COMPETENCY-BASED OCCUPATIONAL FRAMEWORK FOR REGISTERED APPRENTICESHIP

Mechatronics Technician/Engineer (Basic, fitter-focus)

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Contents

Competency-Based Occupational Frameworks

The Urban Institute, under contract by the U.S. Department of Labor, has worked with employers, subject matter experts, labor unions, trade associations, credentialing organizations and academics to develop Competency-Based Occupational Frameworks (CBOF) for Registered Apprenticeship programs. These frameworks defined the **purpose** of an occupation, the **job functions** that are carried out to fulfill that purpose, the **competencies** that enable the apprentice to execute those job functions well, and the **performance criteria** that define the specific knowledge, skills and personal attributes associated with high performance in the workplace. This organizational hierarchy – Job Purpose – Job Functions – Competencies – Performance Criteria – is designed to illustrate that performing work well requires more than just acquiring discrete knowledge elements or developing a series of manual skills. To perform a job well, the employee must be able to assimilate knowledge and skills learned in various settings, recall and apply that information to the present situation, and carry out work activities using sound professional judgement, demonstrating an appropriate attitude or disposition, and achieving a level of speed and accuracy necessary to meet the employer's business need.

The table below compares the terminology of Functional Analysis with that of traditional Occupational Task Analysis to illustrate the important similarities and differences. While both identify the key technical elements of an occupation, Functional Analysis includes the identification of behaviors, attributes and characteristics of workers necessary to meet an employer's expectations.

Framework Terminology	Traditional Task Analysis Terminology
Job Function – the work activities that are carried out to fulfill the job purpose	Job Duties – roles and responsibilities associated with an occupation
Competency – the actions an individual takes and the attitudes he/she displays to complete those activities	Task – a unit of work or set of activities needed to produce some result
Performance Criteria – the specific knowledge, skills, dispositions, attributes, speed and accuracy associated with meeting the employer's expectations	Sub Task – the independent actions taken to perform a unit of work or a work activity

Although designed for use in competency-based apprenticeship, these Competency-Based Occupational Frameworks also support time-based apprenticeship by defining more clearly and precisely what an apprentice is expected to learn and do during the allocated time-period.

CBOFs are comprehensive to encompass the full range of jobs that may be performed by individuals in the same occupation. As employers or sponsors develop their individual apprenticeship programs, they can extract from or add to the framework to meet their unique organizational needs.

Components of the Competency-Based Occupational Framework

Occupational Overview: This section of the framework provides a description of the occupation including its purpose, the setting in which the job is performed and unique features of the occupation.

Work Process Schedule: This section includes the job functions and competencies that would likely be included in an apprenticeship sponsor's application for registration. These frameworks provide a point of reference that has already been vetted by industry leaders so sponsors can develop new programs knowing that they will meet or exceed the consensus expectations of peers. Sponsors maintain the ability to customize their programs to meet their unique needs, but omission of a significant number of job functions or competencies should raise questions about whether or not the program has correctly identified the occupation of interest.

Cross-cutting Competencies: These competencies are common among all workers, and focus on the underlying knowledge, attitudes, personal attributes and interpersonal skills that are important regardless of the occupation. That said, while these competencies are important to all occupations, the relative importance of some versus others may change from one occupation to the next. These relative differences are illustrated in this part of the CBOF and can be used to design pre-apprenticeship programs or design effective screening tools when recruiting apprentices to the program.

Detailed Job Function Analysis: This portion of the framework includes considerable detail and is designed to support curriculum designers and trainers in developing and administering the program. There is considerable detail in this section, which may be confusing to those seeking a more succinct, higher-level view of the program. For this reason, we recommend that the Work Process Schedule be the focus of program planning activities, leaving the detailed job function analysis sections to instructional designers as they engage in their development work.

a. Related Technical Instruction: Under each job function appears a list of foundational knowledge, skills, tools and technologies that would likely be taught in the classroom to enable the apprentice's on-the-job training safety and success.

b. Performance Criteria: Under each competency, we provide recommended performance criteria that could be used to differentiate between minimally, moderately and highly competent apprentices. These performance criteria are generally skills-based rather than knowledge-based, but may also include dispositional and behavioral competencies.

Using the Competency-Based Occupational Framework to Develop a Registered Apprenticeship Program

When developing a registered apprenticeship program, the Work Process Schedule included in this CBOF provides an overview of the job functions and competencies an expert peer group deemed to be important to this occupation. The Work Process Schedule in this document can be used directly, or modified and used to describe your program content and design as part of your registration application.

When designing the curriculum to support the apprenticeship program – including on the job training and related technical instruction – the more detailed information in Section 5 could be helpful. These more detailed job function documents include recommendations for the key knowledge and skill elements that might be included in the classroom instruction designed to support a given job function, and the performance criteria provided under each competency could be helpful to trainers and mentors in evaluating apprentice performance and insuring inter-rater reliability when multiple mentors are involved.

Mechatronics Technician/Engineer (Basic, fitter-focus) Occupational Overview

Occupational Purpose and Context

Mechatronics Technician/Engineers (Basic, fitter-focus) work to combine electronic, mechanical, computer and control skills at the workplace. They work with complex high-performance manufacturing systems and are able to analyze, troubleshoot, and repair systems to maintain process efficiency. They must understand and analyze the technical specifications of mechatronic systems, subsystems, modules, and components; perform scheduled and preventive maintenance to detect and prevent problems; use troubleshooting skills to identify and prevent possible problems and failures, and to systematically and intelligently make repairs; incorporate relevant technical literature into the understanding of system operation and coordinate efforts with other technicians involved in installing or maintaining equipment or components; install, repair, adjust, and test equipment and components to ensure that systems function properly; communicate with machine operators, and operate equipment to detect equipment problems, analyze malfunctions, and verify system problems; and observe and incorporate safety standards and regulations required for safe operation of the system.

Mechatronics Technician/Engineers (Basic, fitter-focus) are engaged in the assembly and maintenance of complex machines, plants, and systems in the mechanical engineering sector or in organizations which purchase and operate such mechatronic systems. They carry out their work at various places, mainly at plant assembly sites, in workshops and in connection with service operations. They are qualified to work autonomously on the basis of technical documents and instructions and carry out their work in compliance with the relevant provisions and safety regulations. They often work in teams. They coordinate their activities with upstream and downstream operations.

