

# Appendix 3 -NCCER Student Learning Outcomes (SLOs)

## NCCER Craft Training

Craft training is for individuals who would like to learn a craft and begin working in the construction industry.

In order to earn industry recognized NCCER credentials, a trainee needs to:

1. Complete training using NCCER Curriculum (“Knowledge Verified”): When a trainee completes and scores a passing grade on the curriculum, the trainee is considered “knowledge verified”. San Jacinto College CPET is an NCCER Accredited Training and Education Facility (ATEF) with facilities to offer the training courses listed below.
  - Core Curriculum: Introductory Craft Skills
  - Managing Electrical Hazards
  - Electrical Levels 1-4
  - Instrumentation Levels 1-4
  - Industrial Maintenance Electrical and Instrumentation Levels 1-4
  - Millwright Levels 1-5
  - Pipefitting Levels 1-4
  - Welding Levels 1-4
2. Pass an Assessment (“Performance Verified”): Assessments evaluate the competence level of experienced workers by documenting knowledge and verifying skills. Assessments must be conducted at an NCCER Assessment Center. San Jacinto College CPET is not currently an NCCER Assessment Center.
3. Confirm registration: “NCCER credentials are tracked through NCCER’s Registry System that allows organizations and companies to track the qualifications of their craft professionals and/or check the qualifications of possible new hires. NCCER’s Registry System also assists craft professionals by maintaining their records in a secure database.” <https://www.nccer.org/about-us>



**Knowledge Verified + Performance Verified = Certified**

### Core Curriculum: Introductory Craft Skills

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| <ol style="list-style-type: none"> <li>1. <b>Basic Safety (Construction Site Safety Orientation)</b> (00101 - 12.5 Hrs.)                     <ul style="list-style-type: none"> <li>• Importance of safety, causes of incidents, hazard recognition/control, HAZCOM, safety data sheet</li> <li>• Fall hazards, prevention, arrest, safe use of ladders, stairs, scaffolds</li> <li>• Identifying and avoiding: struck-by, caught-in-between, caught-in</li> <li>• Electrical safety guidelines, lockout/tagout</li> <li>• Personal protective equipment</li> <li>• Identifying other hazards (exposure, environmental, hot work, fire, confined spaces)</li> </ul> </li> <li>2. <b>Introduction to Construction Math</b> (00102 - 10 Hrs.)                     <ul style="list-style-type: none"> <li>• Whole numbers (adding, subtracting, multiplying, dividing); fractions and decimals</li> <li>• Rulers, tape measures, unit conversions</li> <li>• Angles, shapes, areas, volumes</li> </ul> </li> <li>3. <b>Introduction to Hand Tools</b> (00103 - 7.5 Hrs.)                     <ul style="list-style-type: none"> <li>• Hammers, demolition tools, chisels, punches, screwdrivers, wrenches, pliers, wire cutters</li> <li>• Measurement and layout: (rules, tapes, levels)</li> <li>• Cutting/shaping (handsaws, files, utility knives)</li> <li>• Shovels, picks, chain falls, come-alongs, clamps</li> </ul> </li> </ol> | <ol style="list-style-type: none"> <li>4. <b>Introduction to Power Tools</b> (00104 - 10 Hrs.)                     <ul style="list-style-type: none"> <li>• Drills, impact wrenches</li> <li>• Saws (circular, saber, reciprocating, portable band, miter, cutoff)</li> <li>• Grinders and attachments</li> <li>• Other power tools (pneumatic, powder-actuated fastening, pavement breakers, hydraulic jacks)</li> </ul> </li> <li>5. <b>Introduction to Construction Drawings</b> (00105 -10 hrs.)                     <ul style="list-style-type: none"> <li>• Types and purposes</li> <li>• Drawing components, elements, lines of construction, grid line, symbols</li> <li>• Dimensions, scales</li> <li>• Engineer’s and architect’s scale</li> </ul> </li> <li>6. <b>Introduction to Basic Rigging</b> (00106 – 7.5 Hrs.)                     <ul style="list-style-type: none"> <li>• Identify, inspect slings</li> <li>• Identify, inspect rigging hardware</li> <li>• Identify various types of hoists</li> <li>• Rigging hitches and Emergency Stop hand signal</li> </ul> </li> <li>7. <b>Basic Communication Skills</b> (00107 – 7.5 Hrs.)                     <ul style="list-style-type: none"> <li>• Listening and speaking</li> <li>• Reading and writing</li> </ul> </li> </ol> |
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### **NCCER Managing Electrical Hazards (26501-15)**

1. Managing electrical hazards (8-12 hrs.)
  - Identify electrical hazard types and locations.
  - Explain related safety guidelines and terms.
  - Recognize and explain hazard boundaries.
  - Explain employer and employee responsibilities in recognizing and managing electrical hazards.
  - Identify common factors that lead to electrical incidents and explain the importance of using good judgement, appropriate procedures, and safe work practices.
  - Analyze the electrical hazards of a given task, plan the job, and complete an electrical work permit request.
  - Select, inspect, and maintain personal protective equipment (PPE) and test equipment used for electrical work.
  - Explain how to create an electrically safe work condition.

### **NCCER Electrical Level 1**

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| <ol style="list-style-type: none"><li>8. Orientation to the Electrical Trade (2.5 Hrs.)<ul style="list-style-type: none"><li>• Overview of the electrical trade</li><li>• Career paths available to electricians.</li></ul></li><li>9. Electrical Safety (10 Hrs.)<ul style="list-style-type: none"><li>• Safety rules and regulations for electricians</li><li>• Precautions for electrical hazards found on the job.</li><li>• OSHA-mandated lockout/tagout procedure.</li></ul></li><li>10. Introduction to Electrical Circuits (7.5 Hrs.)<ul style="list-style-type: none"><li>• Ohm's law applied to DC series circuits.</li><li>• Atomic theory, electromotive force, resistance, and electric power equations.</li></ul></li><li>11. Electrical Theory (7.5 Hrs.)<ul style="list-style-type: none"><li>• Series, parallel, and series parallel circuits.</li><li>• Resistive circuits,</li><li>• Kirchhoff's voltage and current laws</li><li>• Circuit analysis.</li></ul></li><li>12. Introduction to the National Electrical Code® (7.5 Hrs.)<ul style="list-style-type: none"><li>• Road map for using the NEC®.</li><li>• Layout and the types of information found within the code book.</li><li>• Finding information using an easy-to-follow procedure.</li></ul></li><li>13. Device Boxes (10 Hrs.)<ul style="list-style-type: none"><li>• Hardware and systems used by an electrician to mount and support boxes, receptacles, and other electrical components.</li><li>• NEC® fill and pull requirements for device, pull, and junction boxes under 100 cubic inches.</li></ul></li></ol> | <ol style="list-style-type: none"><li>14. Hand Bending (10 Hrs.)<ul style="list-style-type: none"><li>• Conduit bending and installation.</li><li>• Techniques for using hand-operated and step conduit benders,</li><li>• Cutting, reaming, and threading conduit.</li></ul></li><li>15. Raceways and Fittings (20 Hrs.)<ul style="list-style-type: none"><li>• Types and applications of raceways, wireways, and ducts.</li><li>• Applicable NEC® requirements.</li></ul></li><li>16. Conductors and Cables (10 Hrs.)<ul style="list-style-type: none"><li>• Types and applications of conductors</li><li>• Proper wiring techniques.</li><li>• Stresses the applicable NEC® requirements.</li></ul></li><li>17. Basic Electrical Construction Drawings (7.5 Hrs.)<ul style="list-style-type: none"><li>• Electrical prints, drawings, and symbols,</li><li>• Information that can be found on schematics, one-lines, and wiring diagrams.</li></ul></li><li>18. Residential Electrical Services (15 Hrs.)<ul style="list-style-type: none"><li>• Electrical devices and wiring techniques common to residential construction and maintenance.</li><li>• Service calculations.</li><li>• Applicable NEC® requirements.</li></ul></li><li>19. Electrical Test Equipment (5 Hrs.)<ul style="list-style-type: none"><li>• Selection, inspection, and use of common electrical test equipment: voltage testers, clamp-on ammeters, ohmmeters, multimeters, phase/motor rotation testers, and data recording equipment.</li><li>• Safety precautions and meter category ratings.</li></ul></li></ol> |
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### **NCCER Electrical Level 2**

