

Lesson Exemplars for Mechatronics

TECH-PRO ELECTIVE

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LESSON EXEMPLAR			
Learning Area	MECHATRONICS	Lesson	1

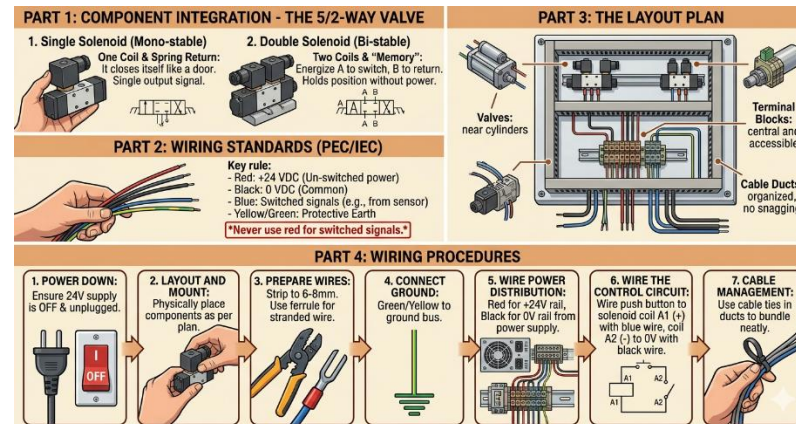
I. OBJECTIVES	
A. Content Standard	The learners demonstrate an understanding of the principles of mechatronics servicing including its fundamentals, installation, and servicing.
B. Performance Standard	The learners perform procedures in mechatronic system installation and servicing while ensuring adherence to safety precautions.
C. Learning Competencies	(LC4) Apply the procedures in installation of mechatronic system based on layout plan.
II. REFERENCES and MATERIALS	<p>DeepSeek. "Picture 1." Generated by AI. Accessed March 27, 2026. https://chat.deepseek.com/a/chat/s/a0dd898d-8d89-4383-9606-ad113a86bf9b.</p> <p>DeepSeek. "Picture 2." Generated by AI. Accessed March 27, 2026. https://chat.deepseek.com/a/chat/s/a0dd898d-8d89-4383-9606-ad113a86bf9b.</p> <p>Department of Education. "Strengthened SHS Program." Department of Education. Accessed March 26, 2026. https://www.deped.gov.ph/strengthened-shs-program/.</p> <p>Festo Didactic. *Electropneumatics - Basic Level (TP 201)*. Festo Didactic SE, 2018.</p> <p>Institute of Integrated Electrical Engineers of the Philippines, Inc. <i>Philippine Electrical Code (PEC) Part 1</i>. 2017 ed. IIEE, 2017.</p> <p>Ningbo VPC Pneumatic Co., Ltd. "How Does a 5/2 Solenoid Valve Work?" YouTube. November 1, 2022. Video, 0:30. https://www.youtube.com/shorts/cIRkyDtJyB4.</p> <p>Siemens AG. <i>Industrial Control Wiring Guide</i>. Siemens AG, 2019.</p> <p><i>(The materials/equipment required for this lesson exemplar are aligned with and can be found in the prescribed Curriculum Guide. These resources are officially identified to support the delivery of the lesson and ensure consistency with the standards and competencies set by the curriculum.)</i></p>