Mechatronics Technician/Engineers (Basic, fitter-focus) apprentices will receive a more comprehensive education than mechatronics technicians with an installer background. While having similar training with computers and PLCs, they have less extensive baseline skills training. As a result, this framework is less comprehensive than the installer framework and should not be used by those wishing to provide a more extensive initiation to the work of mechatronics to apprentices

Potential Job Titles

Electrical and Electronics Repairers, Commercial and Industrial Equipment; Maintenance and Repair Worker; Maintenance Workers, Machinery; Electro-mechanical Technicians; Robotics Technicians; Electrical and Electronic Equipment Assemblers; Automation Technicians

Attitudes and Behaviors

Mechatronics Technician/Engineers (Basic, fitter-focus) should have well developed critical thinking skills to solve problems quickly, be able to identify errors or inconsistencies in product quality, be able to stay focused and observe the work process despite distractions, be able to combine pieces of information to form general rules or conclusions which they should communicate clearly, and be able to arrange objects or actions in an order or pattern related to a specific rule or set of rules.

Apprenticeship Prerequisites

A high school diploma and the ability to pass a drug or background screening test are often necessary.

Occupational Pathways

- Entry-Level Employees
- Certified Machine Operators
- Qualified Apprenticeship Candidates
- Mechatronics Technician Apprentices
- PMMI Core Certificates
    - Mechanical Components I and II
    - Industrial Electricity I and II
    - Programmable Logic Controllers I and II
    - Fluid Power I and II
    - Motors and Motor Control
        - Robotics and Motion Control
        - Machining Certifications (Optional

    - Welding Certifications (Optional)
- Competent and Proficient Mechatronics Technicians
- Mechatronics Engineering Technology Degrees

Certifications, Licensure and Other Credential Requirements

CREDENTIAL	Offered By	Before, During or After Apprenticeship
Mechanical Components I and II	PMMI	During
Industrial Electricity I and II	PMMI	During
Programmable Logic Controllers I and II	PMMI	During
Fluid Power I and II	PMMI	During
Motors and Motor Control	PMMI	During
Motors and Motor Control	PMMI	During
Robotics and Motion Control	PMMI	During
Machining Certifications (optional)	PMMI	During
Welding Certifications (optional)	PMMI	During
Competent and Proficient Mechatronics Technicians	PMMI	During
Mechatronics Engineering Technology Degrees	PMMI	During

Job Functions

JOB FUNCTIONS		Core or Optional	Level
1.	Follows work processes closely to ensure a safe environment		
2.	Communicates and works well within a team environment		
3.	Works capably with technical documentation		
4.	Works capably with a computer		
5.	Installs and sets up a machine		
6.	Performs work with material transfer conveyors		
7.	Understands, identifies, locates malfunctions, removes, replaces, adjusts, and returns to service industrial components		
8.	Works with PLCs		
9.	Performs work with robotic systems		

Stackable Programs

This occupational framework is designed to link to the following additional framework(s) as part of a career laddering pathway.

Stackable Programs		Base or Higher Level	Stacks on top of
1.		Base Program	
2.			
3.			
4.			

Options and Specializations

The following options and specializations have been identified for this occupation. The Work Process Schedule and individual job function outlines indicate which job functions and competencies were deemed by industry advisors to be optional.

Options and Specializations	Option	Specialization
Electrical and Electronics Repairers, Commercial and Industrial Equipment		
Maintenance and Repair Worker		
Maintenance Workers, Machinery		
Electro-mechanical Technicians		
Robotics Technicians		
Electrical and Electronic Equipment Assemblers		
Automation Technicians		

Work Process Schedule

WORK PROCESS SCHEDULE[1]	O*NET-SOC Code: 49-2094.00
Mechatronics Technician (Basic, fitter-focus) (Alternate Title: Electrical and Electronics Repairers, Commercial and Industrial Equipment (Basic, fitter-focus))	RAPIDS Code: 2014CB

Job Title:		
Level:	**Specialization:**	
Stackable Program ___yes ___no **Base Occupation Name:**		
Company Contact:		
Address:	**Phone:**	**Email:**
Apprenticeship Type: **_____Competency-Based** **_____Time-Based _____Hybrid**	**Prerequisites:**	

JOB FUNCTION 1: Follows work processes closely to ensure a safe environment

Competencies	Core or Optional	RTI	OJT
A. Identifies contact points within organization	Core		
B. Follows company policies and regulations	Core		
C. Recognizes safety, health, and environmental requirements in all departments	Core		
D. Recognizes safety machinery procedures	Core		

[1] See full framework for certifications and occupational pathways, cross-cutting competencies, and detailed job functions at https://www.dol.gov/cgi-bin/leave-dol.asp?exiturl=https://www.urban.org/policy-centers/center-labor-human-services-and-population/projects/competency-based-occupational-frameworks-registered-apprenticeships&exitTitle=www.urban.org.

JOB FUNCTION 2: Communicates and works well within a team environment			
Competencies	Core or Optional	RTI	OJT
A. Reliably follows the instructions of others	Core		
B. Willingly asks questions about things not fully understood	Core		
C. Works with due regard for the safety of others	Core		
D. Establishes a system of maintaining appropriate notes and reminders and completes any required logs, calibration records, etc.	Core		
E. Ensures proper communications between previous and next shifts, with both operations and supervision	Core		
F. Identifies problems and changes which could lead to problems by exchanging information with operators, supervisors, and others	Core		
G. Establishes trust and rapport with operators, supervisors, and others	Core		
JOB FUNCTION 3: Works capably with technical documentation			
Competencies	Core or Optional	RTI	OJT
A. Reads and interprets mechanical drawings	Core		
B. Reads and interprets fluid power (hydraulics/pneumatics)	Core		
C. Reads and interprets electrical drawings	Core		
D. Reads and interprets Process and Instrumentation Diagram (P&ID) and process control loop drawings	Core		
E. Reads and interprets vendor information	Core		
JOB FUNCTION 4: Works capably with a computer			
Competencies	Core or Optional	RTI	OJT
A. Uses a personal computer (PC) with appropriate windows or Linux operating systems	Core		
B. Uses basic computer office tools such as word processing, spreadsheets, and databases	Core		
C. Uses a browser and accesses the internet to retrieve information, configures wired and wireless networking, and installs applications	Core		

