

# Industrial Electronics Curriculum Guide

## Program Description

Students learn to operate, troubleshoot, repair and maintain equipment in an industrial/manufacturing setting. Students learn a combination of theory and hands-on skills in AC/DC electronics, power distribution, control panel wiring, mechanical systems, fluid power, automation and controls, manufacturing machines and troubleshooting.

## Program Admissions Requirements

Students who most closely match the U.S. Department of Labor occupational profile for the first exit point of a Custodial Support Worker are accepted for enrollment.

### CAS Scaled Score

Reading and Math: 228+

### Aptitudes

General Learning (G) Career Scope: 80+

Verbal (V) Career Scope: 80+

Numerical (N) Career Scope: 80+

Spatial (S) Career Scope: 80+

Motor Coordination (K) Career Scope: 80+

Finger Dexterity (F) Career Scope: 80+

Manual Dexterity (M) Career Scope: 80+

### Temperaments

Attain precise limits and standards using precision measuring instruments, prepare detailed records, and comply with precise specifications.

Perform a variety of duties involving different equipment and procedures. Complete tasks without loss of efficiency or composure.

## Physical Demands and Work Environment

Minimum Physical Requirements can be found upon request or on the U.S. Bureau of Labor Statistics (BLS) website [U.S. Bureau of Labor Statistics](http://www.bls.gov) under the Publications tab. Click on Occupational Outlook Handbook, and in the page search field, enter the name of one (1) of the certificates of completion listed below in this guide.

## **Certificate(s) of Completion**

Assembler (51-2022: Electrical and Electronic Equipment Assemblers)

Industrial Electronic Mechanic (49-2094: Electrical and Electronics Repairers)

Manufacturing Technician (51-9199): Production Workers, All Other)

Students may be in the Industrial Electronics program for up to four terms. At the end of each term, the instructor invites students who demonstrate academic progress by maintaining an accumulated grade point average of 2.0 or better and good employability skills to advance to the next term.

## **Required Courses**

To advance from term to term, a student must maintain a 2.0 GPA, with at least a grade of C (2.0) in all required courses.

### **Term 1**

- Courses required for this term must complete 300 hours and 12 credits
  - EL 101A – Applies Technical Math 1 (2 credits)
  - EL 102 - AC/DC Electrical Systems (3 credits)
  - EL 103 – Electrical Relay Controls (3 credits)
  - EL 112A - Introduction to Manufacturing Basics (4 credits)

### **Term 2**

Certificate Earned – Assembler

- Courses required for this term must complete 300 hours and 12 credits
  - EL 120C – Applied Technical Mathematics II (2 credits)
  - EL 121 – Electric Circuits II (4 credits)
  - EL 125 – Intro to Manufacturing Machines (2 credits)
  - EL 411 – Mechanical Drive Systems I (4 credits)

### **Term 3**

Certificate Earned – Industrial Electronic Mechanic

- Courses required for this term must complete 300 hours and 12 credits
  - EL 301 – Pneumatics Fundamentals (3 credits)
  - EL 302 – Electro-Pneumatics Fundamentals (3 credits)
  - EL 415 – Power Distribution Systems (4 credits)
  - EL 416 – Manufacturing Skills Institute Studies (2 credits)
  - EL-680 – Independent Study (2-12 credits)
  - EL 690 – Work Internship (6-12 credits)

## Term 4

### Certificate Earned –Industrial Electronics Technician

- Courses required for this term must complete 300 hours and 12 credits
  - EL 417A – Electrical Motor Control I (2 credits)
  - EL 427 – Electrical Motor Control II (4 credits)
  - EL 429A – PLC I Introduction/Troubleshooting PLCs (3 credits)
  - EL 437A – AC Drives, Braking and Starting (3 credits)
- Electives
  - EL 413 – Rotating Electrical Machines (4 credits)
  - EL 421A – Mechanical Drives II (4 credits)
  - EL 432A – Hydraulics (4 credits)
  - EL 439 – PLCs II Application Development & PLC Instructions (4 credits)

Instructors, Vocational Rehabilitation Counselors, and/or the referring counselor may recommend employability skills and elective classes based on the student's needs, interest and abilities. Additional terms or courses are initiated by the instructor and approved by the Manager of Career and Technical Education programs. Job seeking skills are required for all students expecting to graduate from MCTI.

## Course Descriptions

### EL101A – Applied Technical Mathematics 1

This is a remediation course that covers the math fundamentals used in IE coursework, manufacturing careers and electrical apprenticeships. This course will introduce students to fractions, decimals, percents and basic algebra skills. Students learn to solve mathematical problems as they relate to electricity/electronics and Ohm's law.

Topics covered: decimal numbers, fractions, percents, negative numbers, pre-algebra, measuring, converting between fractions, decimals, percents, how to use a calculator and series/parallel circuit calculations. Emphasis is on problem solving with specific applications designed to interface with the student's core program. Cooperative learning activities and technology are used to support learning.