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| <ol style="list-style-type: none"><li>1. Alternating Current (17.5 Hours)<ul style="list-style-type: none"><li>• Forces characteristics of alternating-current systems</li><li>• Application of Ohm's law to AC circuits.</li></ul></li><li>2. Motors: Theory and Application (20 Hours)<ul style="list-style-type: none"><li>○ Covers AC and DC motors, including the main components, circuits, and connections.</li></ul></li><li>3. Electric Lighting (15 Hours)<ul style="list-style-type: none"><li>○ Introduces principles of human vision and the characteristics of light. Focuses on the handling and installation of various types of lamps and lighting fixtures.</li></ul></li><li>4. Conduit Bending (15 Hours)<ul style="list-style-type: none"><li>○ Bends in conduit up to 6 inches.</li><li>○ Mechanical, hydraulic, and electrical benders.</li></ul></li><li>5. Pull and Junction Boxes (12.5 Hours)<ul style="list-style-type: none"><li>○ Selecting and sizing pull boxes, junction boxes, and handholes.</li></ul></li><li>6. Conductor Installations (10 Hours)<ul style="list-style-type: none"><li>○ Transportation, storage, and setup of cable reels;</li><li>○ Procedures for complete cable pulls in raceways and cable trays.</li><li>• Methods of rigging</li></ul></li></ol> | <ol style="list-style-type: none"><li>7. Cable Tray (7.5 Hours)<ul style="list-style-type: none"><li>• Focuses on NEC® installation requirements for cable tray and cable installations.</li></ul></li><li>8. Conductor Terminations and Splices (7.5 Hours)<ul style="list-style-type: none"><li>○ Terminating and splicing conductors,</li><li>○ Preparing and taping conductors.</li></ul></li><li>9. Grounding and Bonding (15 Hours)<ul style="list-style-type: none"><li>○ Grounding and bonding electrical systems.</li><li>○ NEC® requirements.</li></ul></li><li>10. Circuit Breakers and Fuses (12.5 Hours)<ul style="list-style-type: none"><li>○ Practical applications of fuses and circuit breakers.</li><li>○ Fuse and breaker sizing.</li></ul></li><li>11. Control Systems and Fundamental Concepts (12.5 Hours)<ul style="list-style-type: none"><li>○ Descriptions of contactors and relays</li><li>○ Practical application of contactors and relays</li></ul></li></ol> |
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### **NCCER Electrical Level 3**

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| <ol style="list-style-type: none"><li>1. Load Calculations: Branch and Feeder Circuits (17.5 Hours)<ul style="list-style-type: none"><li>○ Calculating branch circuit and feeder loads for residential and commercial applications.</li></ul></li><li>2. Conductor Selection and Calculations (15 Hours)<ul style="list-style-type: none"><li>○ Factors involved in conductor selection, insulation types, current-carrying capacity, temperature ratings, and voltage drop.</li></ul></li><li>3. Practical Applications of Lighting (12.5 Hours)<ul style="list-style-type: none"><li>○ Describes specific types of incandescent, fluorescent, and HID lamps, and ballasts.</li><li>○ Troubleshooting and various types of lighting controls.</li></ul></li><li>4. Hazardous Locations (15 Hours)<ul style="list-style-type: none"><li>○ NEC® requirements for equipment installed in hazardous locations.</li></ul></li><li>5. Overcurrent Protection (25 Hours)<ul style="list-style-type: none"><li>○ Sizing and selecting circuit breakers and fuses for various applications.</li><li>• Short circuit calculations and troubleshooting.</li></ul></li></ol> | <ol style="list-style-type: none"><li>6. Distribution Equipment (12.5 Hours)<ul style="list-style-type: none"><li>○ Overview of switchboards and switchgear,</li><li>○ Grounding and maintenance requirements</li><li>○ Review of drawings.</li></ul></li><li>7. Transformers (12.5 Hours)<ul style="list-style-type: none"><li>○ Covers transformer types, construction, connections, protection, and grounding.</li></ul></li><li>8. Commercial Electrical Services (10 Hours)<ul style="list-style-type: none"><li>○ Covers components, installation, and considerations</li><li>○ NEC® requirements for commercial services.</li></ul></li><li>9. Motor Calculations (12.5 Hours)<ul style="list-style-type: none"><li>○ Covers calculations required to size conductors and overcurrent protection for motor applications.</li></ul></li><li>10. Voice, Data, and Video (10 Hours)<ul style="list-style-type: none"><li>○ Covers installation, termination, and testing of voice, data, and video cabling systems.</li></ul></li><li>11. Motor Controls (12.5 Hours)<ul style="list-style-type: none"><li>○ Selecting, sizing, and installing motor controllers</li><li>• Control circuit pilot devices and basic relay logic.</li></ul></li></ol> |
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### NCCER Electrical Level 4

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| <ol style="list-style-type: none"><li>1. Load Calculations: Feeders and Services (20 Hours)<br/>Basic calculation procedures for commercial and residential applications.</li><li>2. Health Care Facilities (10 Hours)<ul style="list-style-type: none"><li>○ Installation of electric circuits in health care facilities</li><li>○ Requirements for life safety and critical circuits.</li></ul></li><li>3. Standby and Emergency Systems (10 Hours)<ul style="list-style-type: none"><li>○ NEC® requirements for electric generators and storage batteries.</li></ul></li><li>4. Basic Electronic Theory (10 Hours)<ul style="list-style-type: none"><li>○ The function and operation of basic electronic devices, including semiconductors, diodes, rectifiers, and transistors.</li></ul></li><li>5. Fire Alarm Systems (15 Hours)<ul style="list-style-type: none"><li>○ Fire alarm control units</li><li>○ Digital Alarm Communicator Systems</li><li>○ Wiring for alarm initiating and notification devices</li><li>○ Alarm system maintenance</li></ul></li><li>6. Specialty Transformers (10 Hours)<ul style="list-style-type: none"><li>○ Types of transformers and their applications</li><li>○ Selecting, sizing, and installing these devices.</li></ul></li><li>7. Advanced Controls (20 Hours)<ul style="list-style-type: none"><li>○ Applications and operating principles of solid-state controls, reduced-voltage starters, and adjustable frequency drives</li></ul><p>Basic troubleshooting procedures.</p></li></ol> | <ol style="list-style-type: none"><li>8. HVAC Controls (15 Hours)<ul style="list-style-type: none"><li>○ Basic overview of HVAC systems and controls.</li><li>○ Electrical troubleshooting and NEC® requirements.</li></ul></li><li>9. Heat Tracing and Freeze Protection (10 Hours)<ul style="list-style-type: none"><li>○ Heat tracing systems application and installation requirements.</li></ul></li><li>10. Motor Operation and Maintenance (10 Hours)<ul style="list-style-type: none"><li>○ Motor cleaning, testing, and preventive maintenance.</li><li>○ Basic troubleshooting procedures.</li></ul></li><li>11. Medium-Voltage Terminations/Splices (10 Hours)<ul style="list-style-type: none"><li>○ Overview of the NEC® and cable manufacturers' requirements for medium-voltage terminations and splices.</li></ul></li><li>12. Special Locations (20 Hours)<ul style="list-style-type: none"><li>○ NEC® requirements for selecting and installing equipment, enclosures, and devices in special locations including places of assembly, theaters, carnivals, agricultural buildings, marinas, temporary installations, wired partitions, and swimming pools.</li></ul></li><li>13. Fundamentals of Crew Leadership (20 Hours)</li></ol> |
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### NCCER Instrumentation Level 1