D. Uses a tablet device	Core		
E. Adds user accounts to a PC	Core		
F. Installs and uses antivirus software and follows a security policy	Core		
JOB FUNCTION 5: Installs and sets up a machine			
Competencies	Core or Optional	RTI	OJT
A. Locates a machine according to a print	Core		
B. Levels a machine (noncritical machines +/- 1/8")	Core		
C. Verifies circuit size and protection	Core		
D. Verifies proper voltage and phasing, grounding, and proper guards are in place	Core		
E. Installs proper mounts and raceways for adding a component (such as a sensor) or interlocking a machine	Core		
F. Properly sizes, installs, labels, and tests circuit conductors for adding a component or interlocking a machine	Core		
G. Properly lays out, cuts, drills, taps, and assembles a control station for an addition to a machine	Core		
H. Connects compressed air to a machine from a supply header and verifies proper air pressures and volumes for a machine	Core		
I. Adds pneumatic or hydraulic components and lines to a machine	Core		
J. Aligns and adjusts shafts, motors, belts, and chains on a machine	Core		
K. Verifies proper operation of all safety devices and circuits on a machine and checks and verifies circuits on a machine	Core		
L. Checks, lubricates, and powers up a machine	Core		
M. Verifies proper current draw of a machine and machine operation according to a sequence of operation	Core		
JOB FUNCTION 6: Performs work with material transfer conveyors			
Competencies	Core or Optional	RTI	OJT
A. Assembles rollers and belts	Core		
B. Adjusts height and distance to adjoining belts	Core		

C. Reverses direction of travel	Core		
D. Sets and adjusts tracking	Core		
E. Measures and adjusts belt speed	Core		
F. Determines if proper guards are in place	Core		
G. Adjusts and modifies guards and verifies safe operation meets OSHA standards	Core		

JOB FUNCTION 7: Understands, identifies, locates malfunctions, removes, replaces, adjusts, and returns to service industrial components

Competencies	Core or Optional	RTI	OJT
A. Installs and troubleshoots key mechanical components	Core		
B. Installs and troubleshoots electrical components	Core		
C. Installs and troubleshoots electronic sensors and components	Core		
D. Installs and troubleshoots electrical control components	Core		
E. Installs and troubleshoots fluid power components	Core		
F. Installs and troubleshoots vacuum system components	Core		

JOB FUNCTION 8: Works with PLCs

Competencies	Core or Optional	RTI	OJT
A. Installs basic components of a Programmable Logic Controller (PLC) including racks, ethernet, power supply, processor, and single point digital input/output modules	Core		
B. Connects power and digital input/output (I/O) wiring to a PLC	Core		
C. Selects and appropriately connects sinking and sourcing inputs and outputs	Core		
D. Configures and connects a laptop or other programming device to a PLC to upload, download, and save a program	Core		
E. Changes preset timer and counter values and applies and removes forces from a program	Core		
F. Troubleshoots a machine or process by observing PLC indicator lights and reviewing the PLC software ladder diagram (relays, timers, and counters)	Core		

G. Adds a function to a machine or process that requires wiring of additional I/O and basic ladder logic programming	Core		
H. Troubleshoots a PLC or a PLC-controlled machine or process by observing input and output conditions and monitoring the program in real time	Core		
I. Properly installs and terminates wiring for low-level analog signals	Optional		
J. Troubleshoots a machine or process utilizing a PLC or a Programmable Automation Controller (PAC) that implements closed loop process control and general purpose multi-axis motion control	Optional		

JOB FUNCTION 9: Performs work with robotic systems

Competencies	Core or Optional	RTI	OJT
A. Exercises appropriate safety procedures for working with robots	Core		
B. Identifies types of robots	Core		
C. Programs robot movement with a teach pendant	Core		
D. Uploads, downloads, saves, and runs a robot program	Core		
E. Interfaces a robot to a conveyor system	Core		
F. Interfaces an end effector to a robot controller	Core		
G. Calibrates a robot to a conveyor system	Core		
H. Interfaces a robot to a vision system	Optional		
I. Sets up lighting for a vision system	Optional		
J. Teaches a vision system how to identify and orient good and bad products	Optional		
K. Troubleshoots a robot system, replaces components, and returns to operation	Core		
L. Performs repair procedures on a robot arm	Core		

Specialization

Type of Specialization: _____

JOB FUNCTION 1:		**Level**
Competencies	RTI	OJT
JOB FUNCTION 2:		**Level**
Competencies	OJT	RTI
JOB FUNCTION 3:		Level
Competencies	OJT	RTI

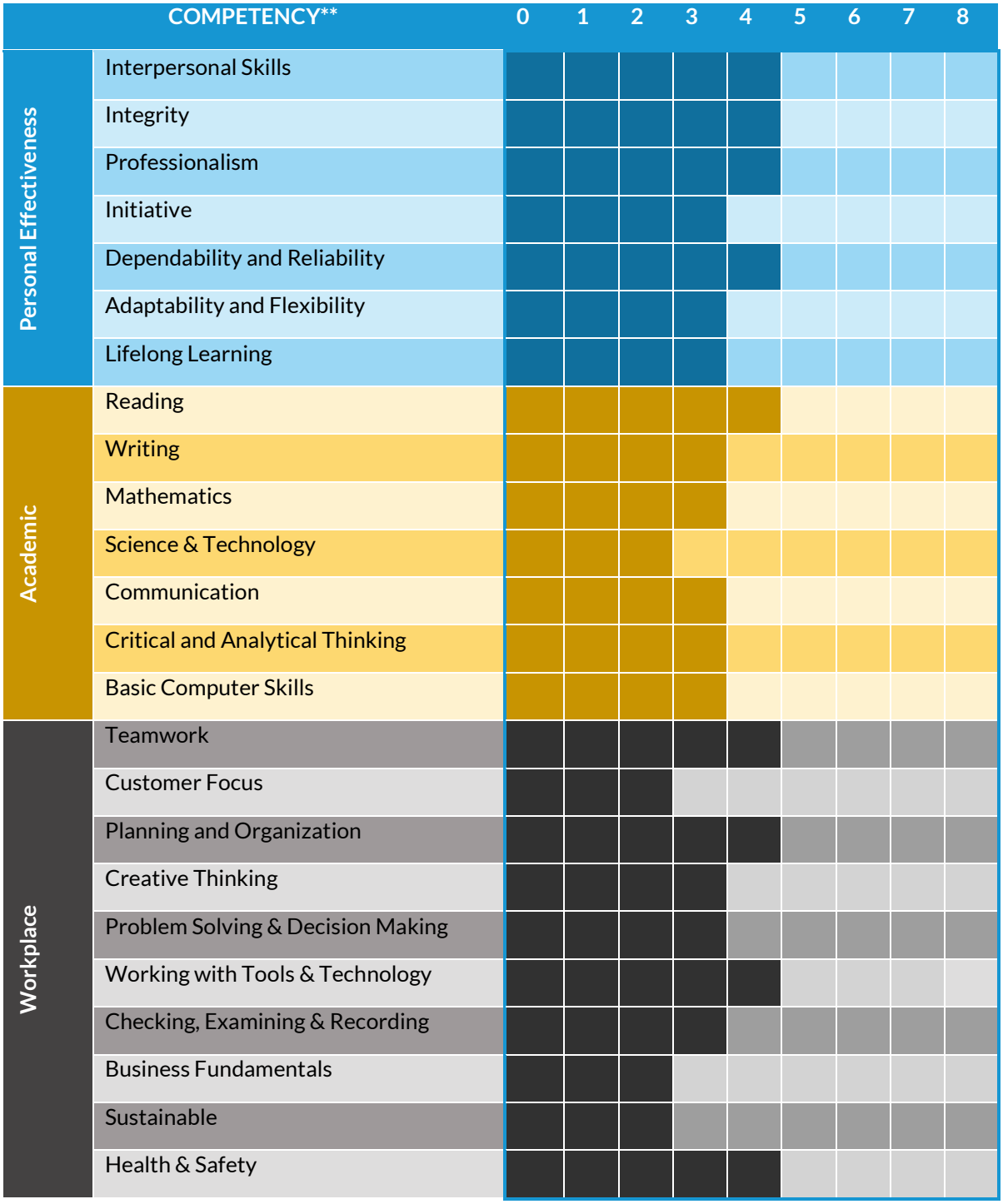
JOB FUNCTION 4:		**Level**
Competencies	OJT	RTI
JOB FUNCTION 5:		**Level**
Competencies	OJT	RTI