## **EL 102 – AC/DC Electrical Systems**

AC/DC Electrical course teaches fundamentals of AC/DC electrical systems used for power and control in industrial, commercial, and residential applications. Students learn industry-relevant skills included in subject areas such as Basic Electrical Circuits, Electrical measurement, Circuit Analysis.

Topics covered: Basic electrical/electronic circuits, electrical measurement (voltage, current resistance), how to use a multimeter, basic electrical switches, series/parallel circuits, open/short circuits, and Ohm's Law calculation.

## **EL 103 – Electrical Relay Controls**

Introduces the functions of relay logic control circuits used in industrial, commercial and residential applications. Ladder Diagrams are explained and learners build, operate and design ladder diagrams using one or more logic elements.

## **EL 120C Applied Technical Mathematics II**

This course is for students who have successfully completed EL 101A and who understand and are proficient using basic decimal and arithmetic computational skills, and basic algebra skills to solve more complex calculations. The course follows Tech Math I and provides tools to solve mathematical problems in electronics.

Topics Covered: logarithms, logarithmic graphing, Algebra: literal numbers, multiplying and factoring polynomials, methods of solving equations, binary conversions and binary truth tables and the design and calculations to solve complex series, parallel and combination circuits. Students will also prepare for and take the MSI Math and Measurement proctored exam.

## **EL 121 Electric Circuits II**

This course builds on the theory learned and practical application of basic electricity learned in EL 102 on the Amatrol AC/DC trainer. This course prepares students to troubleshoot AC circuits as a technician or electrical apprentice.

Topics Covered: electromagnetism, relays, inductors, capacitors, inductive reactance, capacitive reactance, series-parallel and combination circuits, lighting circuits, rheostats, voltage dividers, troubleshooting, using a digital multimeter to measure voltage, current and resistance, and transformers. (Prerequisites: EL 102)

## **EL 125 Intro to Manufacturing Machines**

In this course students will learn the basics of manufacturing machines and the tools used in a manufacturing setting. Robotics introduces the basic operation of a robot, programming and interfacing & material handling. Measurement Tools introduce basic measurement, precision measurement tools, and dimensional gauging.

Topics Covered: robot safety, powerup, shutdown, manual operation, homing, end effector operation. Skills taught also include basic robot programming including movement and effector commands, interfacing and material handling, Metric System of Measurement, U.S. Customary Measurements, Tape Measure and Measurement Conversion. Applications taught include using a dial caliper, digital caliper, English micrometer, and metric micrometer. Dimensional Gauging will include an introduction to gauging as well as indicator measurement and data collection. In addition, students will learn basic data entry on an Excel spreadsheet to record measurements.

## **EI 411 Mechanical Drive Systems 1**

This introductory course teaches the fundamentals of mechanical transmission systems used in industrial, agricultural, and mobile applications.

Topics Covered: mechanical energy transmission concepts, torque, speed, power and work, mechanical safety, gear ratios, speed ratios, component operation and installation, chain drives, V-belt drives, flexible jaw couplings, solid couplings, pillow-block type bearings, shafts, keyways, spur gears, motor mounting, motor leveling, soft foot, straight edge and feeler gage alignment, multiple shaft alignment, manufacturer's component data, component selection, and basic system design.

## **EL 301 Pneumatics Fundamentals**

This course is designed for students with little or no prior knowledge related to pneumatics. This course helps prepare individuals for entry-level employment entering the field of industrial electronics, machine maintenance and manufacturing careers. The student will study construction, troubleshooting, circuit design maintenance and how to work safely with pneumatic systems.

Topics Covered: ISO Symbology, Pneumatic power & safety, pneumatic circuits, pneumatic schematics, the principles of pneumatic pressure and flow, and pneumatic speed control circuits, pressure regulation, air filtration, how to connect pneumatic circuits, pneumatic cylinders, valves, and actuators, a wide array of pneumatic applications, pressure and cylinder force, pneumatic leverage, pressure and volume, and air flow resistance.

## **EL 302 Electro-Pneumatics Fundamentals**

This course is designed for students with little or no prior knowledge related to pneumatics/electro-pneumatics. This course helps prepare individuals for entry-level employment entering the field of industrial electronics, machine maintenance and manufacturing careers. The student will study construction, troubleshooting, circuit design, maintenance and how to work safely with pneumatic systems.

Topics Covered: Ladder diagrams, basic control devices, power devices, control relays, sequencing control, timer control, pressure control applications, and circuit applications. Also discussed in depth to provide further skills is automatic and electrical control concepts and devices, logic elements, hydraulic and pneumatics solenoid-operated valves, electrical sensors, relay and motor control applications, safety circuits and modes of operation.

## **EI 415 Power Distribution Systems**

In this introductory course students learn industry-relevant skills to enable them to construct, troubleshoot, maintain, and repair power distribution systems. Students are introduced to electrical system wiring and developing fundamental knowledge of electrical wiring and components. This course also covers basic electrical system wiring, control panels, interpreting wire installation plans, handling non-metallic cable, understanding application of basic components such as switches, outlets, and lighting, and connecting electrical services. Industry standard safety practices are followed throughout the course. Strategies for locating information in the NEC codebook is also introduced.

