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**On-Line Industrial Maintenance Technician Multi-Craft Training Program Objectives & Descriptions**

**INTRODUCTION**

REA5-Study Skills

Construct spoken and numbered outlines

Summarize a paragraph

Know the three types of reading: study reading, skimming, and scanning

Apply study skills to mathematics

Know a series of steps to solve problems

Maintenance Principles

Shows workers how solid maintenance principles can be used to reduce the influence of defects that come from 5 sources: Workmanship, Operation, Materials, Design, Failure Events

TRB1 – Maintenance Troubleshooting: Procedures

Identify the abnormality or symptom based on normal operation behavior

Determine the faulty element or component based on symptoms

Plan a course of action to repair the equipment

Safely perform repairs on the equipment

Apply observation techniques to prevent reoccurrence once the problem is repaired.

**BASIC MATH**

MAT1-Whole Numbers

Learn to recognize and use symbols of arithmetic

Learn the place value of numbers

Learn to add, subtract, multiply and divide whole numbers

Learn to solve arithmetic problems

MAT2-Fractions

Learn the parts of a fraction

Learn to determine fractional parts of quantities

Learn to add & divide fractions

Learn basic arithmetic functions using fractions and mixed numbers

MAT3-Decimals

Learn about the use of decimals

Learn the value of zeros in decimals

Learn to round off decimals

Learn to identify repeating decimals

Learn to add, subtract, multiply, and divide decimals

Learn to calculate percent’s

MAT4-Algebra

Learn about signed numbers and how they are represented on a number line

Learn to subtract, multiply, and divide signed numbers

Learn to use variables in solving equations

Learn to determine the value of square roots

Learn to use numbers with exponents and powers of 10

Learn to simplify algebraic expressions by removing grouping symbols

Learn to perform operations in their proper sequence

Learn to solve equations that have one unknown

**(TPC) BASIC MECHANICS**

Covers force and motion, work and energy, and fluid mechanics as applied in industrial maintenance. Explains principles of operation for simple machines, such as the lever, inclined plane, wheel and axle, pulley, and screw. Explains the basic elements of industrial machines, as well as common measurement tools used to monitor and adjust equipment. Covers hand tools, power tools and fasteners, ending with a discussion of ways to reduce friction and wear.

**PRINT READING**

PRT1-Print Reading: Orthographic Projections

Identify the principle views used in orthographic projections

Identify the types of lines used in projection drawings and the purpose of each

Identify auxiliary and sectional views

Identify the differences between first and third angle projections

PRT2-Print Reading: Format and Dimension

Identify characteristics of standard sheet sizes

Identify features of engineering drawings

Explain how an object's features are defined and located using dimensions

Explain tolerance dimensioning

PRT3-Print Reading: Types and Symbols

Identify the differences between layout, detail, prefix, and assembly drawings

Recognize general identification and revision notes and symbols

Identify special markings, including surface texture, welds, rivets, and datums

PRT4-Thread Specifications

Identify thread features

Describe the most common thread forms and their characteristics

Recognize the differences between English and metric thread notes

**(TPC) READING SCHEMATICS & SYMBOLS**

Covers all types of schematics and symbols used in commercial and industrial settings. Examines symbols on schematics, electrical symbols and diagrams, piping symbols and diagrams, hydraulic and pneumatic diagrams and symbols. Discusses air conditioning and refrigeration systems, including explanations of electrical/electronic control schematics. Covers welding and joining symbols.

**SAFETY & HEALTH**

Personal Protective Equipment: Don’t Start Work without It

At work, everybody part is vulnerable to injury and you have to make sure that your employees are well-protected. They face unique dangers depending on the job each one does. Accordingly, their PPE must be customized so that they can cope with the risks. Get this comprehensive PPE course, covering eye, face, hearing, head, hand and foot protection, and other PPE rules. Covers:

Personal Protective Equipment

Eye and Face Protection

Hearing Protection

Head Protection

Hand Protection

Foot Protection

Lockout Tagout: Lightening In A Bottle

Lockout/Tagout Basics and Standard

Energy Types and Lockout/Tagout Basics

OSHA's Lockout/Tagout Standard

Six Steps For Lockout/Tagout

Preparation, Shutdown and Isolation

Application, Restraint and Verification

Removal And Re-Energizing

Three Steps of Removal/Re-Energizing

Inspection and Training

Electrical Safety: Beware the Bite

Levels of Protection: Conductivity, Engineering Controls

Safe Work Practices: Safety at Work, Lockout/Tagout, Lockout/Tagout for Energized Systems

Effective Safety Measures: Personal Protective Equipment, Emergency Rescue and First Aid

ArcFlash: Live to Tell

Definition of arc flash

Safety documentation and regulations

Latest information on NFPA 70E

Qualified vs. unqualified persons

Three critical approach boundary areas

Job planning and hazard analysis

Lockout/tagout procedures

Proper PPE application

Machine Guarding: Safeguarding Your Future

Practically every machine has some sort of machine guarding – a shield, automatic shutoff or even a laser curtain – to protect workers if a body part should come in contact with the machine. In fact, OSHA requires specific machines to have specific guards. Make sure your employees understand the importance of knowing about and using the machine guards meant to protect them.