Related Technical Instruction Plan

COURSE NAME	**Course Number**
	Hours
LEARNING OBJECTIVES	
COURSE NAME	Course Number
	Hours
LEARNING OBJECTIVES	
COURSE NAME	Course Number
	Hours
LEARNING OBJECTIVES	
COURSE NAME	Course Number
	Hours

LEARNING OBJECTIVES	
COURSE NAME	Course Number
	Hours
LEARNING OBJECTIVES	

Cross-Cutting Competencies



**Cross-cutting competencies are defined in the Competency Model Clearinghouse: https://www.careeronestop.org/CompetencyModel/competency-models/buidling-blocks-model.aspx

Cross-Cutting Competencies identify transferable skills – sometimes called "soft skills" or "employability skills" – that are important for workplace success, regardless of a person's occupation. Still, the relative importance of specific cross-cutting competencies differs from occupation to occupation. The Cross-Cutting Competencies table, above, provides information about which of these competencies is most important to be successful in a particular occupation. This information can be useful to employers or intermediaries in screening and selecting candidates for apprenticeship programs, or to pre-apprenticeship providers that seek to prepare individuals for successful entry into an apprenticeship program.

The names of the cross-cutting competencies come from the U.S. Department of Labor's Competency Model Clearinghouse and definitions for each can be viewed at https://www.careeronestop.org/CompetencyModel/competency-models/building-blocks-model.aspx.

The scoring system utilized to evaluate the level of competency required in each cross cutting skill aligns with the recommendations of the Lumina Foundation's Connecting Credentials Framework. The framework can be found at: http://connectingcredentials.org/wp-content/uploads/2015/05/ConnectingCredentials-4-29-30.pdf

Detailed Job Functions

JOB FUNCTION 1: Follows work processes closely to ensure a safe environment

Related Technical Instruction		
KNOWLEDGE	**SKILLS**	**TOOLS & TECHNOLOGIES**
• OSHA Safety Standards • Company policies and hierarchy	• Using proper procedures in conducting work • Maintaining situational awareness • Logical thinking • Clear oral communication • Identifying problems and correcting them	• None

Competency A: Identifies contact points within organization	**Core or Optional**
PERFORMANCE CRITERIA	
1. Explains the major responsibilities of each department or unit in the company and the effect of each unit on the job performance	Core
Competency B: Follows company policies and regulations	**Core or Optional**
PERFORMANCE CRITERIA	
1. Follows internal company policies and regulations	Core
Competency C: Recognizes safety, health, and environmental requirements in all departments	**Core or Optional**
PERFORMANCE CRITERIA	
1. Follows OSHA, EPA, NIOSH, and other critical safety requirements when carrying out job functions	Core

Competency D: Recognizes safety machinery procedures	Core or Optional
PERFORMANCE CRITERIA	
1. Correctly uses safety checklist to make sure equipment is ready to come online, including that safety devices are operational and that machine interlocks are functioning properly	Core
2. Correctly identifies machine malfunctions	Core
3. Follows company's standard operating procedures	Core
4. Works with operations staff to start and stop an operation	Core
5. Properly shuts down machines during routine operations, when a malfunction occurs, or in the event of an emergency	Core

JOB FUNCTION 2: Communicates and works well within a team environment

Related Technical Instruction		
KNOWLEDGE	**SKILLS**	**TOOLS & TECHNOLOGIES**
• Company policies and hierarchy	• Using proper procedures in conducting work • Maintaining situational awareness • Logical thinking • Clear oral communication • Identifying problems and correcting them • Teamwork	• None

Competency A: Reliably follows the instructions of others	**Core or Optional**
PERFORMANCE CRITERIA	
1. Follows the instructions of supervisors and offers constructive feedback to ensure proper completion of tasks	Core
Competency B: Willingly asks questions about things not fully understood	**Core or Optional**
PERFORMANCE CRITERIA	
1. Asks about techniques, components, installation, technical aspects, and other key areas of job that are not fully clear	Core
Competency C: Works with due regard to the safety of others	**Core or Optional**
PERFORMANCE CRITERIA	
1. Demonstrates safe workplace practices in material handling, machine operations, and handling of tools	Core
2. Explains actions which directly or indirectly affect safe practices during assigned responsibilities	Core

Competency D: Establishes a system of maintaining appropriate notes and reminders and completes any required logs, calibration records, etc.	Core or Optional
PERFORMANCE CRITERIA	
1. Writes and records the information critical for the proper functioning of the job	Core
2. Types information into easily accessible computer filing systems	Core
Competency E: Ensures proper communications between previous and next shifts, with operations, and with supervision	**Core or Optional**
PERFORMANCE CRITERIA	
1. Demonstrates appropriate interpersonal skills involving a supervisor or team leader and other team members to ensure work is smoothly continued from one shift to the next	Core
Competency F: Identifies problems and changes which could lead to problems through the exchange of information with operators, supervisors, and others	**Core or Optional**
PERFORMANCE CRITERIA	
1. Analyzes the problem(s) and proposes remedies when having authorization to carry it out	Core
Competency G: Establishes trust and rapport with operators, supervisors, and others	**Core or Optional**
PERFORMANCE CRITERIA	
1. Reaches out to and communicates with members of the team to discuss work and any issues that may arise	Core