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| <ol style="list-style-type: none"><li>1. <b>Orientation to the Trade</b> (2.5 hrs.)<ul style="list-style-type: none"><li>▪ Typical work of instrument fitters and technicians</li><li>▪ Responsibilities and required aptitudes.</li><li>▪ Apprenticeship process and career paths</li></ul></li><li>2. <b>Instrumentation Safety Practices</b> (12.5 hrs.)<ul style="list-style-type: none"><li>▪ Precautions for electrical hazards found on the job.</li><li>▪ OSHA-mandated lockout/tagout procedure.</li><li>▪ Safety practices related to potentially hazardous tools and materials.</li></ul></li><li>3. <b>Hand and Power Tools for Instrumentation</b> (15 hrs.)<ul style="list-style-type: none"><li>▪ Identify, inspect, use, and maintain hand and power tools</li></ul></li><li>4. <b>Craft-Related Mathematics</b> (10 hrs.)<ul style="list-style-type: none"><li>▪ Metric system</li><li>▪ Conversion of English units to metric units.</li><li>▪ Basic algebra, geometric figures, triangle calculations</li></ul></li><li>5. <b>Instrumentation Drawings, Documents - 1</b> (15 hrs.)<ul style="list-style-type: none"><li>• Types of drawings used in instrumentation work</li><li>• Basic instrument symbols, lines, and abbreviations</li></ul></li><li>6. <b>Inspect, Handle, and Store Instrumentation Materials</b> (2.5 hrs.)<ul style="list-style-type: none"><li>• Receiving, inspecting, handling, and storing project-related instrumentation equipment.</li></ul></li><li>7. <b>Electrical Systems for Instrumentation</b> (12.5 hrs.)<ul style="list-style-type: none"><li>• Basic electrical concepts and terms.</li><li>• DC circuit calculations.</li><li>• Electrical measuring instruments and wiring</li></ul></li></ol> | <ol style="list-style-type: none"><li>8. <b>Fasteners</b> (7.5 Hrs.)<ul style="list-style-type: none"><li>• Identify, select, and install threaded and non-threaded fasteners and anchors</li></ul></li><li>9. <b>Gaskets and Packing</b> (7.5 hrs.)<ul style="list-style-type: none"><li>• Recognize, select, and properly install gaskets, packing, and O-rings.</li><li>• Materials used in gaskets and O-rings</li><li>• Applications and limitations.</li></ul></li><li>10. <b>Lubricants, Sealants, and Cleaners</b> (7.5 Hrs.)<ul style="list-style-type: none"><li>• Proper use, storage, handling, and safety practices associated with various lubricants, cutting fluids, sealants, and cleaners.</li><li>• Tools and materials used in applying lubricants and cleaning products.</li></ul></li><li>11. <b>Tubing</b> (15 Hrs.)<ul style="list-style-type: none"><li>• Tubing, tubing materials, fittings, and tools.</li><li>• Storage, handling, cutting, deburring, reaming, bending, and joining of tubing.</li></ul></li><li>12. <b>Steel Piping Practices</b> (10 Hrs.)<ul style="list-style-type: none"><li>• Carbon and stainless steel piping measuring 2" as it applies to instrumentation work.</li><li>• Calculating pipe cut length, cutting, deburring, reaming, and threading pipe.</li></ul></li><li>13. <b>Hoses</b> (7.5 Hrs.)<ul style="list-style-type: none"><li>• Hoses and related fittings</li><li>• Storage and handling.</li><li>• Cutting hoses and installing standard reusable fittings.</li></ul></li></ol> |
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## NCCER Instrumentation Level 2

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| <ol style="list-style-type: none"><li>1. <b>Craft-Related Mathematics</b>(15 hrs.)<ul style="list-style-type: none"><li>• Mass, weight, pressure, temperature, and flow</li><li>• Conversion of units</li><li>• Application to instrumentation.</li></ul></li><li>2. <b>Instrumentation Drawings, Documents - 2</b> (20 hrs.)<ul style="list-style-type: none"><li>• Piping and instrumentation drawings,</li><li>• loop sheets,</li><li>• flow diagrams,</li><li>• isometrics and orthographics.</li></ul></li><li>3. <b>Principles of Welding for Instrumentation</b> (10 hrs.)<ul style="list-style-type: none"><li>• Welding procedure for instrument installation</li><li>• Basic techniques and applications</li><li>• Safety precautions</li><li>• Equipment,</li><li>• Brazing and welding procedures.</li></ul></li><li>4. <b>Process Control Theory</b> (20 hrs.)<ul style="list-style-type: none"><li>• Operation of control systems</li><li>• Common modes of control; advantages and disadvantages.</li><li>• Fundamentals and types of controls,</li><li>• individual components and their roles in typical control loops.</li></ul></li><li>5. <b>Detectors, Secondary Elements, Transducers, and Transmitters</b> (20 hrs.)<ul style="list-style-type: none"><li>• Instrumentation elements; operation principles</li><li>• Variables measured by each element</li><li>• Device selection technical manuals, specification sheets, pictures, or actual samples.</li></ul></li><li>6. <b>Controllers, Recorders, and Indicators</b> (10 hrs.)<ul style="list-style-type: none"><li>• Theory of operation and application</li><li>• Pneumatic and electronic equipment.</li></ul></li><li>7. <b>Control Valves, Actuators, and Positioners</b> (15 hrs.)<ul style="list-style-type: none"><li>• Construction, operation, and use</li><li>• Identification and selection of control valves using applicable specifications and schematics.</li></ul></li></ol> | <ol style="list-style-type: none"><li>8. <b>Relays and Timers</b> (7.5 hrs.)<ul style="list-style-type: none"><li>• Principles of operation, variables measured</li><li>• Selection using specification sheets or samples.</li></ul></li><li>9. <b>Switches and Photoelectric Devices</b> (5 hrs)<ul style="list-style-type: none"><li>• Principles of operation, variables measured</li><li>• Device selection using specification sheets or samples.</li></ul></li><li>10. <b>Filters, Regulators, and Dryers</b> (7.5 hrs.)<ul style="list-style-type: none"><li>• Construction, operation, and uses</li><li>• Selection using applicable specifications and schematics.</li></ul></li><li>11. <b>Analyzers and Monitors</b> (5 Hrs.)<ul style="list-style-type: none"><li>• Instrumentation used to sample, analyze, and/or monitor industrial processes</li><li>• Principles of operation.</li><li>• Selection using technical manuals, specification sheets, pictures, or actual equipment samples.</li></ul></li><li>12. <b>Panel-Mounted Instruments</b> (7.5 hrs.)<ul style="list-style-type: none"><li>• Selection of instruments</li><li>• Locating the instruments using drawings,</li><li>• Procedures for installations</li></ul></li><li>13. <b>Installing Field-Mounted Instruments</b> (25 hrs.)<ul style="list-style-type: none"><li>• Selection and mounting of instruments at locations other than panels, including stand mounting, in-line mounting, structure mounting, strap mounting, and insertion mounting.</li></ul></li><li>14. <b>Raceways for Instrumentation</b> (17.5 hrs.)<ul style="list-style-type: none"><li>• Identification and selection of conduit, raceways, wireways, cable trays, fittings</li><li>• NEC® requirements for installation.</li></ul></li></ol> |
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## NCCER Instrumentation Level 3

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| <ol style="list-style-type: none"><li>1. <b>Control Valves, Actuators, and Positioners</b> (15 hrs.)<ul style="list-style-type: none"><li>• Construction and operation</li><li>• Application and operation of valve positioners.</li><li>• Valve selection criteria; valve and actuator markings and nameplate information.</li></ul></li><li>2. <b>Detectors, Secondary Elements, Transducers, and Transmitters</b> (25 hrs.)<ul style="list-style-type: none"><li>• Detecting different process variables,</li><li>• Converting variables into transmittable form,</li><li>• Transmitting the information to another device for control or informational purposes.</li><li>• Sensing flow, level, temperature, and pressure,</li><li>• Various types of transducers and transmitters.</li></ul></li><li>3. <b>Instrumentation Electrical Circuitry</b> (25 hrs.)<ul style="list-style-type: none"><li>• Series and parallel circuits;</li><li>• resistance, inductance, capacitance in AC circuits;</li><li>• DC power supplies;</li><li>• analog and digital signals;</li><li>• Applications of electrical/electronic circuitry.</li></ul></li></ol> | <ol style="list-style-type: none"><li>4. <b>Relays and Timers</b> (10 Hrs.)<ul style="list-style-type: none"><li>• Principles of operation and applications</li><li>• Selection process.</li></ul></li><li>5. <b>Switches and Photoelectric Devices</b> (10 Hrs.)<ul style="list-style-type: none"><li>• Principles of operation and applications</li></ul></li><li>6. <b>Terminating Conductors</b> (20 Hrs.)<ul style="list-style-type: none"><li>• Methods, procedures, and standards used to terminate and test common types of conductors</li></ul></li><li>7. <b>Grounding, Shielding of Wiring</b> (10 hrs.)<ul style="list-style-type: none"><li>• Grounding, shielding; wire and cable identification.</li><li>• Induced noise and methods to reduce or eliminate</li></ul></li><li>8. <b>Process Control Theory</b> (25 Hrs.)<ul style="list-style-type: none"><li>• Principles and types of control loops</li><li>• ON-OFF and modulating control schemes.</li><li>• Flow, level, temperature, and pressure control loops.</li></ul></li><li>9. <b>Controllers</b> (10 Hrs.)<ul style="list-style-type: none"><li>• Theory of operation and the application</li><li>• Pneumatic and electronic devices.</li></ul></li></ol> |
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### **NCCER Instrumentation Level 4**