HAzCom: In Sync with GHS

As you know, the chemicals that your employees work with everyday can cause a multitude of physical and health hazards including chemical burns, respiratory problems, and fires and explosions. The Occupational Safety and Health Administration's (OSHA) Hazard Communication standard has recently been enhanced with the Globally Harmonized System of Classification and Labeling of Chemicals (GHS). This new HazCom standard not only gives workers the right to know the chemicals and hazards they face, but the right to understand them and how to protect themselves from danger. DuPont Sustainable Solutions' new HazCom: In Sync with GHS will help employees understand this new standardized process of communicating chemical hazards. Covers:

Classes of Hazards

 Hazard Classification Labels

 Labels on Shipped Containers

 Pictograms

 Workplace Labeling

Safety Data Sheets

 Communicating Chemical Hazards

Communication

 Written Program

 Information for Workers

**(TPC) INDUSTRIAL SAFETY & HEALTH**

Explains government involvement in ensuring a safe workplace. Discusses safety in various situations. Discusses personal protective equipment and fire safety. Includes expanded coverage of many health hazards. Covers ergonomics, environmental responsibility and importance of maintaining a safe work environment.

**OSHA 10 HOUR GENERAL INDUSTRY**

The 10-hour General Industry Outreach Training Program is intended to provide an entry level general industry worker's broad awareness on recognizing and preventing hazards on a general industry site. Students will be introduced to OSHA policies, procedures and standards as well as general industry safety and health principles and work practices covered in OSHA Act Part 1910. Special emphasis will be placed on areas most hazardous using OSHA standards as a guide. General industry workers must receive additional training, when required by OSHA standards, on specific hazards of the job Upon successful completion of the course, participants will receive an OSHA 10-Hour General Industry Outreach DOL course completion card within 4-6 weeks.

**LUBRICATION**

MLU1-Lube Oil: Types Properties and Handling

Understand the significance of proper lubrication

Identify the types of oils used, their characteristics, and the various ways to apply lubricants

Describe the centralized and portable methods for applying lubricants and various fittings that may be necessary for proper lubrication

Understand the guidelines for proper lubricant storage, both indoors and outdoors

MLU2-Lube Oil: Equipment and Procedures

Describe lubricant applications and standards

Properly dispense machinery oils using lubrication equipment and fittings

Describe the proper procedures for oiling with various lubrication systems

MLU3-Lube Grease: Types Application and Equipment

Describe the key grease properties and functions

Identify grease types

Use manual, powered, and automatic lubricators properly

Understand safe procedures to handle, store, and dispense grease

INS9-Lubrication System Inspection

Identify the types of lubrication oils

Inspect grease packs, pumps, distribution valves, pipes, joints, and bearings

Inspect suction filters, pump units, and pressure and check valves

Inspect lubrication parts

**DRIVE COMPONENTS**

MDR1-Industrial Drive Systems: Belt Drives

Identify common industrial belt drive systems

Identify the different drive systems and discuss drive ratios

Perform basic installation and maintenance procedures

Troubleshoot

MDR2-Industrial Drive Systems: Chain Drives common belt drive system problems

Perform basic chain drive installation and maintenance procedures

Troubleshoot some common chain drive system problems

INS7-Operator Inspection: Belt Drive, chain drive, & gear box inspection

Identify and describe the types and functions of belts and gears

Describe the inspection procedures of belt and chain transmission parts and units

Explain methods for inspecting gears.

CDP1-Complete Drive Packages

Identify the components of a directly coupled drive system

Understand the characteristics of operation unique to directly coupled drive systems

Identify the components of jackshaft and auxiliary drive systems

Explain the unique properties of jackshaft and auxiliary drive systems

Explain the effects of changing input and output speeds on auxiliary and jackshaft drive systems

Compute drive system efficiency

Understand the principles of operation for spring operated, shear pin, and heat-actuated overload devices

Learn troubleshooting strategies for drive packages

EDS1 - Enclosed Drive Systems

Understand the principles of operation and terminology used in enclosed drive systems

Identify the components used in an enclosed gear drive

Identify different gear types

Understand applications for enclosed gear drives

Identify the various types of adjustable speed enclosed drives

Understand applications of an enclosed chain drive system

Identify and describe the component parts and operation of an enclosed chain drive

Install an enclosed drive

Explain proper maintenance procedures

Describe proper procedures when troubleshooting an enclosed drive system

CBR1-Clutches & Brakes: Types, Principles, and Functions

Describe the different types of mechanical clutches and brakes, their components, and operation

Describe applications and troubleshooting procedures for mechanical clutches and brakes

Describe pneumatic and hydraulic clutches and brakes, their components, and operation

Describe pneumatic and hydraulic control systems

Describe applications and troubleshooting procedures for pneumatic and hydraulic clutches and brakes

Explain the purpose and operation of electrically controlled clutches and brakes

Identify an electric control system

CBR2-Clutches & Brakes: Troubleshooting

Troubleshoot several problems in mechanical clutch and brake systems

Troubleshoot several problems in pneumatic and hydraulic clutch and brake systems

Troubleshoot several problems in electric clutch and brake systems

INS8-Operator Inspection: Clutch & Brake Inspection

Identify and describe the types and functions of clutches and brakes

Identify and describe the types and functions of cams and guide surfaces

Describe the inspection procedures of clutches and brakes

Describe the inspection procedures of cams and guide surfaces.