JOB FUNCTION 3: Works capably with technical documentation

Related Technical Instruction		
KNOWLEDGE	**SKILLS**	**TOOLS & TECHNOLOGIES**
• Technical documentation • Power systems • Drawings	• Using proper procedures in conducting work • Maintaining situational awareness • Logical thinking • Clear oral communication • Identifying problems and correcting them • Critical thinking and reading	• None

Competency A: Reads and interprets mechanical drawings	**Core or Optional**
PERFORMANCE CRITERIA	
1. Demonstrates the six rules of drawing a ladder diagram	Core
2. Draws a ladder diagram of a control circuit	Core
Competency B: Reads and interprets fluid power (hydraulics/pneumatics)	**Core or Optional**
PERFORMANCE CRITERIA	
1. Identifies electrical symbols and schematics for hydraulic systems	Core
2. Describes electric and electronic control circuits, devices, and feedback as they relate to hydraulics	Core
3. Examines characteristics of hydraulic pumps	Core
4. Explains the transmission and conditioning of hydraulic fluid	Core
5. Measures oil flow and oil pressure	Core
6. Operates manual and pilot directional control valves	Core
7. Describes and explains hydraulic actuators	Core

8. Operates hydraulic actuator circuits	Core
9. Constructs, tests, and troubleshoots hydraulic control circuits	Core
10. Applies knowledge of basic electricity in analyzing hydraulic circuits	Core
11. Explains where electronic switches and sensors may be found in hydraulic systems	Core
12. Identifies and uses proper size hydraulic lines	Core
13. Describes the relationship between hydraulic pressure and flow	Core
Competency C: Reads and interprets electrical drawings	**Core or Optional**
PERFORMANCE CRITERIA	
1. Identifies and interprets electrical symbols, notes, details, and components on schematics	Core
2. Draws a schematic of electrical circuits, either by hand or with computer software	Core
Competency D: Reads and interprets Process and Instrumentation Diagram (P&ID) and process control loop drawings	**Core or Optional**
PERFORMANCE CRITERIA	
1. Explains the purpose of using standardized codes and symbols in drawings	Core
2. Illustrates how P&IDs are constructed as single line drawings	Core
3. Interprets a basic P&ID	Core
4. Defines and sketches a 2-wire transmission system	Core
Competency E: Reads and interprets vendor information	**Core or Optional**
PERFORMANCE CRITERIA	
1. Identifies and interprets the information provided by the vendor, and any details or components specific to the vendor	Core

JOB FUNCTION 4: Works capably with a computer

Related Technical Instruction		
KNOWLEDGE	**SKILLS**	**TOOLS & TECHNOLOGIES**
• Methods for working safely • Principles of identification and mitigation • Computer and editor software • Software and coding • Installation and wiring	• Selecting proper tools and procedures • Using proper procedures in conducting work • Maintaining situational awareness • Clear thinking • Identifying problems and correcting them	• PC • Tablet • Computer accessories

Competency A: Uses a PC with appropriate windows or Linux operating systems	**Core or Optional**
PERFORMANCE CRITERIA	
1. Selects a computer that uses Microsoft Windows or Linux operating system software	Core
Competency B: Uses basic computer office tools such as word processing, spreadsheet, and database	**Core or Optional**
PERFORMANCE CRITERIA	
1. Uses software programs such as MS Word, Excel, Access, and other tools	Core
Competency C: Uses a browser and accesses the internet to retrieve information, configures wired and wireless networking, and installs applications	**Core or Optional**
PERFORMANCE CRITERIA	
1. Uses a browser to access key information on the internet and configure the networking and install applications pertinent to job	Core
Competency D: Uses a tablet device	**Core or Optional**
PERFORMANCE CRITERIA	
1. Works with a tablet device	Core

Competency E: Adds user accounts to a PC	Core or Optional
PERFORMANCE CRITERIA	
1. Adds additional users to PCs to allow others in company to access information and assist in the completion of tasks	Core
Competency F: Installs and uses anti-virus software and follows a security policy	**Core or Optional**
PERFORMANCE CRITERIA	
1. Installs proper anti-virus software to protect against computer or tablet viruses	Core
2. Follows proper company security policy to ensure data are handled properly	Core

JOB FUNCTION 5: Installs and sets up a machine

Related Technical Instruction		
KNOWLEDGE	**SKILLS**	**TOOLS & TECHNOLOGIES**
• Methods for working safely • Principles of identification and mitigation • Measurement principles • Risk assessment techniques and protocols • Mathematical calculations and measurements • Installation and wiring	• Selecting proper tools and procedures • Using proper procedures in conducting work • Maintaining situational awareness • Clear thinking • Identifying problems and correcting them	• Machine and machine components • Hand tools

Competency A: Locates a machine according to a print	**Core or Optional**
PERFORMANCE CRITERIA	
1. Locates the proper code for wiring	Core
2. Uses the proper reference book to locate regulations for industrial electrical installations	Core
Competency B: Levels a machine (non-critical machines +/- 1/8")	**Core or Optional**
PERFORMANCE CRITERIA	
1. Designs a level sensing control circuit which uses a capacitive proximity sensor	Core
2. Levels the machine (non-critical machines +/- 1/8")	Core
Competency C: Verifies circuit size and protection	**Core or Optional**
PERFORMANCE CRITERIA	
1. Checks and verifies circuit size	Core
2. Selects circuit protection for an application	Core