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| <ol style="list-style-type: none"><li><b>1. Instrument Calibration and Configuration (60 Hrs.)</b><ul style="list-style-type: none"><li>• Basic concepts of calibration<ul style="list-style-type: none"><li>➢ Three- and five-point methods.</li><li>➢ Pneumatic, analog, and smart instrumentation calibration methods.</li></ul></li><li>• Other devices that require calibration.</li></ul></li><li><b>2. Proving, Commissioning, and Troubleshooting a Loop (17.5 Hrs.)</b><ul style="list-style-type: none"><li>• Three stages in readying a loop for operation: checking, proving, and commissioning.</li><li>• Key ideas and differences behind each step</li><li>• Troubleshooting techniques/methodologies - use during 3 stages of readying a loop.</li></ul></li><li><b>3. Tuning Loops (15 hrs.)</b><ul style="list-style-type: none"><li>• Techniques for PID loops</li><li>• Basic tuning theory and formulas.</li><li>• Open, closed, and visual loop tuning methods.</li></ul></li></ol> | <ol style="list-style-type: none"><li><b>4. Digital Logic Circuits (15 Hrs.)</b><ul style="list-style-type: none"><li>• Gates, combination logic, and truth tables.</li><li>• Memory devices, counters, and arithmetic circuits</li><li>• Numbering systems</li></ul></li><li><b>5. Programmable Logic Controllers (12.5 Hrs.)</b><ul style="list-style-type: none"><li>• PLCs and their uses in industrial control.</li><li>• Hardware components, applications, communications, number systems, and programming methods.</li></ul></li><li><b>6. Distributed Control Systems (15 Hrs.)</b><ul style="list-style-type: none"><li>• Surveys DCS technologies and development.</li><li>• Key components, fieldbuses, servers, and human-machine interfaces.</li><li>• Maintenance and security.</li></ul></li><li><b>7. Analyzers and Monitors (30 Hrs.)</b><ul style="list-style-type: none"><li>• Chemistry application in instrumentation.</li><li>• Physical and chemical properties of matter.</li><li>• Different analytical methods: pH, conductivity, ORP, gas analysis, and particulate counts.</li><li>• Specific instruments and techniques.</li></ul></li></ol> |
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### **NCCER Industrial Maintenance Electrical and Instrumentation Level 1**

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| <ol style="list-style-type: none"><li><b>1. 32101-07 Orientation to the Trade (2.5 Hours)</b><ul style="list-style-type: none"><li>• History of the trade</li><li>• Kinds of work and work environments</li><li>• Apprenticeship and training programs</li><li>• Career opportunities</li><li>• Responsibilities and characteristics a worker should possess.</li></ul></li><li><b>2. 32102-07 Tools of the Trade (5 Hours)</b><ul style="list-style-type: none"><li>• Introduction to hand and power tools</li><li>• Safety procedures and techniques</li></ul></li><li><b>3. 32103-07 Fasteners and Anchors (5 Hours)</b><ul style="list-style-type: none"><li>• Hardware and systems used.</li><li>• Types of anchors, supports, applications, installation.</li></ul></li><li><b>4. 32104-07 Oxyfuel Cutting (17.5 Hours)</b><ul style="list-style-type: none"><li>• Safety requirements for oxyfuel cutting.</li><li>• Identifies oxyfuel cutting equipment - setting up, lighting, and using the equipment.</li><li>• Includes straight line cutting, piercing, beveling, washing, and gouging.</li></ul></li><li><b>5. 32105-07 Gaskets and Packing (10 Hours)</b><ul style="list-style-type: none"><li>• Gaskets and gasket material,</li><li>• Packing and packing material</li><li>• O-ring material.</li><li>• Use and fabrication of a gasket.</li></ul></li><li><b>6. 32106-07 Craft-Related Mathematics (15 Hours)</b><ul style="list-style-type: none"><li>○ Using ratios and proportions, basic algebra, area, volume, and circumference, and right triangles using the Pythagorean theorem.</li></ul></li></ol> | <ol style="list-style-type: none"><li><b>7. 32107-07 Construction Drawings (12.5 Hours)</b><ul style="list-style-type: none"><li>• Plot plans, structural drawings, elevation drawings, as-built drawings, equipment arrangement drawings, P&amp;IDs, isometric drawings, basic circuit diagrams, and detail sheets.</li></ul></li><li><b>8. 32108-07 Pumps and Drivers (5 Hours)</b><ul style="list-style-type: none"><li>• Centrifugal, rotary, reciprocating, metering, and vacuum pump operation</li><li>• Installation methods and types of drivers.</li><li>• Net positive suction head and cavitation.</li></ul></li><li><b>9. 32109-07 Valves (5 Hours)</b><ul style="list-style-type: none"><li>• Installation methods for different types of valves.</li><li>• Valve storage and handling.</li></ul></li><li><b>10. 32110-07 Introduction to Test Instruments (7.5 hrs.)</b><ul style="list-style-type: none"><li>• tachometers, pyrometers, strobe meters, voltage testers, and automated diagnostic tools.</li></ul></li><li><b>11. 32111-07 Material Handling and Hand Rigging (15 Hours)</b><ul style="list-style-type: none"><li>• Equipment and techniques</li><li>• Procedures and communicating with riggers.</li></ul></li><li><b>12. 32112-07 Mobile and Support Equipment (10 Hours)</b><ul style="list-style-type: none"><li>• Safe operational procedures for motorized support equipment, forklifts, manlifts, compressors, and generators.</li></ul></li><li><b>13. 32113-07 Lubrication (12.5 Hours)</b><ul style="list-style-type: none"><li>• Lubrication safety, storage, and classifications.</li><li>• Selecting lubricants, additives, lubrication equipment, and lubricating charts.</li></ul></li></ol> |
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## **NCCER Industrial Maintenance Electrical and Instrumentation Level 2**

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| <ol style="list-style-type: none"><li>1. <b>40201-08 Industrial Safety for E&amp;I Technicians (12.5 hrs.)</b><ul style="list-style-type: none"><li>• Safety regulations for electrical workers</li><li>• OSHA-mandated lockout/tagout procedure.</li></ul></li><li>2. <b>40202-08 Introduction to the National Electrical Code (5 Hours)</b><ul style="list-style-type: none"><li>• Use and layout of the NEC®</li><li>• Trainees to practice finding information</li></ul></li><li>3. <b>40203-08 Electrical Theory (15 Hours)</b><ul style="list-style-type: none"><li>• Ohm's law as applied to DC series circuits.</li><li>• Atomic theory, electromotive force, resistance, and electric power equations.</li><li>• Series, parallel, and series-parallel circuits.</li><li>• Resistive circuits, Kirchoff's voltage and current laws, and circuit analysis.</li></ul></li><li>4. <b>40204-08 Alternating Current (20 Hours)</b><ul style="list-style-type: none"><li>• Transformers, single-phase and three-phase power distribution, capacitors</li><li>• Theory and operation of induction motors</li><li>• Instruments and techniques used in testing AC circuits and components.</li></ul></li><li>5. <b>40205-08 E &amp; I Test Equipment (10 Hours)</b><ul style="list-style-type: none"><li>• Proper selection, inspection, and use of common electrical and instrumentation test equipment</li><li>• Voltage testers, clamp-on ammeters, ohmmeters, multimeters, phase/motor rotation testers, data recording equipment, field communicators, pressure testers, and dead weight tester</li><li>• Safety precautions and meter category ratings.</li></ul></li><li>6. <b>40206-08 Flow, Pressure, Level, Temperature (15 hrs.)</b><ul style="list-style-type: none"><li>• Measuring flow, pressure, level, and temperature</li><li>• Principles of operation.</li></ul></li></ol> | <ol style="list-style-type: none"><li>7. <b>40207-08 Process Mathematics (15 Hours)</b><ul style="list-style-type: none"><li>• Mass, weight, and flow, unit conversions.</li></ul></li><li>8. <b>40208-08 Hand Bending (10 Hours)</b><ul style="list-style-type: none"><li>• Conduit bending and installation</li><li>• Techniques for using hand-operated and step conduit benders, as well as cutting, reaming, and threading conduit.</li></ul></li><li>9. <b>40209-08 Tubing (15 Hours)</b><ul style="list-style-type: none"><li>• Tubing, tubing materials, tools, and work practices.</li><li>• Proper storage and handling, cutting, deburring, reaming, bending, and flaring of tubing.</li></ul></li><li>10. <b>40210-08 Clean, Purge, and Test Tubing and Piping Systems (7.5 Hours)</b><ul style="list-style-type: none"><li>• Cleaning, purging, blowing down, pressure testing, and leak testing tubing, piping, and hoses used in instrumentation.</li></ul></li><li>11. <b>40211-08 Instrument Drawings and Documents, Part 1 (15 Hours)</b><ul style="list-style-type: none"><li>• Instrument symbols, abbreviations</li><li>• Types of drawings and documents: indexes, installation detail drawings, location drawings, and control loops.</li></ul></li><li>12. <b>40212-08 Conductors and Cables (10 Hours)</b><ul style="list-style-type: none"><li>• Types/applications of conductors/electrical cabling.</li><li>• Proper wiring techniques.</li><li>• Applicable NEC® requirements.</li></ul></li><li>13. <b>40213-08 Conductor Terminations and Splices (10 Hours)</b><ul style="list-style-type: none"><li>• Describes methods of terminating and splicing conductors of all types and sizes, including preparing and taping conductors.</li></ul></li></ol> |
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## **NCCER Industrial Maintenance Electrical and Instrumentation Level 3**