GGS1 - Gear and Gear Systems

Understand parallel and perpendicular shaft configurations

Identify and describe the attributes of gears

Understand gear considerations, Calculate critical dimensions of gears

Explain installation procedures specific to spur, helical, bevel, miter, and worm gearing

Describe the types of wear associated with open gearing systems

Explain the inspection procedures for spur, helical, bevel, miter, and worm gear sets

Identify common symptoms and how to determine causes of failure

Explain solutions for open gear systems. Understand safety procedures with open gear systems

SJC1-Shaft Joining and Coupling Devices

Identify different types of shaft joining and coupling devices

Understand the operating principles governing shaft joining and coupling devices

Identify critical application considerations when selecting a connecting device

Differentiate between rigid, flexible, fluid couplings, and universal joints based upon construction, purpose, and application

Understand the safety precautions to follow when performing inspection, maintenance, and repairs

Install and align mechanical couplings

Maintain mechanical couplings

Install, mount, align, test, and maintain a fluid coupling

Recognize symptoms of and troubleshoot fluid couplings and Coupling Devices

**BEARINGS**

BRG1-Ind. Bearings: Application and Technology

Understand the definition of a bearing

Understand the different types of bearings, including plain, ball, cylindrical, spherical, tapered, and needle

Understand bearing wear and life expectancy

Understand protective housings for bearings

Explain the different types of loads

BRG2-Ind. Bearings: Maint. and Installation

Learn the proper way to install and care for both plain and rolling-element bearings

Identify the different types of fittings for installation

Check proper operating clearances

Understand the importance of proper bearing alignment

BRG3-Ind. Bearings: Troubleshooting

Understand the various ways to identify potential problems and their sources

Understand how to maintain a schedule of monitoring on four major areas of identification

Explain the proper procedures for removing failed bearings

Determine the reasons for failed bearings

**PIPING SYSTEMS**

(TPC) Piping Systems

Examines piping system materials and sizing. Includes coverage of codes, valves and fittings, and the cutting and joining of piping and tubing. Explains the function and unique requirements of the discharge line, liquid line, and suction line. Concludes with a lesson on piping system maintenance, including handling dirt and scale, expansion, vibration, corrosion, and leaks

**VALVES**

FVB1-Shutoff Valve Designs and Application Considerations

Explain the general characteristics, construction options, and application considerations of various shutoff valves

Identify the features and limitations of the various valve types

Evaluate shutoff valve performance

FVB2-Selecting Shutoff Valves and Accessories

Understand the major considerations for selecting a shutoff valve type

Identify pressure and temperature requirements

Identify the unique valve requirements imposed by the nature of the controlled fluid

Identify the features, limitations, and suitability of different valve styles

Select an appropriate valve

Select an appropriate means of operating the valve (handwheel, gear drive, power actuator, etc.)

FVB3-Installing Shutoff Valves

Explain good piping practices, including proper valve location and orientation in the pipeline

Understand the importance of pipeline and valve supports

Prevent line hammering

Explain installation considerations for specific types of shutoff valves, including plug, ball, butterfly, globe, gate, and check valves

Properly install valves with screwed, flanged, and welded-end connections

Describe actuator mounting and adjustment

FVB4-Maintaining Shutoff Valves

Identify components and their functions for various valve types

Explain routine preventive maintenance procedures for each valve type

Explain common procedures involved in complete valve repair

CVA1-Basics and Function

Identify the characteristics, function, and application of the control valve

Describe the factors that must be considered when selecting the proper control valve

Describe the functions of a valve actuator and a control valve positioner and how these work within a control system

CVA2-Types & Design

Describe the functions, applications, and differences of linear motion control valves and rotary motion control valves

Describe the functions, applications, and differences of pneumatically operated actuators, electrically operated actuators, and rotary motion actuators

Describe the basic operation and function of the components of the control valve

Identify factors that affect control valve safety

CVA3-Fundamentals and Selection

Describe the different types of fluid flow

Identify the factors that affect fluid flow

Explain the formulas used for determining valve selection

Describe the conditions of fluid flowing through a restriction such as a Herschel venture, a concentric orifice, and Vena Contracta

Explain cavitation, flashing, and fluid flow

Explain the considerations for selecting a control valve

Describe the preliminary criteria for selecting the proper actuator and auxiliary devices

CVA4-Sizing and Installation

Describe the factors to consider for correctly sizing a valve

Recognize what items are needed to determine proper valve sizing

Determine the proper control valve to be used for a liquid, gas, and vapor application

Describe the factors involved with actuator sizing, such as static force, valve leakage classification, and dynamic forces

Recognize the proper installation and maintenance procedures of a control valve

**PNEUMATICS**

PNM1-The Power of Compressed Air

Power transmission systems are found in equipment ranging from simple devices to complex industrial machines. This course introduces pneumatics — the transfer, control, and use of energy contained in compressed and flowing air. It provides a basic description of the characteristics of matter and describes the relationship between pneumatic properties. In addition, it describes the factors that affect air flow and velocity as well as the effects that temperature, water vapor, air saturation, and condensation have on a pneumatic system. The course covers: The characteristics of matter, Molecular level, Air, Properties of pneumatics, Specific volume, pressure, and temperature; Air flow, Factors affecting air flow, Air saturation, Condensation.