Competency D: Verifies proper voltage and phasing, grounding, and proper guards are in place	Core or Optional
PERFORMANCE CRITERIA	
1. Connects a dual-voltage three-phase motor for low voltage operation	Core
2. Connects a dual-voltage three-phase motor for high voltage operation	Core
Competency E: Installs proper mounts and raceways for adding a component (such as a sensor) or interlocking a machine	**Core or Optional**
PERFORMANCE CRITERIA	
1. Uses fasteners appropriately to attach a motor mount to a bedplate	Core
2. Selects appropriate fastener size and type for a motor mount	Core
3. Mounts and levels an electric motor	Core
4. Mounts an electric motor and corrects for a soft foot condition	Core
Competency F: Properly sizes, installs, labels and tests circuit conductors for adding a component or interlocking a machine	**Core or Optional**
PERFORMANCE CRITERIA	
1. Selects the proper size raceway for same size/type conductors using tables in the NEC	Core
2. Determines conduit size when conductors are of different sizes and/or types using tables in the NEC	Core
3. Determines electrical box size when conductors are the same size	Core
4. Determines electrical box size when conductors are the different size	Core
Competency G: Properly layouts, cuts, drills, taps, and assembles a control station for an addition to a machine	**Core or Optional**
PERFORMANCE CRITERIA	
1. Lays out the location of hole centers and surfaces with accuracy	Core
2. Drills and taps holes by hand using aluminum or mild steel	Core
3. Sets up and performs sawing to a layout	Core
4. Develops a process plan for a part requiring milling, drilling, turning, or grinding	Core

Competency H: Connects compressed air to a machine from a supply header and verifies proper air pressures and volumes for a machine	Core or Optional
PERFORMANCE CRITERIA	
1. Converts air volumes at pressures to free air volumes	Core
Competency I: Adds pneumatic or hydraulic components and lines to a machine	**Core or Optional**
PERFORMANCE CRITERIA	
1. Identifies hydraulic components	Core
2. Reads a hydraulic pressure gauge	Core
3. Identifies hydraulic power unit components	Core
4. Reads the liquid level and temperature in the reservoir	Core
5. Operates a hydraulic power unit	Core
6. Connects and disconnects a hydraulic hose that uses quick-connect fittings	Core
Competency J: Aligns and adjusts shafts, motors, belts, and chains on a machine	**Core or Optional**
PERFORMANCE CRITERIA	
1. Aligns two shafts using a straight edge and feeler gauge	Core
2. Connects and operates a simple motor control circuit	Core
3. Tests the operation of a manual motor starter using a multimeter	Core
4. Starts and stops a motor using a manual starter	Core
5. Installs and aligns a fractional horsepower v-belt drive with a finished bore	Core
6. Determines the belt deflection force for a given application	Core
7. Adjusts belt tension using an adjustable mounting base	Core
8. Uses a belt tension tester to measure belt tension	Core
9. Adjusts chain sag to a specified amount using adjustable centers	Core
10. Installs and removes a chain with a master link using sprocket teeth	Core
11. Installs and removes a chain with a master link using a chain puller	Core

Competency K: Verifies proper operation of all safety devices and circuits on a machine and checks and verifies circuits on a machine	**Core or Optional**
PERFORMANCE CRITERIA	
1. Connects and operates a control relay in a circuit	Core
2. Connects and operates a memory logic circuit	Core
3. Connects and operates a magnetic motor starter connected to a three-phase motor	Core
4. Connects and operates a two-wire motor control circuit	Core
5. Connects and operates a three-wire motor control circuit	Core
Competency L: Checks, lubricates, and powers up a machine	**Core or Optional**
PERFORMANCE CRITERIA	
1. Cleans and lubricates equipment or machinery	Core
2. Powers the machine	Core
Competency M: Verifies proper current draw of a machine and machine operation according to a sequence of operation	**Core or Optional**
PERFORMANCE CRITERIA	
1. Understands and draws a schematic of electrical circuits, either by hand or by using computer software	Core

JOB FUNCTION 6: Performs work with material transfer conveyors

Related Technical Instruction		
KNOWLEDGE	**SKILLS**	**TOOLS & TECHNOLOGIES**
• Methods for working safely in confined spaces • OSHA Safety Standards • Principles of hazard identification and mitigation • Measurement principles • Risk assessment techniques and protocols • Mathematical calculations and measurements	• Selecting proper tools and procedures • Using proper procedures in conducting work • Maintaining situational awareness • Clear thinking • Identifying problems and correcting them	• Rollers and belts • Conveyors

Competency A: Assembles rollers and belts	**Core or Optional**
PERFORMANCE CRITERIA	
1. Installs and aligns a roller chain drive system with adjustable centers	Core
2. Installs and aligns a fractional horsepower v-belt drive with a finished bore	Core
3. Determines the belt deflection force for a given application	Core
Competency B: Adjusts height and distance to adjoining belts	**Core or Optional**
PERFORMANCE CRITERIA	
1. Adjusts belt tension using an adjustable mounting base	Core
2. Uses a belt tension tester to measure belt tension	Core
Competency C: Reverses direction of travel	**Core or Optional**
PERFORMANCE CRITERIA	
1. Determines the direction of rotation of a conveyor given its position	Core
2. Reverses direction of travel	Core

Competency D: Sets and adjusts tracking	Core or Optional
PERFORMANCE CRITERIA	
1. Checks that the conveyor frame is level and square	Core
2. Ensures the end pulleys are square	Core
3. Checks for debris	Core
Competency E: Measures and adjusts belt speed	**Core or Optional**
PERFORMANCE CRITERIA	
1. Calculates the shaft speed and torque of a belt drive system	Core
2. Determines the belt deflection force for a given application	Core
3. Adjusts belt tension using an adjustable mounting base	Core
Competency F: Determines if proper guards are in place	**Core or Optional**
PERFORMANCE CRITERIA	
1. Checks guards to see if they properly fit within the conveyor system	Core
Competency G: Adjusts and modifies guards and verifies safe operation meets OSHA standards	**Core or Optional**
PERFORMANCE CRITERIA	
1. Adjusts and modifies guards if they do not properly fit the conveyor system	Core
2. Ensures conveyors meet the mechanical power transmission safety test standards	Core

JOB FUNCTION 7: Understands, identifies, locates malfunctions, removes, replaces, adjusts, and returns to service industrial components

Related Technical Instruction		
KNOWLEDGE	**SKILLS**	**TOOLS & TECHNOLOGIES**
• Methods for working safely • Principles of identification and mitigation • Measurement principles • Risk assessment techniques and protocols • Mathematical calculations and measurements • Computer and editor software • Software and coding • Installation and wiring	• Selecting proper tools and procedures • Using proper procedures in conducting work • Maintaining situational awareness • Clear thinking • Identifying problems and correcting them	• Electrical power components • Fluid power components • Vacuum power components

