recognize the importance of proper bearing lubrication.
- List the different materials used to make plain bearings and how material type affects their use.
- Explain how to prevent premature bearing failure.

Contents
Introduction to Bearings; Journal Bearings; Other Types of Plain Bearings; Installing and Maintaining Plain Bearings; Plain Bearing Failure.

Special Notes:
This updated course replaces 2602.

286094
Bearings and Seals, Part 2

Duration:
10 hours (includes 1 test)

What Students Learn:
Preview
Bearings and seals are used in most every type of machine. This study unit will help you learn how to identify, lubricate, maintain, and replace antifriction bearings and seals.

As students know, there are two types of bearings, plain and antifriction. Plain bearings use a sliding motion to reduce friction, while an antifriction bearing contacts the shaft it supports with a rolling element. This rolling motion helps reduce friction. The rolling motion produces less friction than the sliding motion produced from plain bearings. Therefore, the rotation of a shaft is smoother with an antifriction bearing. In this study unit, students will learn about the various types of antifriction bearings and their different parts. They will also learn about the basic characteristics of these bearings, and how to apply them to a particular shaft. The study unit will also cover proper installation and maintenance and properly applying them. An important part of proper application is correctly combining the various materials available in bearings with the material the shaft is made from.

This study unit will also help students better understand seals. They will learn what a seal does, the different types of seals available, and how they are used. Students will also learn; the various types of material that seals are manufactured from, their advantages, the importance of maintaining bearings, and how to replace seals when they fail.

Objectives
When a student completes this study unit, he and she will be able to:
- Identify the various elements used in antifriction bearings.
- Properly identify and correct problems in antifriction bearings.
- Choose the proper seal.
- Choose and apply the proper lubricants for seals and antifriction bearings.
- Understand the need for clearance and tolerances in bearings.

- Identify the various parts of a seal.

Contents
Antifriction Bearings; Antifriction Bearing Replacement; Maintaining Antifriction Bearings; Installing and Maintaining Lip Seals.

Special Notes:
This updated course replaces 2602.

6569A-B
Transfer Devices for Machine Tools

Duration:
20 hours (includes 2 tests)

Course Prerequisites:
Practical Measurements (Block X22)

What Students Learn:
PART 1 (6569A). The History and Development of Transfer Devices; Manual and Power-Operated Devices; Indexing; Cam and Roller Drives.
PART 2 (6569B). Devices Used for Linear Transfer; Chain Transfer Devices; Linkages; Trolleys; Bar Systems; Walking Beams; Compound Motion Transfer Devices.

286085
Preventive Maintenance

Duration:
5 hours (includes 1 test)

Course Prerequisites:
Basic Industrial Math (Block X21)
Practical Measurements (Block X22)
Trades Safety: Getting Started (186001)

What Students Learn:
Preview
The purpose of a preventive maintenance program is to locate possible machine or equipment faults before the machine fails.

Objectives
When a student completes this study unit, he and she will be able to:
- Describe the function of inspection and scheduled maintenance as the basis of preventive maintenance.
- Explain why preventive maintenance is performed and how it's scheduled.
- Identify those within industry who should be part of preventive maintenance planning and execution.
- Discuss the causes, effects, and goals of a successful preventive maintenance program.
- Explain how a computerized preventive maintenance program can be developed and implemented.

Contents
Introduction To Preventive Maintenance; Why Perform Preventive Maintenance?; Scheduling Preventive Maintenance; PM Program Personnel; PM Program Goals; Computerized PM Programs.

286086
Preventive Maintenance Techniques

Duration:
5 hours (includes 1 test)

Course Prerequisites:
Basic Industrial Math (Block X21)
Practical Measurements (Block X22)
Trades Safety: Getting Started (186001)

What Students Learn:
Preview
How to implement a preventive maintenance (PM) program is just as important as the why and when of such a program. It doesn't pay to create a well thought out and scheduled PM program only to have the lubrication, inspection, or repair tasks performed improperly. The objective of this unit is to show you how to perform these tasks safely and properly. This will include showing you typical PM tasks as they are performed on common industrial equipment.

Objectives
When a student completes this study unit, he and she will be able to:
- Explain how to inspect and properly maintain a belt, chain, and gearbox power transmission system.
- Discuss why proper alignment is necessary when operating a power transmission system.
- List the steps needed to properly maintain an AC or DC motor.
- Explain how to perform a start-up or bump test of a motor.
- Describe how to perform PM tasks on pneumatic systems.
- Describe how to maintain both floor and elevated conveyor systems.
- Identify the types of elevators and vertical lifts in your plant and the proper PM procedures for this equipment.
- Explain how to maintain liquid and vacuum pump systems.
- Describe how to perform a basic alignment of in-line shafts.
- List the proper PM procedures for electronic controllers and robot systems.