III. CONTENT	<p>To develop this understanding, you are expected to teach the following topic:</p> <ul style="list-style-type: none"> Mechatronic Systems Installation <ul style="list-style-type: none"> Electro-Pneumatics Component Integration and System Wiring. (** A+, A-. using 5/2way solenoid valve) <p>As you teach this topic, learners will clearly distinguish among the related processes of electrical control signaling and pneumatic power execution. These will help learners organize their thinking and better understand how the transition from electrical command signals to mechanical fluid movement ensures the development of precise, high-speed, and robust industrial actuation systems.</p>
IV. OBJECTIVES	<p>At the end of the lesson, the learners should be able to:</p> <ol style="list-style-type: none"> identify and assemble the electrical symbols and physical components of a 5/2-way solenoid valve and its corresponding cylinder based on a given sequence condition; install and validate the electro-pneumatic circuit based on layout plans following PEC/IEC wiring standards; test and troubleshoot the electro-pneumatic circuit using systematic diagnostic procedures to ensure proper operation; and demonstrate compliance with safety procedures by performing a pre-power check and properly wearing appropriate personal protective equipment (PPE) during installation.
V. PROCEDURES	
A. Activating Prior Knowledge	<p>1. Activating Prior Knowledge (Activity Title: Name That Symbol)</p> <div data-bbox="846 911 1218 1150" data-label="Image"> </div> <p style="text-align: center;"><i>Electro-Pneumatic Symbols</i></p> <div data-bbox="1496 847 2056 1401"> <p>Facilitation Notes:</p> <p>Activity 1: Name That Symbol!</p> <p>The teacher flashes images of:</p> <ol style="list-style-type: none"> 5/2-way solenoid valve symbol Spring return symbol Limit switch (electrical) symbol Double-acting cylinder symbol DC power supply symbol <p>This quick activity uses visual recognition to activate prior knowledge on pneumatic symbols and electrical basics.</p> </div>

	<p>2. Establishing the Purpose of the Lesson</p> <p>The teacher will give a brief statement:</p> <p>"As a Mechatronics Technician, your mission is to transform a layout plan into a functional automated system by precisely wiring a 24V DC control circuit to a 5/2-way solenoid valve, ensuring every connection meets the professional neatness, color-coding, and safety standards mandated by the Philippine Electrical Code (PEC).</p>	<p>Rationale: It bridges the gap between the previously learned pneumatic control and the new concept of electro-pneumatic integration.</p> <p><i>*Picture 1 – generated from DeepSeek</i> https://chat.deepseek.com/a/chat/s/a0dd898d-8d89-4383-9606-ad113a86bf9b</p> <p>Facilitation Notes: The purpose is explicitly stated, connecting the lesson's activities to the real-world role of a mechatronics technician. The mention of safety standards emphasizes professionalism.</p> <p>Rationale: Providing a clear "why" increases student engagement and helps them see the value of what can be tedious wiring tasks.</p>
<p>B. Instituting New Knowledge</p>	<p>1. Presenting Examples</p> <p>The teacher presents an instructional video about the working principle of 5/2way valve and double-acting cylinder.</p> 	<p>Facilitation Notes:</p> <p>This provides a "vision of success." The circuit presented should be a simple A+ A- (extend/retract) sequence using a 5/2-way single solenoid valve.</p> <p><i>Instructional video links from Youtube Channel: Ningbo VPC Pneumatic Co., Ltd.</i></p>

How does a 5/2 solenoid valve work?
<https://www.youtube.com/shorts/cIRkyDtJyB4>

2. Discussing New Concept



Mechatronics System Installation

Component Integration - The 5/2-way Valve

1. **Single Solenoid (Mono-stable):** This has one coil. It uses a spring to return to its normal position when the coil is de-energized. It's like a door that closes itself. In our wiring, this requires a single output signal.

2. **Double Solenoid (Bi-stable):** This has two coils. It has a 'memory'. If you energize coil A, the valve switches and stays there even after you de-energize coil A. You need to energize coil B to switch it back. This is crucial for systems that need to hold a position without continuous power.

Wiring Standards (PEC/IEC)

- **Red:** +24 VDC (Un-switched power).
- **Black:** 0 VDC (Common or Ground).
- **Blue:** Switched control signals (e.g., from a sensor or push button to an input on a relay or PLC).

Facilitation Notes:

This is the core lecture. The teacher should have the physical components on hand to point to while explaining. This guide is written to be read directly or used as the teacher's script.

Rationale:

A structured, detailed lecture ensures all students receive the same foundational knowledge regarding component identification, safety standards, and wiring procedures before they start the hands-on task.