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| <ol style="list-style-type: none"><li>1. <b>40301-09 Hazardous Locations (10 Hours)</b><ul style="list-style-type: none"><li>• Classes of hazardous locations,</li><li>• Seals, components, and equipment</li></ul></li><li>2. <b>40302-09 Electronic Components (10 Hours)</b><ul style="list-style-type: none"><li>• Theory, components, and applications.</li></ul></li><li>3. <b>40303-09 E &amp; I Drawings (10 Hours)</b><ul style="list-style-type: none"><li>• Reading and interpretation of piping and instrumentation drawings, loop sheets, flow diagrams, isometrics, and orthographics</li><li>• Instrumentation types and specifications</li></ul></li><li>4. <b>40304-09 Motor Controls (15 Hours)</b><ul style="list-style-type: none"><li>• Selecting, sizing, and installing motor controllers.</li><li>• Control circuit pilot devices and basic relay logic.</li></ul></li><li>5. <b>40305-09 Distribution Equipment (17.5 Hours)</b><ul style="list-style-type: none"><li>• Distribution equipment</li><li>• Grounding, switchboard, ground fault maintenance, transformers, and electrical drawing identification.</li></ul></li><li>6. <b>40306-09 Transformer Applications (7.5 Hours)</b><ul style="list-style-type: none"><li>• Transformer types, capacitors, and rectifiers.</li><li>• Construction, connections, protection, grounding</li></ul></li><li>7. <b>40307-09 Conductor Selection, Calculation (15 hrs.)</b><ul style="list-style-type: none"><li>• Types of conductors in wiring systems</li><li>• Insulation, current-carrying capacity, and temperature ratings.</li></ul></li></ol> | <ol style="list-style-type: none"><li>8. <b>40308-09 Temporary Grounding (15 Hours)</b><ul style="list-style-type: none"><li>• How to eliminate/reduce electrical shock hazards</li></ul></li><li>9. <b>40309-09 Layout and Installation of Tubing and Piping Systems (22.5 Hours)</b><ul style="list-style-type: none"><li>• Introduces piping and tubing layout procedures.</li><li>• Creating a hand-sketched isometric drawing</li><li>• Introduces methods and procedures used to measure, cut, bend, and support piping and tubing.</li></ul></li><li>10. <b>40310-09 Machine Bending of Conduit (15 Hours)</b><ul style="list-style-type: none"><li>• Types of bends in conduit up to six inches.</li><li>• Mechanical, hydraulic, and electrical benders.</li></ul></li><li>11. <b>40311-09 Hydraulic Controls (15 Hours)</b><ul style="list-style-type: none"><li>• Hydraulic principles and fluids, system devices functions/controls, hydraulic symbols, drawings.</li><li>• Safety considerations, troubleshooting.</li></ul></li><li>12. <b>40312-09 Pneumatic Controls (15 Hours)</b><ul style="list-style-type: none"><li>• Principles of atmospheric and compressed air gases</li><li>• How compressors transmit/treat compressed air.</li><li>• Symbols, drawings, system safety.</li><li>• Functions and control of components</li><li>• Guidelines for troubleshooting.</li></ul></li><li>13. <b>40313-09 Motor-Operated Valves (15 Hours)</b><ul style="list-style-type: none"><li>• Small, servo-mechanical actuators to large valves.</li><li>• Electrical, pneumatic, and hydraulic operators.</li></ul></li></ol> |
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### **NCCER Industrial Maintenance Electrical and Instrumentation Level 4**

<p><b>1. 40401-09 Standby/Emergency Systems (12.5 Hours)</b></p> <ul style="list-style-type: none"><li>• NEC® requirements for installation and control of emergency power and lighting systems</li><li>• Batteries, generators, and uninterruptible power supplies.</li></ul> <p><b>2. 40402-09 Instrument Calibration and Configuration (10 Hours)</b></p> <ul style="list-style-type: none"><li>• Instrumentation calibration, including the three- and five-point methods.</li><li>• Components requiring calibration in pneumatic, analog, and smart loops.</li><li>• Methods to calibrate these components.</li></ul> <p><b>3. 40403-09 Basic Process, Control Elements, Transducers, and Transmitters (15 Hours)</b></p> <ul style="list-style-type: none"><li>• Elements and principles of operation.</li><li>• Variables measured by each element</li><li>• Selection of the proper devices in a loop</li><li>• Using the device's technical manuals, specification sheets, pictures, or actual samples.</li></ul> <p><b>4. 40404-09 Control Valves, Actuators, and Positioners (40 Hours)</b></p> <ul style="list-style-type: none"><li>• Construction, operation, and uses of control valves, actuators, and positioners.</li><li>• Identification, selection, and maintenance of control valves using applicable specifications and schematics.</li></ul> <p><b>5. 40405-09 Performing Loop Checks (7.5 Hours)</b></p> <ul style="list-style-type: none"><li>• Loop check steps.</li><li>• Verifying mechanical installation</li><li>• Validating that the loop has correct tag numbers, performing loop checks, and finally proving the loop.</li></ul>	<p><b>6. 40406-09 Troubleshooting and Commissioning a Loop (10 Hours)</b></p> <ul style="list-style-type: none"><li>• Methodical troubleshooting techniques used to locate problems in control loops.</li><li>• Isolating a loop to troubleshoot it.</li><li>• Commissioning of a loop once it is repaired, loop checked, and calibrated.</li></ul> <p><b>7. 40407-09 Process Control Loops and Tuning (20 Hours)</b></p> <ul style="list-style-type: none"><li>• Formulas and applications to PID control.</li><li>• Theory-based approach to PID control and its application in industrial process control.</li><li>• Open, closed, and visual loop tuning.</li></ul> <p><b>8. 40408-09 Data Networks (10 Hours)</b></p> <ul style="list-style-type: none"><li>• Types of cables and cable terminations used with computer networks.</li><li>• Types of networks used in data systems and how information is exchanged over data networks.</li></ul> <p><b>9. 40409-09 Programmable Logic Controllers (10 Hours)</b></p> <ul style="list-style-type: none"><li>• The application of PLCs in industrial process control.</li><li>• Binary numbering system used in computer-based control.</li><li>• Components of PLCs, including power supplies, I/O modules, processor modules, types of communication bus, and memory.</li></ul> <p><b>10. 40410-09 Distributed Control Systems (10 Hours)</b></p> <ul style="list-style-type: none"><li>• The development of DCS by combining the technologies of single loop control, direct digital control, and supervisory control.</li><li>• DCS basic hardware requirements, how control loops are implemented into a DCS.</li><li>• Types of data transmission used in DCS, communication protocols, and human interfaces.</li></ul>
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### **NCCER Millwright Level 1**