Topics Covered: conduit bending, installation, sizing, and selection; IMC, EMT and flexible conduit; wire sizing, circuit protection, disconnect selection and installation; fitting and selection; system layout, and schematic interpretation.

## **EL 416 Manufacturing Skills Institute Studies**

In this course students will learn the fundamentals of Quality and Lean Manufacturing, Financial Literacy and Business Acumen and prepare for the Business Acumen and Financial Literacy proctored exam to earn the MSI Business Certificate (BC).

Topics Covered: value stream mapping, waste elimination, 5S, DMAIC, Total Preventative Maintenance, financial terms, balance sheets, assets, liabilities, balance sheet, income statement, cash flow statement and COGS.

## **EI 417A Electrical Motor Control 1**

This introductory course teaches electric relay control of AC electric motors found in industrial, commercial, and residential applications. Students learn to operate, install, and design AC electric motor control circuits for various applications.

Topics Covered: motor safety, lockout/ tagout, troubleshooting methods, interpreting ladder diagrams, system design, component operation, motor control applications, control transformers, manual motor starters, magnetic motor starters, motor overloads, and AC induction motors.

## **EI 427 Electrical Motor Control II**

This course is a continuation of Electrical Motor Control I (EI-417). Students continue to operate, install, design, and troubleshoot AC electric motor control circuits for various applications. Circuit faults are introduced using either the manual fault insertion or the computer-based fault insertion system. Students learn how to troubleshoot motor control circuits under realistic conditions.

Topics Covered: Topics include voltage testing equipment, control component troubleshooting, motor starter troubleshooting, power component troubleshooting, troubleshooting methods, systems troubleshooting, and troubleshooting motor control circuits, troubleshooting methods, types of switches (e.g., limit, pressure, liquid level, pushbutton and selector switches); indicators, overload protection, timer relays, control relays, drum switches, motor sequence control, reversing motor control, motor jogging, safety interlocks, time- delay relay control.

## **EI 429A PLC I Introduction/ Troubleshooting PLCs**

This hands-on course is for students with prior knowledge of electrical motor control and ladder diagrams. The course focuses on constructing, programming, maintaining, and troubleshooting programmable logic controllers (PLCs) and their use in industrial, commercial, and residential applications.

Topics Covered: system design, interfacing to I/O devices, contact and coil instructions, motor control applications, electro- pneumatic applications, BCD/ LED instructions/ applications, program interpretation, PLC system construction, programming, operation, maintenance, and troubleshooting.

## **EI 437A AC Drives, Braking and Starting**

In this course, students study construction, troubleshooting, maintenance, and how to work safely with AC drives, braking and starting motor systems.

Topics Covered: motor plugging, braking, and reduced voltage starting; AC drives, 2-wire control, 3-wire control, manual control, open loop speed control, dynamic braking, programmable acceleration, and deceleration, programmed diagnostics, motor jogging and motor breaking

## **EI 413 Rotating Electrical Machines**

This is an introductory course in electric motors, covering electric motor construction, troubleshooting, maintenance, and safety. Students learn how to operate, install, analyze performance, and select electric motors for various applications.

Topics Covered: DC Series Motors, DC Shunt Motors, DC Compound Motors, Split Capacitor, AC Single Phase Motor, Capacitor Start AC Single Phase Motor, Two Capacitor AC Single Phase Motor, Three-Phase AC Induction Motor, Generators, Motor Speed Measurement, Motor Torque Measurement, Motor Power Measurement, Motor Performance Measurement, Motor Performance Analysis.

## **EL 421A Mechanical Drives Systems II**

This course is designed for students who have already been exposed to the entry level course Mechanical Drives I. This is a highly interactive course which prepares individuals for entry-level employment to enter the field of Industrial Electronics Maintenance. The course focuses on the fundamentals of mechanical transmission systems used in industrial applications.

Topics Covered: Heavy Duty V-Belt Drives, V-Belt Selection and Maintenance, Synchronous Belt Drives, Lubrication Concepts, Precision Shaft Alignment, Couplings and Heavy-Duty Chain Drives.

## **EI 432A Hydraulics**

In this introductory hydraulics course, students complete 16 exercises (activities/problems) that illustrate hydraulic principles and functions of hydraulic components. Students apply basic hydraulic theory in designing, building, and testing actual circuits.

Topics Covered: hydraulic power units, pressure relief valves, directional control valves, single and double acting cylinders, cylinder positioning, check and pilot check valves, restrictions to fluid flow, speed control circuits.

## **EI 439 PLC's II Application Development/PLC Instructions**

This course is for students with prior knowledge of programmable logic controllers (PLCs). The student studies construction, troubleshooting, maintenance and how to work safely with PLC systems.

Topics Covered: system design, interfacing to I/O devices, instructions (e.g., timer/ counter, contact and coil, math, move, subroutine/ zone); applications (e.g., motor control, electro- pneumatic); BCD/ LED instructions/applications, program interpretation, PLC programming, operation, troubleshooting; event sequencing, application development.