*Picture 2 - generated from DeepSeek
<https://chat.deepseek.com/a/chat/s/a0dd898d-8d89-4383-9606-ad113a86bf9b>

	<p>- Yellow/Green: Protective Earth (for the power supply chassis).</p> <p><i>Never</i> use a red wire for a switched signal. This is a safety standard. If someone later troubleshoots the system, they know a red wire is always live.</p> <p>The Layout Plan Valves: Mounted on a manifold near the cylinders to reduce air line length. Terminal Blocks: Placed in a central, accessible location. All field wires (from sensors, valves) go to the terminal block, not directly to the controller. Cable Ducts: Wires are routed through ducts to keep the panel neat and prevent snagging.</p> <p>Wiring Procedures 1. Power Down: Ensure the 24V power supply is OFF and unplugged. 2. Layout and Mount: Physically mount the components (valve, terminal block) on the panel as per the layout plan. 3. Prepare Wires: Strip wires to the correct length (usually 6-8mm). For stranded wire, use a ferrule to prevent fraying under the screw terminal. 4. Connect Ground: Connect the protective earth (green/yellow) from the power supply's grounding terminal to the panel's ground bus. 5. Wire Power Distribution: Run a red wire from the +24V terminal of the power supply to the common rail of your terminal block. Run a black wire from the 0V terminal to another common rail. 6. Wire the Control Circuit: This is where we follow our diagram. For our simple A+ A- circuit:</p>	<p>Facilitation Notes:</p> <p>Activity 2: Build, Wire, Test</p> <p>Differentiated Guided Practice</p> <p>To accommodate varied learner abilities:</p> <ul style="list-style-type: none"> • Beginning Learners <ul style="list-style-type: none"> ○ Use color-coded wiring guides and labeled terminal diagrams. ○ Receive step-by-step scaffolding checklist during installation. • Developing Learners <ul style="list-style-type: none"> ○ Perform wiring with minimal prompts and peer support. • Advanced Learners <ul style="list-style-type: none"> ○ Modify the circuit using a double-solenoid valve or additional sensors in FluidSIM.
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	<p>- From the terminal block's +24V rail, wire to one side of the push button.</p> <p>- From the other side of the push button, wire a blue wire to the A1 (coil +) terminal of the solenoid valve.</p> <p>- From the A2 (coil -) terminal of the solenoid, wire a black wire back to the terminal block's 0V rail.</p> <p>7. Cable Management: Use cable ties to bundle wires neatly in the ducts. This isn't just for looks; it prevents electrical noise and makes troubleshooting easier.</p> <p>3. Developing Mastery (Activity 2 Build, Wire, Test)</p> <p>Task: Learners will build the simple A+ A- circuit they saw/watched in the instructional video.</p> <p>Key steps to remember:</p> <ol style="list-style-type: none"> 1. Power off the control circuit while working. 2. Match the wire colors to the standard. 3. Use the layout for component placement. 4. Ask the teacher when testing the control circuit. <p><i>Follow questions:</i></p> <ol style="list-style-type: none"> 1. "Why did you use a blue wire there?", "Can you show me where the 0V common is?", 2. "Is the coil on the valve rated for 24V DC? Check the datasheet." 	<p>Peer Coaching Strategy</p> <p>Each group assigns:</p> <ul style="list-style-type: none"> • Lead Installer • Safety Inspector • Wiring Validator • Documentation Officer <p>This ensures active participation and collaborative learning.</p> <p>Rationale:</p> <p>"We do" phase allows for immediate correction and peer collaboration in a low-stakes environment before individual assessment.</p>
<p>C. Demonstrating Knowledge and Skills</p>	<p>1. Finding Practical Application (Activity 3 Test Before You Power!)</p> <p>Let the students perform the testing procedures on installed electro-pneumatic circuit.</p>	<p>Facilitation Notes:</p> <p>Activity 3: Test Before You Power!</p> <p>After groups have their circuit wired, the teacher performs a guided pre-</p>

- Continuity Check
- Short Circuit Check
- Check Coil Resistance

Testing Procedures Checklist

Student

Name: _____ Date: _____

Group No.: _____

Instructions: Perform the three testing procedures on your installed electro-pneumatic circuit. Check each item as you complete it. Ask the teacher to verify your results.