<p><b>1. Orientation to the Trade (15101 - 5 Hours)</b></p> <ul style="list-style-type: none"><li>• History of the trade</li><li>• Career paths</li><li>• Characteristic environments and types of work.</li></ul> <p><b>2. Millwright Hand Tools (15102 -15 Hours)</b></p> <ul style="list-style-type: none"><li>• Introduces various hand tools</li><li>• Explains basic safety</li><li>• Methods for selecting, inspecting, using, and maintaining these tools.</li></ul> <p><b>3. 15103-06 Fasteners and Anchors (10 Hours)</b></p> <ul style="list-style-type: none"><li>• Identify types</li><li>• applications and installation procedures.</li></ul>	<p><b>4. 15104-06 Basic Layout (20 Hours)</b></p> <ul style="list-style-type: none"><li>• Tools used in layout.</li><li>• How to lay out baselines (arc and 3-4-5 methods).</li></ul> <p><b>5. 15105-06 Gaskets and O-Rings (10 Hours)</b></p> <ul style="list-style-type: none"><li>• Types and applications.</li><li>• Laying out, cutting, and installing</li></ul> <p><b>6. 15106-06 Oxyfuel Cutting (15 Hours)</b></p> <ul style="list-style-type: none"><li>• Safety requirements</li><li>• Identify equipment</li><li>• Instructions for setting up, lighting, and using</li><li>• Straight line cutting, piercing, beveling, washing, and gouging.</li></ul>
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### NCCER Millwright Level 2

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| <ol style="list-style-type: none"><li>1. <b>Intermediate Trade Math (15201 - 20 Hours)</b><ul style="list-style-type: none"><li>• Ratios and proportions.</li><li>• Basic algebra, area, volume, circumference, and circular speed problems.</li><li>• Use a scientific calculator.</li></ul></li><li>2. <b>Field Sketching (15202 - 10 Hours)</b><ul style="list-style-type: none"><li>• Creating field sketches to indicate how parts should be made or assembled.</li></ul></li><li>3. <b>Intermediate Blueprint Reading (15203 - 20 Hours)</b><ul style="list-style-type: none"><li>• Orthographic projection, isometric, and schematic drawings used to show piping, hydraulic, and pneumatic systems.</li></ul></li><li>4. <b>Specialty Tools (15204 - 10 Hours)</b><ul style="list-style-type: none"><li>• Select, inspect, use, and maintain torque multipliers, cable cutters, nut splitters, key-seat gauges, and hardness testers.</li></ul></li><li>5. <b>Millwright Power Tools (15205 - 20 Hours)</b><ul style="list-style-type: none"><li>• Introduces power tools</li><li>• Selecting, using, and maintaining</li></ul></li></ol> | <ol style="list-style-type: none"><li>6. <b>Rigging (15206 - 20 Hours)</b><ul style="list-style-type: none"><li>• Identify, select, and inspect rigging hardware.</li><li>• Lifting capacity charts, load balancing, and pick points.</li></ul></li><li>7. <b>Setting Baseplates and Soleplates (15207 - 15 Hours)</b><ul style="list-style-type: none"><li>• How to lay out and install baseplates and soleplates.</li><li>• How to field-verify a plate installation.</li></ul></li><li>8. <b>Lubrication (15208 - 20 Hours)</b><ul style="list-style-type: none"><li>• Safety, storage, and classifications.</li><li>• Lubricant and additive selection, lubrication equipment, and lubricating charts.</li></ul></li><li>9. <b>Introduction to Bearings (15209 - 15 Hours)</b><ul style="list-style-type: none"><li>• Types: plain, ball, roller, thrust, guide, flanged, pillow block, and take-up</li><li>• Materials and designations.</li></ul></li></ol> |
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### NCCER Millwright Level 3

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| <ol style="list-style-type: none"><li>1. <b>Advanced Trade Math (15301 - 20 Hours)</b><ul style="list-style-type: none"><li>• Right triangle trigonometry and its use.</li><li>• Interpolation,</li><li>• Equilateral, isosceles, and acute triangles.</li></ul></li><li>2. <b>Precision Measuring Tools (15302 - 20 Hours)</b><ul style="list-style-type: none"><li>• Select, inspect, use, care for levels, calipers, micrometers, height gauges and surface plates, dial indicators, protractors, parallels and gauge blocks, trammels, and pyrometers.</li></ul></li><li>3. <b>Installing Packing (15303 - 10 Hours)</b><ul style="list-style-type: none"><li>• Types of packing and packing materials found in a typical stuffing box.</li><li>• Remove and install packing (compression lip-type)</li></ul></li><li>4. <b>Installing Seals (15304 - 5 Hours)</b><ul style="list-style-type: none"><li>• Applications, removal, and installation procedures for dynamic and static seals, and lip, cup, oil, and labyrinth seals.</li></ul></li><li>5. <b>Installing Mechanical Seals (15305 - 20 Hours)</b><ul style="list-style-type: none"><li>• Function and advantages</li><li>• Parts and types</li><li>• Procedures for removing, inspecting, and installing</li><li>• Install axial-flow fans, centrifugal fans, and roots-type and screw-type blowers.</li></ul></li><li>6. <b>Removing and Installing Bearings (15306 - 20 Hours)</b><ul style="list-style-type: none"><li>• Remove, troubleshoot, and install tapered, thrust, spherical roller, pillow block, and angular contact ball bearings.</li></ul></li></ol> | <ol style="list-style-type: none"><li>7. <b>Couplings (15307 - 15 Hours)</b><ul style="list-style-type: none"><li>• Types of couplings</li><li>• Installation (press-fit, interference-fit methods)</li><li>• Removal procedures.</li></ul></li><li>8. <b>Fabricating Shims (15308 - 5 Hours)</b><ul style="list-style-type: none"><li>• Types of shim stock and materials</li><li>• Fabricating shims.</li></ul></li><li>9. <b>Alignment Fixtures and Specialty Jigs (15309 -10 hrs.)</b><ul style="list-style-type: none"><li>• Applications and fabrication procedures</li><li>• Angle iron, chain, complex reverse-indicator, Christmas tree, and piano wire jigs.</li></ul></li><li>10. <b>Pre-alignment for Equipment Installation (15310 -15 Hours)</b><ul style="list-style-type: none"><li>• How to level equipment using jack bolts, wedges, and shims.</li><li>• Precision leveling procedures</li><li>• Performing clearance installation.</li><li>• Setting motors and pumps.</li></ul></li><li>11. <b>Installing Belt and Chain Drives (15311 - 10 Hours)</b><ul style="list-style-type: none"><li>• Sizes, uses, and installation procedures</li><li>• Six types of drive belts</li><li>• Two types of chain drives.</li></ul></li><li>12. <b>Installing Fans and Blowers (15312 - 10 Hours)</b></li></ol> |
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### NCCER Millwright Level 4

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| <ol style="list-style-type: none"><li>1. <b>Conveyors (15401 – 5 hrs.)</b><ul style="list-style-type: none"><li>• Types and principles of operation.</li></ul></li><li>2. <b>Troubleshooting, Repairing Conveyors (15402 - 12.5 hrs.)</b><ul style="list-style-type: none"><li>• Maintaining and repairing belt, roller, chain, screw, and pneumatic conveyors.</li></ul></li><li>3. <b>Conventional Alignment (15403 - 30 Hours)</b><ul style="list-style-type: none"><li>• Aligning shafts (first with straight edge and feeler gauges, then with dial indicators.)</li></ul></li><li>4. <b>Pumps (15404 - 20 Hours)</b><ul style="list-style-type: none"><li>• Common types and principles of operation</li><li>• Centrifugal, rotary, reciprocating, metering pumps.</li><li>• Net positive suction head and cavitation.</li></ul></li><li>5. <b>Troubleshooting, Repairing Pumps (15405 - 7.5 hrs.)</b><ul style="list-style-type: none"><li>• Inspecting, troubleshooting, assembling, disassembling</li><li>• Installing and preparing for start-up.</li><li>• Shutdown, repair, and removal</li></ul></li><li>6. <b>Compressors and Maintenance (15406 - 20 Hours)</b><ul style="list-style-type: none"><li>• Types and principles of maintenance</li><li>• Troubleshooting and maintenance procedures</li><li>•</li></ul></li></ol> | <ol style="list-style-type: none"><li>7. <b>Basic Pneumatic Systems (15407 - 7.5 Hours)</b><ul style="list-style-type: none"><li>• Components and compressed-air treatment.</li><li>• Auxiliary and special application equipment</li></ul></li><li>8. <b>Troubleshooting, Repairing Pneumatic Equipment (15408 - 10 Hours)</b><ul style="list-style-type: none"><li>• Repair and maintenance of components</li><li>• Troubleshooting process and methods, including pressure sensors and flow sensors.</li></ul></li><li>9. <b>Basic Hydraulic Systems (15409 - 10 Hours)</b><ul style="list-style-type: none"><li>• Principles and types</li><li>• Safety procedures</li><li>• Application of hydraulic equipment.</li></ul></li><li>10. <b>Troubleshooting, Repairing Hydraulic Equipment (15410 - 7.5 Hours)</b><ul style="list-style-type: none"><li>• Inspecting, diagnosing problems, and repairing</li><li>• How to read hydraulic schematic symbols.</li></ul></li><li>11. <b>Troubleshooting, Repairing Gearboxes (15411 - 20 Hours)</b><ul style="list-style-type: none"><li>• Types, operation, and diagnostics.</li><li>• How to troubleshoot, remove, and disassemble</li><li>• Identify gear wear patterns</li><li>• Install and maintain gearboxes.</li></ul></li></ol> |
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### NCCER Millwright Level 5