PNM2-The Pneumatic Circuit

A pneumatic circuit is a combination of components that work together to produce, control, and transmit energy. This course introduces several of these energy-transferring and air control components and the symbols used to represent them. The course covers:

Energy transferring components, Compressors, Valves, Actuators

Air control components. Directional control valves, Flow control valves

Regulators, Tanks and filters

Pneumatic symbols, Communicating with pictures

Pumps, filters, and lubricators

PNM3-Processing Air

This course introduces components that process air by compressing, storing, treating, and distributing air to the actuator. Although sometimes overlooked, these components have a major impact on system operation. The course covers:

Compressors, Single-stage, Multi-stage and dynamic

Pressure and flow rate capacities, Sustaining compression

Air storage, Tank accessories, Air sustaining components

Branch and loop systems.

PNM4-Using Compressed Air

Linkages can produce complex motion patterns, the origin of the motion is always one of these two types. This course focuses on the pneumatic components that produce motion. The course covers:

Linear actuators, cylinders, cylinder accessories

Theory of operation

Seals, Nonlinear actuators, Rotary actuators

Air motors, Torque, Nozzles and orifices.

PNM5-Pneumatic Control Valves

To be effective, actuators must move loads in the proper sequence, at the correct time, and at the desired speed. In pneumatic systems, this type of control is accomplished through the use of valves that control the direction of air flow, regulate actuator speed, and respond to changes in air pressure. This course focuses on pneumatic control valves. The course covers:

Directional control valves, One- and two-way valves, Three- and four-way valves

Methods of actuation, Flow control valves

Exhaust valves and air fuses

Simple and specialized regulators

Valve performance, Selecting valves.

PNM6-Working Safely with Pneumatic Systems

This course describes the safety hazards associated with pneumatic systems. It also covers the safety rules that should be followed when working with individual pneumatic components. The course covers:

Pneumatic system safety, Common hazards and remedies

Working with air tools, Oil and water

Safe installation and operation

Compressors, tanks, and actuators

Control valves

Air treatment devices

PNM7-Pneumatic System Maintenance

This course explains the importance of a pro-active maintenance program for pneumatic systems. It describes the major categories of tasks that should be part of a preventative maintenance program and identifies some specific tasks that should be performed during routine maintenance. The course covers:

Pro-active maintenance, Types of maintenance systems

Inspection, Valves and conductors, Checking alignment

System cleanliness, Servicing, Preparing for servicing

Air treatment components, Final maintenance tasks, Testing

Reconditioning and scheduling.

PNM8-System Troubleshooting

This course explores the concept of troubleshooting and covers one systematic approach to identifying problems and determining their causes. The course also examines the various root causes of bearing failure, including over-lubrication, contamination, and misalignment. The course covers:

The four indicators for determining bearing condition

Temperature, Noise and vibration, Seals, Lubrication

Removing and inspecting failed bearings

Causes of premature failure

Pitting and spalling, Electrostatic pitting, True brinelling

Fretting corrosion, Heat damage, Frictional bearing wear

Rust or corrosion, Equipment adjustment

INS1-Pneumatic System Inspection

Understand the basic characteristics of air, including pressure, flow, and volume

Explain how external conditions can affect air

Identify the operating principles of pneumatic systems, including Pascal's Law

Identify the components and function of the air compression system

Understand the general safety procedures for operating a pneumatic system

Differentiate between suction pressure and discharge pressure

Describe the three-step process for establishing the general inspection components and inspection points of the pneumatic system

**HYDRAULICS**

IDH1- Basic Principles and Application

Understand the basic principles and components of hydraulic power systems

Explain proper storage, handling, and maintenance procedures

IDH2-Types and Concepts

Identify and explain hydraulic piping, fitting, and connections

Understand hydraulic pumps

Identify and explain hydraulic system and pump mechanisms

Understand pressure control valves

IDH3-Function and Operating Principles

Identify the types and functions of directional control valves and accumulators

Identify the types of hydraulic cylinders

Understand operating principles and applications of hydraulic motors

Identify types, operating principles, and common uses of rotary actuators

Explain maintenance and troubleshooting practices that apply to the entire hydraulic system

IDH4-Maintenance and Troubleshooting

Perform reservoir, heat exchanger, and pump maintenance

Understand maintenance safety

Explain troubleshooting procedures for hydraulic systems

HDL1-Harnessing Hydraulic Power

Identify the conditions that cause fluids to flow and exert pressure

Explain Pascal's law

Describe the relationship between fluid pressure and fluid flow

Identify factors that affect pressure level, flow rate, and fluid velocity in a hydraulic circuit