Test Procedure	Task	Status	Teacher Verification
1. Continuity Check	Set multimeter to continuity mode (beep symbol). Place one probe on the +24V terminal block rail. Place the other probe on the wire going to the solenoid A1 terminal.	Pass ☐ Fail ☐	☐ Verified
2. Short Circuit Check	Set multimeter to continuity mode. Place one probe on the +24V rail. Place the other probe on the 0V rail. Ensure there is NO beep or low resistance reading.	Pass ☐ Fail ☐	☐ Verified
3. Coil Resistance Check	Set multimeter to resistance (Ω) mode. Place probes on solenoid coil terminals A1 and A2. Record resistance reading: _____ Ω (Expected: 50–200 Ω)	Pass ☐ Fail ☐	☐ Verified

power check using a multimeter. The teacher demonstrates the process, then asks groups to perform the same checks.

Rationale:

This is a critical safety and professional practice. It teaches students that a technician does not simply 'turn it on and hope for the best'. This activity applies their knowledge of electricity (continuity, resistance) to a real-world verification task.

Facilitation Notes:

Use a "Think-Pair-Share" structure. This allows students to process their learning individually before articulating it to a partner and then to the class.

Rationale:

Solidifies the abstract concept of translating a plan to a physical system and reinforces the importance of standards.