Competency A: Installs and troubleshoots key mechanical components	Core or Optional
PERFORMANCE CRITERIA	
1. Adheres to OSHA, NIOSH, EPA, and other federal and state safety requirements for the workplace	Core
2. Properly inspects dimensions of shafts and other components	Core
3. Safely examines, troubleshoots, and repairs power transmissions	Core
4. Aligns and adjusts gear drives	Core
5. Installs, aligns, and adjusts a pillow block bearing	Core
6. Lubricates equipment using correct lubricants and as recommended by manufacturer's guidance	Core
7. Performs preventive maintenance procedures for a given machine to extend machine life and minimize downtime	Core

Competency B: Installs and troubleshoots electrical components	Core or Optional
PERFORMANCE CRITERIA	
1. Adheres to OSHA, NIOSH, EPA, and other federal and state safety requirements for the workplace	Core
2. Interprets electrical control and power schematics to ensure the operation of the components and system	Core
3. Adjusts limit switches and electronic sensors	Core
4. Measures voltage, current, and resistance in an electrical circuit to verify system operation and power levels	Core
5. Selects, installs, and tests fuses and circuit breakers	Core
6. Troubleshoots an electrical motor relay control circuit	Core
Competency C: Installs and troubleshoots electronic sensors and components	**Core or Optional**
PERFORMANCE CRITERIA	
1. Adheres to OSHA, NIOSH, EPA, and other federal and state safety requirements for the workplace	Core
2. Connects and operates inductive proximity sensors	Core
3. Designs drill motor control circuits which use an inductive proximity sensor	Core
4. Connects and operates a capacitive proximity sensor	Core
5. Designs level sensing control circuits which use a capacitive proximity sensor	Core
6. Connects and operates a photoelectric sensor	Core
7. Connects and operates motor control circuits with photoelectric sensors	Core
8. Troubleshoots motor control circuits with capacitive and inductive proximity sensors	Core
9. Designs motor control circuits that will sense product jams on a conveyor system using capacitive proximity sensors	Core

Competency D: Installs and troubleshoots electrical control components	Core or Optional
PERFORMANCE CRITERIA	
1. Adheres to OSHA, NIOSH, EPA, and other federal and state safety requirements for the workplace	Core
2. Troubleshoots and repairs motor controls	Core
3. Troubleshoots and replaces relays	Core
4. Troubleshoots and replaces sensors	Core
5. Troubleshoots and replaces limit switches	Core
6. Troubleshoots and replaces power supplies	Core
7. Troubleshoots and replaces electronic sensors	Core
Competency E: Installs and troubleshoots fluid power components	**Core or Optional**
PERFORMANCE CRITERIA	
1. Adheres to OSHA, NIOSH, EPA, and other federal and state safety requirements for the workplace	Core
2. Troubleshoots and replaces hydraulic lines	Core
3. Troubleshoots and replaces hydraulic pumps	Core
4. Troubleshoots and replaces hydraulic gauges	Core
5. Troubleshoots and replaces hydraulic filters	Core
6. Troubleshoots and replaces hydraulic directional control valves	Core
7. Troubleshoots and replaces hydraulic pressure control valves	Core
8. Performs adjustments to control oil temperature and pressure	Core

Competency F: Installs and troubleshoots vacuum system components	Core or Optional
PERFORMANCE CRITERIA	
1. Adheres to OSHA, NIOSH, EPA, and other federal and state safety requirements for the workplace	Core
2. Adjusts vacuum grippers	Core
3. Adjusts vacuum switches	Core
4. Troubleshoots and replaces vacuum grippers	Core
5. Troubleshoots and replaces vacuum switches	Core

JOB FUNCTION 8: Works with PLCs

Related Technical Instruction		
KNOWLEDGE	**SKILLS**	**TOOLS & TECHNOLOGIES**
• Methods for working safely • Principles of identification and mitigation • Measurement principles • Risk assessment techniques and protocols • Mathematical calculations and measurements • Computer and editor software • Software and coding • Installation and wiring	• Selecting proper tools and procedures • Using proper procedures in conducting work • Maintaining situational awareness • Clear thinking • Identifying problems and correcting them	• Programmable Logic Controllers • Robots • Conveyor systems

Competency A: Installs basic components of a PLC including racks, ethernet, power supply, processor, and single point digital input/output modules	**Core or Optional**
PERFORMANCE CRITERIA	
1. Starts scan of the PLC	Core
2. Checks the PLC for any issues	Core
3. Scans inputs into the PLC	Core
4. Executes program logic	Core
5. Updates outputs of the PLC	Core
Competency B: Connects power and digital input/output wiring to a PLC	**Core or Optional**
PERFORMANCE CRITERIA	
1. Connects and tests a limit switch to a discrete MicroLogix 1000 Input	Core
2. Connects and tests the operation of a solenoid valve to a MicroLogix 1000 PLC output	Core
3. Connects and tests the operation of a motor starter to a MicroLogix 1000 PLC output	Core
4. Connects and tests the operation of an electronic sensor to a MicroLogix 1000 PLC input module	Core

5. Develops an interface wiring diagram to interface a MicroLogix 1000 PLC to a machine controller	Core
6. Connects and operates a conveyor system using discrete MicroLogix 1000 PLC inputs and outputs	Core
Competency C: Selects and appropriately connects sinking and sourcing inputs and outputs	**Core or Optional**
PERFORMANCE CRITERIA	
1. Operates PLC inputs and outputs using RS Logix software	Core
2. Operates inputs and outputs instructions using RS Logix software	Core
Competency D: Configures and connects a laptop or other programming device to a PLC to upload, download, and save a program	**Core or Optional**
PERFORMANCE CRITERIA	
1. Configures a serial communications driver using RS Linux software	Core
2. Monitors PLC operation using the using RS Logix software's system communications dialog	Core
3. Runs a PLC processor file using RS Logix PLC programming software	Core
4. Stops a PLC processor file using RS Logix PLC programming software	Core
5. Operates PLC inputs and outputs using RS Logix software	Core
6. Operates input and output instructions using RS Logix software	Core
7. Operates basic PLC logic elements using RS Logix software	Core

Competency E: Changes preset timer and counter values and applies and removes forces from a program	Core or Optional
PERFORMANCE CRITERIA	
1. Connects and operates a control circuit with an on-delay timer relay	Core
2. Designs a time-driven traffic light circuit using an on-delay timer relay	Core
3. Connects and operates an on-delay timer to control circuit to perform an unloaded start of a motor	Core
4. Designs a control circuit using an on-delay timer to perform a cylinder dwell	Core
5. Designs a control circuit to perform time-driven sequencing using an on-delay timer	Core
6. Connects and operates a control circuit with an on-delay timer relay	Core
Competency F: Troubleshoots a machine or process by observing PLC indicator lights and reviewing the PLC software ladder diagram (relays, timers, and counters)	**Core or Optional**
PERFORMANCE CRITERIA	
1. Creates a PLC project using RS Logix PLC software	Core
2. Enters a basic PLC program using RS Logix PLC software	Core
3. Saves a PLC program using RS Logix PLC software	Core
4. Edits a PLC program using RS Logix PLC software	Core
5. Generates and prints out a ladder logic report using RS Logix PLC software	Core