HDL2-The Hydraulic Circuit

Identify the components of a typical hydraulic circuit

Describe the function of components found in a basic hydraulic circuit

Explain the structure and operation of basic hydraulic components

Identify graphic symbols used to represent basic hydraulic components

HDL3-The Hydraulic Pumps & Actuators

Describe the basic structure and operation of balanced and unbalanced vane pumps, internal and external gear pumps, and radial and axial piston pumps

Identify methods of varying the displacement in vane pumps and radial and axial piston pumps

Describe the basic structure and operation of various types of motors and rotary actuators

Describe the basic structure and operation of various types of cylinder devices such as rod gland bushings and seals, piston seals, air bleed passages, stroke adjusters, stop tubes, and cushions

HDL4-Hydraulics: Control Valves

Describe the basic structure and operation of normally closed and normally open pressure control valves

Describe the uses for relieve, unloading, sequence, counterbalance, brake, pressure-reducing valves, and flow control valves

Explain how pressure compensation enables a flow control valve to maintain a desired flow rate regardless of pressure fluctuations

Describe the function and basic operation of one-way, two-way, three-way, and four-way directional control valves

Identify methods of spool actuation for directional control valves

HDL5-Hydraulic Fluid

Identify the characteristics that enable hydraulic fluid to perform required functions within a hydraulic system

Describe the function, structure, and basic operation of reservoirs and accumulators, various types of conductors and fittings, hydraulic seals, and hydraulic filters

Describe the structure and basic operation of various types of hydraulic heat exchangers

HDL6-Hydraulics: System Safety & Maintenance

Identify common hazards associated with the workplace

Describe proper procedures for working with various hydraulic components

List the safety rules that must be followed when operating or maintaining a hydraulic system

Describe the factors that determine the intervals at which proactive maintenance tasks should be performed

Describe the inspections and tests that should be part of a preventative maintenance program

HDL7-The Hydraulic Systems Troubleshooting

Identify the factors that must be considered when evaluating the operation of a hydraulic system

Describe the tasks that should be part of a systematic troubleshooting process

Identify symptoms of several hydraulic components

Identify possible causes of some common hydraulic component and system failures

HPS1-Identification and Operation

Describe the operation of basic hydraulic circuits

Explain how load sensing and demand circuits operate

Describe how intensification and hydrostatic circuits operate

Discuss the operation of regenerative, prefill, and high-low circuits

Explain the importance of using a print when working with hydraulic systems

Describe the procedure for analyzing a complex hydraulic circuit

Identify pressure, drain, and control lines in a hydraulic system

Separate the various functions of a hydraulic circuit for closer analysis

HPS2-Troubleshooting Techniques

Describe proper troubleshooting techniques

Describe various kinds of modern hydraulic system test equipment

Explain how to select proper test points in a circuit

Describe repair procedures when troubleshooting and repairing a hydraulic system

Troubleshoot problems that occur in hydraulic power systems, including lack of motion, poor motion, and temperature and system malfunctions

**MEASUREMENT / INTRUMENTATION**

PME1 - Thermometers and Thermocouples

Temperature scales

Factors affecting accuracy of measurement

Types of thermometers

Thermocouples

PME3 - Pressure 1: Manometers and Gages

Manometers

Mechanical pressure transducers

PME5 - Level 1: Measurement and Gages

Visual level sensors

Variable displacement devices

PME7 - Flow 1: Measurement Overview

Fluid properties

Measuring flow

**BASIC ELECTRCITY / ELECTRICAL MEASUREMENTS**

ELS1-Basic Principles

Identify the parts of an atom

Understand how electrons move and react

Define terms associated with electricity, static electricity, and magnetism

Discuss how current flows through basic electrical circuits

ACDC1-Current

Identify the electronic charge of the atom, electron, proton, neutron, nucleus, and ion

Describe Coulomb's Law

Define terms associated with current

Measure current with an ammeter

ACDC2-Voltage

Explain how connecting batteries in series or in parallel will affect voltage and current capability

Differentiate between voltage drop and rise

Explain ground, negative, and positive voltage

Measure voltage with a voltmeter

ACDC3-Resistance

Differentiate between conductors and insulators and describe the characteristics that affect them

Interpret resistor color codes

Describe various types of resistors

Describe how resistors can be connected to achieve different amounts of total resistance

ACDC4-Ohm’s Law

Write Ohm's Law in three different forms

Select the proper equation to calculate voltage, current, and resistance

Calculate the amount of power in a circuit

ACDC5-Magnetism

Define electromagnetic terms

Explain basic electromagnetic rules and principles

Describe the operation of generators and motors

ACDC6-Electrical Measurements

Explain how the VOM works and should be connected to a circuit

Calculate the value of shunt required to increase the current capability

Calculate the series dropping resistance required to increase the voltage capability

Define voltmeter loading

ACDC10-AC Measurements

Explain the operation of AC meters and the oscilloscope

Measure alternating current, AC voltage, amplitude, period, and frequency

Analyze phase relationships of AC waveform

**(TPC) Electrical Measuring Instruments**

Covers the principles on which electrical test instruments operate. Basic instruments covered include voltmeter, ammeter, wattmeter, ohmmeter, and megohmmeter. Covers AC metering, split-core ammeter, use of current and potential transformers. Includes detailed coverage of modern multimeters. Explains functions and uses of oscilloscopes.