Contents

PM Of Power Transmission Systems; PM Of Electric Motors And Controllers; PM Of Pneumatic Systems; PM Of Conveyors; PM Of Vertical Lifts; PM Of Vacuum And Fluid Pumps; PM Of Electronic Controllers; PM Of Robots.

286087
Predictive Maintenance

Duration:
5 hours (includes 1 test)

Course Prerequisites:
Basic Industrial Math (Block X21)
Practical Measurements (Block X22)
Trades Safety: Getting Started (186001)

What Students Learn:
Preview
Predictive technologies measure one or more characteristics of machine operation, calculate the expected life of the monitored system, and then estimate the condition of equipment and, therefore, the need for maintenance on that equipment. With this information passed along to a good preventive maintenance program, the preventive maintenance team can make informed decisions on task scheduling and make the most of its maintenance and inspection tasks.

Vibration analysis programs are the most commonly conducted PDM efforts. By performing inspection and repairs during downtime, uptime failures of the analyzed components are all but eliminated. PDM is more than vibration analysis, however; multiple technologies, such as infrared thermography, balance, alignment, and electrical signature analysis are part of many PDM programs. Because of these technologies, plants run better and are more competitive. PDM allows maintenance departments to predict when a unit will fail and plan its maintenance during a scheduled downtime, usually when the unit is cooler, cleaner, and not needed for the manufacturing process.

Objectives
When a student completes this study unit, he and she will be able to:
- Define what PDM is and how it can be used in industry.
- Identify the various types of technologies used in PDM.
- Explain what goals should be considered for a new and a maturing PDM program.
- Discuss the scope of basic mechanical PDM.
- Explain how a time waveform and a frequency spectrum can be used to identify machine faults.

Contents
What Is Predictive Maintenance?; Predictive Maintenance Program Goals; Basic Mechanical Predictive Maintenance; Forms Of PDM Data.

286088
Predictive Maintenance: Vibration Analysis

Duration:
5 hours (includes 1 test)

Course Prerequisites:
Basic Industrial Math (Block X21)
Practical Measurements (Block X22)
Trades Safety: Getting Started (186001)

What Students Learn:
Preview
When a company decides to begin a predictive maintenance (PDM) program, the first technology usually embraced is vibration analysis. Vibration analysis allows the technicians or other specially trained personnel to perform condition monitoring of equipment. Condition monitoring is used at first as a coarse comb to pull out those programs that will imminently cause downtime. Then the program can progress beyond condition monitoring to provide scheduling services for preventive maintenance and identification of redesigns that address repetitive faults.

This study unit will show you the basics of vibration analysis as performed with a data collector and a computer software program. These devices will be used to collect vibration measurement data and to store and display the results.

Objectives
When a student completes this study unit, he and she will be able to:
- Explain how vibration measurements are taken and the systems used to identify measurement points.
- Identify balance, looseness, and misalignment problems.
- Discuss the techniques used to diagnose rolling-element bearing faults.
- Explain how journal bearing condition monitoring and fault analysis is performed.
- Identify speed reducer faults that occur in the gear sets or the internal bearings.
- Describe how resonance can affect the operation of equipment.

Contents
Vibration Measurements; Analyzing Balance And Looseness Problems; Misalignment Of Inline And Overhung Drive Systems; Analyzing Rolling-Element Bearing Systems; Condition Monitoring Of Journal Bearings; Condition Monitoring Of Speed Reducers; Resonance.

286089
Predictive Maintenance: Advanced Topics

Duration:
5 hours (includes 1 test)

Course Prerequisites:
Basic Industrial Math (Block X21)
Practical Measurements (Block X22)
Trades Safety: Getting Started (186001)

What Students Learn:
Preview
Vibration analysis alone cannot perform sufficient condition monitoring to meet the needs of today's industry. Vibration analysis cannot easily find electrical faults, air leaks, electrical discharges, metal particles or contamination and breakdown of lubricants, or other important monitoring processes. Other technologies are needed for these tasks. This study unit will introduce you to these other technologies.
In this study unit, we will investigate many different technologies that can and should often be part of a good predictive maintenance program (PDM). This course is designed to discuss these technologies at a basic level. If you're considering working with one of these technologies, it's very important to understand how to operate the equipment involved and to gain additional equipment training from the manufacturer. These actions will provide you with a safe and profitable expanded PDM program.

Objectives
When a student complete this study unit, he and she will be able to:

- Explain the steps involved in performing balance and alignment on industrial machines.
- Discuss the use and operation of ultrasonic equipment to find problems such as electrical arcing, bearing faults, and internal and external air leaks in pneumatic systems.
- Describe the procedures used in electrical signature analysis (ESA) and how this inspection system can find motor problems.
- Explain how oil analysis can find lubricant problems and contamination.
- Describe how thermography can be used in a PDM environment.

Contents
Modern Balance And Alignment; Ultrasonic Testing; Electrical Signature Analysis; Oil Analysis; Infrared Thermography.