Competency G: Adds a function to a machine or process that requires wiring of additional I/O and basic ladder logic programming	Core or Optional
PERFORMANCE CRITERIA	
1. Identifies the four basic components of a ladder diagram	Core
2. Reads and interprets the operation of a circuit given a ladder diagram	Core
3. Connects and operates a logic circuit given a ladder diagram	Core
4. Designs a ladder diagram using one or more logic elements	Core
5. Connects and operates a circuit using a solenoid valve given a ladder diagram	Core
6. Designs a control circuit in a ladder diagram format to operate a solenoid valve	Core
Competency H: Troubleshoots a PLC or a PLC controlled machine or process by observing input and output conditions and monitoring the program in real time	**Core or Optional**
PERFORMANCE CRITERIA	
1. Observes the input and output of PLC using proper software	Core
2. Troubleshoots any issues that may arise	Core
Competency I: Properly installs and terminates wiring for low level analog signals	**Core or Optional**
PERFORMANCE CRITERIA	
1. Connects and tests a limit switch to a discrete MicroLogix 1000 Input	Optional
2. Connects and tests the operation of a solenoid valve to a MicroLogix 1000 PLC output	Optional
3. Connects and tests the operation of a motor starter to a MicroLogix 1000 PLC output	Optional
4. Connects and tests the operation of an electronic sensor to a MicroLogix 1000 PLC input module	Optional
5. Develops an interface wiring diagram to interface a MicroLogix 1000 PLC to a machine controller	Optional

6. Connects and operates a conveyor system using Discrete MicroLogix 1000 PLC inputs and outputs	Optional
Competency J: Troubleshoots a machine or process utilizing a PLC or a Programmable Automation Controller (PAC) that implements closed loop process control and general purpose multi-axis motion control	**Core or Optional**
PERFORMANCE CRITERIA	
1. Designs a robot program that uses looping, speed, and delay commands to move an object	Optional
2. Troubleshoots program if issues arise	Optional

JOB FUNCTION 9: Performs work with robotic systems

Related Technical Instruction		
KNOWLEDGE	**SKILLS**	**TOOLS & TECHNOLOGIES**
• Methods for working safely • Principles of identification and mitigation • Measurement principles • Risk assessment techniques and protocols • Mathematical calculations and measurements • Computer and editor software • Software and coding	• Selecting proper tools and procedures • Using proper procedures in conducting work • Maintaining situational awareness • Clear thinking and speaking	• Robots • Conveyor systems • Computer programming • Vision systems

Competency A: Exercises appropriate safety procedures for working with robots	**Core or Optional**
PERFORMANCE CRITERIA	
1. Demonstrates safety rules and regulations for working around robots	Core
Competency B: Identifies the types of robots	**Core or Optional**
PERFORMANCE CRITERIA	
1. Identifies major systems of a robot	Core
2. Identifies a robot's "work envelope" in a manufacturing cell	Core
Competency C: Programs robot movement with a teach pendant	**Core or Optional**
PERFORMANCE CRITERIA	
1. Jogs a servo robot using a teach pendant	Core
2. Jogs a servo robot using the Pegasus control software	Core
3. Adjusts the fast and slow jog speed settings	Core
4. Uses a teach pendant to teach robot position points	Core

Competency D: Uploads, downloads, saves, and runs a robot program	Core or Optional
PERFORMANCE CRITERIA	
1. Uploads a robotics program to equipment	Core
2. Downloads a robotic program to equipment	Core
3. Saves a robotic program to equipment	Core
4. Runs a robotic program on equipment	Core
Competency E: Interfaces a robot to a conveyor system	**Core or Optional**
PERFORMANCE CRITERIA	
1. Describes how to interface a PLC to a robot using discrete I/O	Core
2. Designs a mechatronics PLC to robot workstation interface wiring diagram using discrete I/O	Core
Competency F: Interfaces an end effector to a robot controller	**Core or Optional**
PERFORMANCE CRITERIA	
1. Enters a robot program that uses the pmove command	Core
2. Enters a robot program that uses the grasp and release commands	Core
3. Designs a robot program to perform a basic material handling task	Core
4. Enters a robot program that uses the label and branch commands	Core
5. Enters a robot program that uses the speed and delay commands	Core
6. Designs a robot program that uses looping, speed, and delay commands to move an object	Core
Competency G: Calibrates a robot to a conveyor system	**Core or Optional**
PERFORMANCE CRITERIA	
1. Designs a robot program that uses a manual operator station	Core
2. Designs a robot program that will unload an automatic machine	Core

Competency H: Interfaces a robot to a vision system	Core or Optional
PERFORMANCE CRITERIA	
1. Develops an interface wiring diagram to interface a MicroLogix 1000 PLC to a machine controller	Optional
2. Connects and operates a conveyor system using discrete MicroLogix 1000 PLC inputs and outputs	Optional
Competency I: Sets up lighting for a vision system	**Core or Optional**
PERFORMANCE CRITERIA	
1. Connects and operates a basic lighting circuit	Optional
2. Connects and operates a rheostat as a light dimmer	Optional
Competency J: Teaches a vision system how to identify and orient good and bad products	**Core or Optional**
PERFORMANCE CRITERIA	
1. Tests teach points	Optional
2. Edits teach points	Optional
3. Enters and edits a basic robot program	Optional
Competency K: Troubleshoots a robot system, replaces components, and returns to operation	**Core or Optional**
PERFORMANCE CRITERIA	
1. Properly shuts down robotic system	Core
2. Diagnoses problems with robot	Core
3. Uses company manual for repair and ordering of spare parts	Core
4. Restarts robot after fixtures have been completed	Core

Competency L: Performs repair procedures on a robot arm	Core or Optional
PERFORMANCE CRITERIA	
1. Properly starts-up, operates, and shutdowns the robot	Core
2. Disassembles and reassembles mechanical unit	Core
3. Uses company manual for repair and ordering of spare parts	Core
4. Performs preventive maintenance procedures on the robot	Core
5. Calibrates robot with calibration fixtures	Core

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