**DC CIRCUITS / FUNDAMENTALS**

ACDC7-DC Circuits

Explain how a voltage divider works

Describe an application for a bridge circuit

Describe Kirchhoff's Law

Explain the superposition theorem, Thevenin's Theorem, and Norton's Theorem

ADC2-Ohm's Law and DC Circuits

Understand the various Ohm's law relationships

Understand known and unknown values and how to use the proper Ohm's law relationships to solve for the unknown values

Calculate the total equivalent resistance of series, parallel, and series-parallel resistive currents

Calculate currents and voltages in series and parallel circuits

Understand the proper formula for calculating DC-circuit power

Explain simple rules and formulas for calculating circuit values

Calculate voltages and currents for circuits consisting of both series- and parallel-connected resistors

Determine resistance values for multi-range voltmeter and ammeter circuits

Calculate the power dissipated by each resistor in a series DC circuit

Calculate the power dissipated by each resistor in DC circuits consisting of both parallel- and series-parallel-connected resistors

ADC3-Electronic Components and Magnetism

Select the proper wire gage and insulation for a specific application

Explain hole and electron flow in N-type and P-type semiconductor materials

Understand the operation and function of a diode

Describe LED and LCD indicators and displays and their advantages and disadvantages

Understand the operation of bipolar PNP and NPN transistors in switching and amplifier circuits

Understand passive components such as capacitors, inductors, and resistors

Identify the different types of magnets and their operating principles

Explain how a magnetic field can induce current in a conductor

Identify different types of relays and their applications

Describe the operation of analog meter movements

Understand the operation and characteristics of DC motors

Explain how magnetism deflects the electron beam in a cathode-ray tube (CRT)

ADC4-Electronic Schematics and Circuit Analysis

Identify the electronic circuit symbols for conductors, connectors, batteries, capacitors, inductors, and various grounded and undergrounded tie points

Identify the electronic circuit schematic symbols for solid-state devices and other miscellaneous devices

Identify various types of electronic system documentation and how they are used

Apply Kirchhoff's current and voltage laws to determine circuit values

Determine unknown component values in circuits with more than one voltage source

Calculate simple voltage divider output voltages and currents

Determine the voltage divider components required to provide specific outputs

Analyze voltage divider circuits for simple problems, such as component shorts and opens

Describe the effects of fluctuations in load resistance on voltage divider outputs

**AC CIRCUITS / TRANSFORMERS**

ELS2-Alternating Current

Understand the differences between alternating and direct current

Describe how alternating current is generated

Learn the difference between single- and three-phase alternating current systems

Understand inductance and capacitance

Explain how transformers work

ELS3-Conductors

Explain the basic principles of conductivity and conductors

Understand the principles of circuit protection, including fuses and circuit breakers

Discuss the reasons for grounding electrical components and systems

ACDC8-Inductance & Capacitance

Define the terms, units, and symbols related to inductance and capacitance

Explain inductance and capacitance

Calculate total capacitance and solve time constant problems

ACDC11-Capacitive Circuits

Describe commonly used capacitors

Calculate total capacitance for capacitors in series and parallel

Describe the phase relationships between current and voltage in different types of capacitor circuits

Calculate impedance in series and parallel RC circuits

ACDC12-Inductive Circuits

Explain how inductors operate and which features affect them

Explain mutual inductance

Describe the phase relationship between current and voltage

Compute inductive reactance

ACDC13-AC/DC Electronics: Transformers

Describe the construction and operation of transformers

Describe sources of loss in transformers

Solve problems dealing with turns ratio, voltage ratio, current ratio, and impedance

Describe how the autotransformer and isolation transformer work

ACDC14-Tuned Circuits

 Calculate impedance, current, voltage, power factor, and phase angle in RLC circuits

 Calculate resonant frequency, capacitance value, or inductance value in RLC circuits

 Describe series and parallel resonant circuits

 Explain the relationship between bandwidth and Q

 Describe four basic types of filters.

**MOTOR DRIVES**

MTD1-Motor Drive Identification

Identify regenerative and nonregenerative DC drives

Identify voltage source and current source inverters

Understand and identify pulse width modulated inverters

Identify vector control drives

MTD2-Open and Closed Loop Systems

Understand the concept of feedback

Identify open and closed loop systems

Identify direct and inverse feedback

Identify tachometers and understand their use

Identify encoders and understand their use

MTD3-Variable Speed AC Drives

Understand voltage rectification

Identify controlled and uncontrolled rectifiers

Identify silicon-controlled rectifiers

Identify and understand the operation of the DC bus

Identify and understand the operation of the inverter section

Describe the operation of pulse width modulated drives

Describe the operation of vector control in AC drives

MTD4-Servo & Stepper Motors

 Identify servo motors and their uses

 Understand stepper motor operation

 Identify and understand the types of stepper motors and stepper motor controls.