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| <ol style="list-style-type: none"><li>1. <b>Performing Reverse Alignment (15501 - 30 Hours)</b><ul style="list-style-type: none"><li>• Reading plant or foundation layouts</li><li>• assembly and preparation for dial indicator reverse alignment</li><li>• Set up procedures for reverse alignment jigs.</li><li>• Graphic and mathematical techniques for aligning equipment, based on reverse dial indicator measurements.</li></ul></li><li>2. <b>Performing Laser Alignment (15502 - 25 Hours)</b><ul style="list-style-type: none"><li>• Use and principles.</li></ul></li><li>3. <b>Advanced Blueprint Reading (15503 - 25 Hours)</b><ul style="list-style-type: none"><li>• Use of drawing sets to obtain information</li><li>• Identifying a machine part from drawings.</li></ul></li><li>4. <b>Performing Optical Alignment (15504 - 25 Hours)</b><ul style="list-style-type: none"><li>• How to use theodolites, optical levels, auto levels, and total stations.</li></ul></li><li>5. <b>Turbines (15505 - 10 Hours)</b><ul style="list-style-type: none"><li>• Types and components</li><li>• Basic operation</li><li>• Applications (gas, steams, and water).</li></ul></li></ol> | <ol style="list-style-type: none"><li>6. <b>Maintaining and Repairing Turbine Equipment (15 Hours)</b><ul style="list-style-type: none"><li>• Describes the process of inspecting and repairing key components of turbines. Explains the guidelines for maintaining large steam turbines.</li></ul></li><li>7. <b>Installing Electric Motors (15507 - 15 Hours)</b><ul style="list-style-type: none"><li>• Describes the types of electric motors. Explains the installation of motors.</li></ul></li><li>8. <b>Preventive/Predictive Maintenance (15508 - 10 hrs.)</b><ul style="list-style-type: none"><li>• Overview of PPM</li><li>• Nondestructive testing techniques</li><li>• Lubricant analysis</li><li>• Acoustic, infrared, and vibration testing.</li></ul></li><li>9. <b>Vibration Analysis (15509 -10 Hours)</b><ul style="list-style-type: none"><li>• Causes of vibration</li><li>• Procedures and equipment for vibration analysis.</li><li>• Equipment for vibration testing and monitoring.</li><li>• Field machine balancing.</li></ul></li></ol> |
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### NCCER Pipefitting Level 1

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| <ol style="list-style-type: none"><li><b>Orientation to the Pipefitting Craft (08101 – 5 hrs.)</b><ul style="list-style-type: none"><li>Describe the types of work performed by pipefitters</li><li>Identify career opportunities</li><li>Explain purpose and objectives of an apprentice training program</li><li>Explain the responsibilities and characteristics of a good pipefitter</li><li>Explain the importance of safety</li></ul></li><li><b>Pipefitting Hand Tools (08102 - 20 hours)</b><ul style="list-style-type: none"><li>Describe safety requirements</li><li>Explain how to properly care for hand tools</li><li>Demonstrate how to safely/properly use hand tools</li><li>Identify tools and state their use</li><li>Use selected hand tools.</li></ul></li><li><b>Pipefitting Power Tools (08102 -15 hours)</b><ul style="list-style-type: none"><li>Identify safety procedures for power tools</li><li>Cut pipe using a portable band saw</li><li>Identify and explain the uses of portable grinders</li><li>Explain the proper use/operation of machines used in pipe joint preparations (pipe threaders, portable power drives, pipe bevelers)</li><li>Perform selected pipe joint preparations operations using power tools</li></ul></li></ol> | <ol style="list-style-type: none"><li><b>Oxyfuel Cutting (29102 - 17.5 hours)</b><ul style="list-style-type: none"><li>Identify use and set up</li><li>Light and adjust an oxyfuel torch</li><li>Shut down oxyfuel cutting equipment</li><li>Disassemble oxyfuel equipment</li><li>Charge empty cylinders</li><li>Perform oxyfuel cutting (straight line, square shapes, piercing, slot cutting, bevels, washing)</li><li>Operate a motorized, portable oxyfuel gas cutting machine</li></ul></li><li><b>Ladders and Scaffolds (08105 - 12.5 hours)</b><ul style="list-style-type: none"><li>Identify different types</li><li>Describe safe use</li><li>Properly set up, inspect, and use</li></ul></li><li><b>Motorized Equipment (08106 - 10 hours)</b><ul style="list-style-type: none"><li>Safety precautions</li><li>Identify and explain operation/use of:<ul style="list-style-type: none"><li>Welding machines, portable generators, air compressors, portable pumps, aerial lifts, forklifts, compaction equipment, trenching equipment, backhoe loaders, mobile cranes</li></ul></li><li>Perform prestart checks and operation on:<ul style="list-style-type: none"><li>Portable generators, welding machines, portable pumps, air compressors</li></ul></li></ul></li></ol> |
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### NCCER Pipefitting Level 2

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| <ol style="list-style-type: none"><li><b>Piping Systems (08201 – 5 hrs.)</b><ul style="list-style-type: none"><li>Identify/explain types of piping systems</li><li>Identify piping systems according to color-coding.</li><li>Explain the effects and corrective measures for thermal expansion in piping systems.</li><li>Explain types and applications of pipe insulation</li></ul></li><li><b>Drawings and Details Sheets (08202 – 15 hrs.)</b><ul style="list-style-type: none"><li>Identify types and parts of drawings</li><li>Make field sketches</li><li>Interpret drawing indexes and line lists</li></ul></li><li><b>Identifying and Installing Valves (08203 – 20 hrs.)</b><ul style="list-style-type: none"><li>Types: start/stop flow, regulate flow, relieve pressure, regulate flow direction,</li><li>Types of valve actuators</li><li>How to properly store and handle valves</li><li>Valve locations and positions</li><li>Factors that influence valve selection</li><li>Valve markings and nameplate identification</li></ul></li><li><b>Pipefitting Trade Math (08204– 15 hrs.)</b><ul style="list-style-type: none"><li>Architect and engineer scale</li><li>Tables of weights and measurements</li><li>Formulas to solve basic problems</li><li>Area, volume, and circumference problems</li><li>Solve right triangles using Pythagorean theorem</li></ul></li><li><b>Threaded Pipe Fabrication (08205 – 15 hrs.)</b><ul style="list-style-type: none"><li>Materials, fittings</li><li>Read/interpret screwed fitting joint drawings</li><li>Identify/explain types of threads</li><li>Determine pipe lengths between joints, offsets</li><li>Thread and assemble piping and valves</li></ul></li></ol> | <ol style="list-style-type: none"><li><b>Socket Weld Pipe Fabrication (08206 – 25 hrs.)</b><ul style="list-style-type: none"><li>Identify materials and fittings</li><li>Read/interpret drawings</li><li>Determine pipe lengths between fittings</li><li>Fabricate socket weld fittings to pipe</li></ul></li><li><b>Butt Weld Pipe Fabrication (08207 – 37.5 hrs.)</b><ul style="list-style-type: none"><li>Identify materials and fittings</li><li>Read/interpret drawings</li><li>Prepare pipe lengths between fittings</li><li>Select/install backing rings</li><li>Perform alignment procedures for various fittings</li></ul></li><li><b>Excavations (08208 – 10 hrs.)</b><ul style="list-style-type: none"><li>Shoring materials</li><li>Premanufactured support systems</li><li>Install a vertical shore to be used for shoring</li><li>Determine the overall fall of a sewer line</li><li>Determine, set the grade/elevation of a trench</li><li>Explain backfilling procedures</li></ul></li><li><b>Underground Pipe Installation (08209 – 20 hrs.)</b><ul style="list-style-type: none"><li>Identify materials, size classifications</li><li>Fittings and joining methods</li><li>Explain storage and handling methods</li><li>Identify/explain installation guidelines</li><li>Join CPVC, PVC, ductile iron</li></ul></li></ol> |
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## NCCER Pipefitting Level 3