MTD5-AC Motor Operation

Understand how a rotating magnetic field is created

Understand how voltage is induced in a rotor

Understand and calculate slip

Understand and calculate torque and horsepower

Understand and calculate power factor

MTD6-AC Drive Selection and Setup

Determine drive requirements based on motor application

Set up a drive for basic control requirements

Determine run, protection, and stop parameters for common applications

INS6-Operator Inspection: Motor Drive System Inspection

Identify and describe the types and function of drive units

Describe the inspection of three-phase AC induction motors

Describe the inspection of step motors

Describe the inspection of bearings, shafts, and couplings

**AC/DC EQUIPMENT & CONTROLS**

ELS6-Generators and Motors

Explain the basic differences between motors and generators

Discuss how motors and generators function and are controlled

Understand basic maintenance and troubleshooting techniques

ELS7-AC Motor Control and Current Measurement

Describe motor control devices and methods

Describe different types of motor overload protection devices

Troubleshoot common motor control problems

Determine how to effectively use voltage and current measuring devices

DCM1-DC Motors: Basics and Internal Parts of DC Motors

Identify and locate the basic parts of a DC motor

Describe the effects magnetic fields have on the armature of a motor

Define the right-hand rule

Describe the effects of force and motion on a motor

Explain the physical differences between the various DC motors

Select the proper DC motor for a specific task

Describe the internal construction of a field coil

Locate the poles in a DC motor field

Explain the function of an interpole

Describe the types of windings used in the armature coil

Describe the interaction between coils and other parts of the DC motor

Identify the types of armature construction

Identify the elements of the commutator segment

Describe how connections are made to other parts of the motor

List the types of insulation material used in commutators

Describe how brushes interact with the commutator

DCM2-DC Motors: Wiring Diagrams and Troubleshooting

Read and understand motor wiring diagrams

Connect a motor properly and identify connection errors

Select the proper terminal identifiers

Locate the lubrication ports on a DC motor

Designate the proper lubricant for the DC motor

Identify a bad brush and how to replace it

Detect problems within a DC motor using the correct inspection methods

DCC1-DC Motor Controllers-Controller Function and Operation

Explain basic controller functions

Identify the three types of speed controllers and describe their operation

Describe typical applications for DC motor speed control systems

Define commonly used terms in DC motor control systems

Describe how to control motor speed using a rheostat in the shunt field of a DC motor

Explain how a rheostat in the armature of a DC motor can be used to control the motor's torque

Explain how variable voltage controllers operate

Describe how a chopper controller works

Explain the operation of a single-phase motor controller

Describe the operation of a three-phase motor controller

Identify a Ward/Leonard motor controller and describe its operation

DCC2-DC Motor Controllers-Maintenance and Troubleshooting

Identify each type of maintenance and when it is applicable

List typical inspection procedures to use for DC motor control systems

Identify proper testing procedures for DC motor controllers

Describe proper cleaning procedures for DC motor controllers

Describe the correct troubleshooting technique for a specific problem

Isolate a problem in a DC motor controller

INS5-Operator Inspection: Electrical Equipment Control System Inspection

Understand electricity and control system basics

Identify inspection procedures for equipment main switches, control panels, and external wiring

Identify general inspection procedures for junction boxes, electrical motors, and detectors.

**MOTOR CONTROLS**

MTR1-Basic Motor Controls & Relays

Describe the three basic types of control systems

Discuss the operation of magnetic relays

Draw schematic symbols for normally open and closed contacts

Draw the standard symbol for a coil

Discuss the operation of solid-state relays

MTR2-Overload Protection Devices

Discuss the difference between overloads and fuses

List the major types of overload relays

Differentiate between the major types of thermal overload relays

Describe the operation of a dashpot timer

List the ways of changing the time setting of a dashpot timer

MTR3-Motor Controls: Time Delay Relays

Describe the operation of an ON delay timer

Describe the operation of an OFF delay timer

Draw the standard NEMA schematic symbols for ON and OFF delay timers

MTR4-Motor Controls: Schematic Symbols

Recognize the symbols used in schematic diagrams

Determine when a contact should be connected normally open or normally closed

Draw schematic diagrams using the proper NEMA symbols

MTR5-Motor Controls: Schematics and Wiring Diagrams

Describe the differences between schematics and wiring diagrams

Determine the logic of a control circuit by reading a schematic diagram

Read a wiring diagram

Convert a schematic diagram into a wiring diagram

MTR6-Motor Controls: Starting Methods for Squirrel Cage Motors

Discuss across the line starting

Explain resistor starting

Describe reactor staring

Discuss auto-transformer starting

MTR8-Motor Controls-Installing/Troubleshooting

Explain the different methods of installing control systems

Describe the steps required to install a control system using terminal strips and identifying wires with numbers

Troubleshoot a control system from a properly installed control cabinet

TRB3-Maintenance Troubleshooting: Motors and Motor Controls

Identify motor and motor control problems

Test motor windings

Wire and troubleshoot two- and three-wire motor control circuits

Troubleshoot variable speed frequency drive systems

**BASIC ELECTRONICS**

BEC1-Types and Diagrams

Become familiar with various types of electronic diagrams

Become familiar with interconnection diagrams

Read linear and nonlinear scale meters

Calculate circuit values

Understand analog and digital multimeters

List sources of measurement error with VOMs

Define the procedures for measuring voltage and current with an electronic VOM

Define the procedures for measuring resistance with a VOM

Explain the operation of bridge instruments

BEC2-Controls and Application

Identify the basic parts and controls of an oscilloscope and explain how they work

Identify and use the vertical deflection, horizontal deflection, and triggering controls

Check vertical and horizontal calibration

List the steps necessary to align and measure sine wave voltages, frequencies, and DC offset voltages

Identify Lissajous figures

Determine an amplifier's response to a square wave input by identifying the output waveforms

BEC3-Operation and Troubleshooting

Operate RF generators, function and pulse generators, and counter-timers for appropriate signal-testing operations

Identify the steps for troubleshooting a circuit using signal tracking and signal injection

Test the functioning of capacitors and inductors

Test a transformer and calculate transformer power losses

Perform function and specification tests on diodes

Use an ohmmeter to determine transistor types, identify transistor terminals, and test transistors

Use an ohmmeter to test silicon-controlled rectifiers and triacs

Describe the function of semiconductor testers

ECI1-Basic Principles

Define voltage, current, and resistance in operational terms

Calculate voltage, current, and resistance drops in series and parallel circuits

Identify the operation of capacitors in series and parallel circuits and calculate related circuit values

Describe the action of magnetic fields in inductors and how to calculate the inductance of series and parallel circuits

Calculate sine wave values

Describe the relationship between current and voltage in resistive, capacitive, and inductive circuits

ECI2-Characteristics and Operations

Identify circuit configurations of half-wave and full-wave rectifiers and how to compute output voltages from rectifiers

Describe the functions of power supply components and voltage multipliers and how to compute power supply ripple and regulation percent

Describe how to bias transistors and calculate amplifier gains

Identify the circuit configurations and characteristics of basic operational amplifiers

Identify the sequence of events in a tank circuit

Describe the operation and the resonant frequency of a Hartley oscillator

Describe the operation and the resonant frequency of a lag-lead network used in RC oscillators

Describe and determine the characteristics of a pulse waveform, including rise time, pulse width, period, pulse repetition rate, and duty cycle

Identify clipper and clamper circuits

Identify RC and RL differentiating and integrating circuits

Describe the operation of multivibrator and Schmitt-trigger pulse-generation circuits

ECI3-Logic Fundamentals, Types, and Applications

Identify relay circuits arranged to perform AND, OR, and inversion functions

Create truth tables for the inverter and for the AND and OR functions

Count in the binary number system and add and subtract binary numbers

Count in the hexadecimal number system and add and subtract hexadecimal numbers

Count in the octal number system and add and subtract octal numbers

Convert binary, hexadecimal, and octal numbers to decimal equivalents

Identify logic symbols and truth tables for NAND and NOR gates

Identify S-R and J-K flip-flop outputs resulting from different inputs

Describe the uses and functions of shift registers, counters, half adders, and full adders

Identify whether a flip-flop is triggered by a positive or a negative edge of the clock pulse

Describe the operation of bilateral switches and divide-by-N counters

Describe how the modulus of a counter can be changed to some other modulus

**PROGRAMMABLE LOGIC CONTROLLERS**

PLC1-Fundamentals

Understand how the components of the PLC interact with each other

Discuss the different types of ladder logic

Explain AND, OR, and NOT functions with PLC ladder logic and Boolean identities

Explain the difference between decimal, BCD, binary, hexadecimal, and octal numbering systems

Complete simple conversions

PLC2-Programming

Use programming codes for normally open and normally closed contacts

Program AND, OR, and NOT logic functions with mnemonic codes or ladder logic
Interpret addressing schemes

Properly document a PLC program

PLC3-Inputs and Outputs

Discuss the different types of discrete and analog inputs/outputs

Understand how to use the MOVE and COMPARE functions to handle analog derived inputs

Understand multiplexing wiring schemes

PLC4-Troubleshooting

Understand how to use the troubleshooting devices and functions common to most PLCs

Troubleshoot a PLC system for a problem

PLC5-Communications and Advanced Programming

Discuss PLC communications

Program the Add, Subtract, Multiply, and Divide math functions

Program the One Shot, R-S, D, and T Flip-Flops

Use the Sub-routine commands JUMP, SKIP, and MCR

Understand how to use the Sequencer function

RSX1-Configuring Hardware and Software

Identify the hardware necessary for communicating with the PLC

Create and configure drivers

Access the software and select drivers

Go online to the PLC and access essential help functions

RSX2-Programming and Editing

Open a new file, add rungs and instructions, edit and address, and add comments and symbols

Verify, save, and download files

Edit online and access program files

RSX3-Testing/Troubleshooting Functions

Apply forcing in RSLogix™

Understand forcing conventions, inputs, and outputs

Understand data monitors and searches, including histograms

Discuss advanced tools such as configuring intelligent modules and trending

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