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| <p>1. <b>Rigging Equipment (08301 – 10 hrs.)</b></p> <ul style="list-style-type: none"><li>• Hardware and equipment</li><li>• Perform a safety inspection on hooks, slings, and other equipment</li><li>• Common slings, sling capacities, and angles</li><li>• Select, inspect, use, and maintain special equipment including: (simple block and tackle, chain hoists, come-alongs, jacks, tuggers)</li><li>• Inspect heavy rigging hardware</li><li>• Tie knots used in rigging</li></ul> <p>2. <b>Rigging Practices (08302 – 10 hrs.)</b></p> <ul style="list-style-type: none"><li>• Hand signals to guide a crane operator</li><li>• Basic rigging and crane safety procedures and determine the center of gravity of a load</li><li>• Identify crane pinch points and how to avoid them</li><li>• Identify site and environmental hazards</li><li>• Properly attach rigging hardware for routine lifts and pipe lifts</li><li>• Identify the components of a lift plan</li></ul> <p>3. <b>Standards and Specifications (08303 – 7.5 hrs.)</b></p> <ul style="list-style-type: none"><li>• Understand/interpret standards and codes</li><li>• Read/interpret specifications</li><li>• Identify pipe and components per specifications</li></ul> <p>4. <b>Advanced Trade Math (08304 – 20 hrs.)</b></p> <ul style="list-style-type: none"><li>• Use table of equivalents</li><li>• Perform right angle trigonometry</li><li>• Calculate takeouts using trigonometry</li></ul> <p>5. <b>Motorized Equipment II (08305 – 20 hrs.)</b></p> <ul style="list-style-type: none"><li>• Identify/explain types of manlifts</li><li>• Explain manlift safety rules and hazards</li><li>• Inspect scissors-type and telescoping boom manlifts</li><li>• Explain the use of cable lifts</li><li>• Identify/use hydraulic torque wrenches</li><li>• Identify and explain the use of drain cleaners</li></ul> | <p>6. <b>Intro. to Aboveground Pipe Installation (08306–20 hrs.)</b></p> <ul style="list-style-type: none"><li>• Store pipe and materials</li><li>• Identify types of flanges</li><li>• Identify types of gaskets used with flanges</li><li>• Lay out and cut gaskets</li><li>• Explain the location of flange bolt holes</li><li>• Install pipe with flanged connections</li><li>• Lay out/install pipe sleeves and floor penetrations</li><li>• Read and interpret spool sheets</li><li>• Explain how to erect spools in a piping system.</li></ul> <p>7. <b>Field Routing and Vessel Trim (08307 – 10 hrs.)</b></p> <ul style="list-style-type: none"><li>• Secure the work area</li><li>• Determine field run specifications</li><li>• Determine the required rigging equipment based on weight, location, and configuration</li><li>• Determine the load weight for erection equipment</li><li>• Determine the support needs</li><li>• Select and install erection materials</li><li>• Fabricate the field run of piping</li><li>• Erect vessel trim</li></ul> <p>8. <b>Pipe Hangars and Support (08308 – 25 hrs.)</b></p> <ul style="list-style-type: none"><li>• Identify types of hangars and supports</li><li>• Identify/interpret pipe support drawings/symbols</li><li>• Determine field placement of hangars</li><li>• Identify/install concrete fasteners</li><li>• Fabricate angle iron brackets to support pipe</li><li>• Spring can supports:<ul style="list-style-type: none"><li>➤ types (including variable and constant)</li><li>➤ storing/handling procedures</li><li>➤ how to install and maintain</li></ul></li></ul> <p>9. <b>Testing Piping Systems, Equipment (08309 – 20 hrs.)</b></p> <ul style="list-style-type: none"><li>• Perform pretest requirements</li><li>• Perform service and flows tests</li><li>• Perform head pressure tests</li><li>• Perform hydrostatic tests</li><li>• Explain how to perform steam blow tests</li><li>• Explain nondestructive examinations (NDE)</li></ul> |
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### NCCER Pipefitting Level 4

<p><b>1. Advanced Blueprint Reading (08401 – 50 hrs.)</b></p> <ul style="list-style-type: none"> <li>• Identify symbols/abbreviations on P&amp;IDs</li> <li>• Identify piping arrangement drawings</li> <li>• Read/interpret GPS coordinates, control points, and elevation</li> <li>• Read/interpret P&amp;IDs, plan views, and section views</li> <li>• Identify isometric drawings</li> <li>• Read isometrics drawings taken from plan views</li> <li>• Draw isometric drawings</li> <li>• Read/interpret spool drawings from isometrics</li> </ul> <p><b>2. Advanced Pipe Fabrication (08402 – 50 hrs.)</b></p> <ul style="list-style-type: none"> <li>• Calculate simple piping offsets</li> <li>• Calculate three-line, 45°, offsets around a vessel (equal and unequal spread)</li> <li>• Fabricate tank heating coils</li> <li>• Perform mitering procedures</li> <li>• Lay out three- and four-piece mitered turns.</li> <li>• Lay out 45° laterals using references or a calculator</li> <li>• Fabricate dummy legs and trunions using references</li> <li>• Perform geometric layout of pipe laterals/supports</li> <li>• Lay out and fabricate a fishmouth</li> <li>• Lay out and fabricate a wye.</li> </ul> <p><b>3. Stress Relieving and Aligning (08403 – 15 hrs)</b></p> <ul style="list-style-type: none"> <li>• Explain thermal expansion, anchors, cold springing</li> <li>• Explain stress-relief procedures</li> <li>• Explain grouting</li> <li>• Explain types of misalignment</li> <li>• Align pipe flanges to rotating equipment nozzles</li> </ul> <p><b>4. Steam Traps (08407 – 15 hrs)</b></p> <ul style="list-style-type: none"> <li>• Types of steam traps</li> <li>• Installation and troubleshooting</li> </ul>	<p><b>5. In-line specialties (08405 – 10 hrs.)</b></p> <ul style="list-style-type: none"> <li>• Potential hazards</li> <li>• Identify in-line specialties (snubbers, ball joints, bleed rings, drip legs, steam traps, strainers, expansion joints, filters, flowmeters, level measurement devices, flow pressure switches, rupture discs, thermowells, desuperheaters)</li> <li>• Storing/handling</li> </ul> <p><b>6. Special Piping (08406 – 25 hrs.)</b></p> <ul style="list-style-type: none"> <li>• Flared/compression joints using copper tubing</li> <li>• Solder/braze joints using copper tubing</li> <li>• Bend pipe to a specified radius</li> <li>• Install glass-lined pipe</li> <li>• Install hydraulic fitted compression joints</li> <li>• Install grooved pipe couplings</li> </ul> <p><b>7. Hot Taps (08407 – 10 hrs.)</b></p> <ul style="list-style-type: none"> <li>• Safety and potential hazards</li> <li>• Fittings used with hot taps</li> <li>• Use of hot tap machines</li> <li>• Use of stopples</li> </ul> <p><b>8. Maintaining Valves (08408 – 10 hrs.)</b></p> <ul style="list-style-type: none"> <li>• Remove/install threaded valves</li> <li>• Remove/install flanged valves</li> <li>• Replace valve stem O-rings</li> <li>• Replace bonnet gaskets</li> <li>• Explain purpose of valve packing</li> <li>• Explain/demonstrate how to repack a valve</li> </ul> <p><b>9. Introduction to Supervisory Roles (08409 – 7.5 hrs)</b></p>
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### NCCER Welding Level 1

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### NCCER Welding Level 2

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### NCCER Welding Level 3

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### NCCER Welding Level 4

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