	<p>2. Making Generalization</p> <p>Let the learners answer the following:</p> <p><i>In your own words, what is the most important reason we follow a layout plan and strict wiring standards like color coding and pre-power checks? Discuss this with your partner. After one minute, I'll ask a few pairs to share."</i></p> <p>3. Evaluating Learning</p> <p>Quiz: Electro-pneumatic Component Integration and Wiring</p> <p>I. Multiple Choice (1 point each). Choose the letter of the best answer.</p> <ol style="list-style-type: none"> 1. According to PEC/IEC standards for a 24 VDC system, what color wire is used for a switched control signal? <ol style="list-style-type: none"> a) Red b) Black c) Blue d) Yellow/Green 2. A 5/2-way bi-stable (double solenoid) valve is characterized by: <ol style="list-style-type: none"> a) A spring return mechanism. b) A single coil that needs continuous power to stay switched. c) Two coils that allow the valve to maintain its position without power. d) An inability to control a double-acting cylinder. 3. What is the primary purpose of performing a pre-power check using a multimeter before energizing a circuit? <ol style="list-style-type: none"> a) To measure the voltage output of the power supply. b) To verify the system is aesthetically pleasing. c) To check for short circuits and ensure continuity as per the schematic. d) To test the speed of the cylinder. 	<p>Facilitation Notes:</p> <p>Distribute the quiz. This is a summative assessment of the knowledge and comprehension parts of the objectives.</p> <p>Rationale:</p> <p>To formally assess students' understanding of component symbols, wiring standards, and the functional difference between valve types.</p> <p>Facilitation Notes:</p> <p>Provide early finishers with access to FluidSIM. Display the task on the board or give a printed task card. Circulate briefly to confirm students understand the goal: to design a bi-stable (memory) circuit. Have students test their simulation and call the teacher for a "design review" before saving.</p> <p>Rationale:</p> <p>This challenges advanced students to apply their knowledge of the 5/2-way double solenoid valve in a practical simulation. Using PEC color codes reinforces professional standards in a risk-free environment. It also prepares them for more complex sequencing circuits in future lessons.</p>
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	<p>4. What is the primary function of a terminal block in a control panel?</p> <p>a) To provide a mounting point for the solenoid valve. b) To serve as a central, organized point for making electrical connections. c) To regulate the air pressure to the cylinder. d) To act as a manual override for the system.</p> <p>5. Which of the following is an example of an industry wiring standard?</p> <p>a) Using the same color wire for all connections to save money. b) Stripping wires to at least 2 inches to ensure a good connection. c) Routing wires through cable ducts and using cable ties. d) Connecting wires without ferrules for stranded wire.</p> <p>4. Additional Activities</p> <p>Enrichment: For those who finish early, design a circuit in FluidSIM that uses a 5/2-way double solenoid valve to control a cylinder that extends and retracts based on two separate push buttons (one for extend, one for retract). Implement the wiring using our PEC color codes.</p> <p>Remediation: For those who need more practice, you will work with the teacher assistant to re-wire the simple A+ A- circuit. Focus will be on proper wire stripping, using ferrules, and correctly landing wires on the solenoid valve terminals. A checklist will guide you.</p>	<p>Facilitation Notes:</p> <p>Pull struggling students into a small group with the teacher or assistant. Provide a laminated step-by-step checklist with visuals for wire stripping, ferrule crimping, and terminal connections. Use a "watch-do" approach: demonstrate, then have the student perform while verbalizing the steps.</p> <p>Rationale:</p> <p>This addresses foundational wiring skills that are critical for success. The checklist reduces cognitive load, allowing students to focus on precision. Small-group instruction provides immediate feedback and builds confidence before moving to more complex tasks.</p>
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VI. ASSESSMENT	<p align="center">Culminating Performance Task: Electro-Pneumatic System Installation</p> <p>Scenario: You are a newly hired Mechatronics Technician at "Precision Automation Inc." Your supervisor has assigned you a task: to install the control system for a double-acting cylinder on a packaging line based on a provided layout plan. The system must extend when a push button is pressed and retract when a limit switch is activated.</p> <ul style="list-style-type: none"> • Layout Plan: A schematic and physical layout diagram is provided showing a 5/2-way single solenoid valve, a double-acting cylinder, a push button, a roller lever limit switch, and a 24VDC power supply. • Task: Using the provided components, materials, and safety guidelines, you must install and wire the system according to the layout plan and PEC standards. <p>Rubric</p>				
	Criteria	Excellent (4)	Proficient (3)	Developing (2)	Beginning (1)
	Component Layout	All components mounted accurately and logically following layout plan	Minor placement errors with accessible layout	Several placement errors affecting accessibility	Layout plan not followed
	Wiring and Termination	All wires properly stripped, ferrules secured, and wiring neatly routed	Minor wiring inconsistencies observed	Multiple loose or improper terminations	Unsafe or incorrect wiring connections
	Wiring Standards Compliance	All PEC/IEC color codes followed correctly	1–2 minor colorcoding errors	Multiple coding errors present	Color coding largely incorrect
	System Functionality	Circuit operates completely as intended without faults	Circuit functions with minimal adjustment	Partial functionality observed	Circuit fails to operate

	Troubleshooting and Testing	Continuity, short circuit, and resistance tests completed accurately and independently	Testing completed with minor assistance	Testing completed with significant assistance	Testing procedures not completed properly
	Safety Compliance	PPE worn correctly and all pre-power safety procedures followed consistently	Minor safety reminders needed	Multiple safety reminders needed	Safety procedures disregarded
VII. REFLECTION	<p><i>Teacher's Reflection</i></p> <p>1. Teacher's Highlights:</p> <p>Which part of the lesson were students most engaged with? Was it the simulation, the hands-on wiring, or the pre-power check?</p> <p>2. Challenges Encountered:</p> <p>Did students struggle with wire color coding or interpreting the layout plan? Were there any safety concerns that needed immediate attention?</p> <p>3. Adjustments and Innovations:</p> <p>What changes will I make next time? Should I spend more time on ferrule crimping? Should I provide a larger, clearer layout plan?</p> <p><i>Learner's Reflection</i></p> <p>Name: _____ Date: _____</p>				

	4. Self-Assessment			
	Skill	I Can Perform Independently	I Need Assistance	I Need More Practice
	Assemble electro-pneumatic components	☐	☐	☐
	Validate wiring using layout plans	☐	☐	☐
	Troubleshoot wiring faults	☐	☐	☐
	Follow PEC/IEC standards	☐	☐	☐
	Perform safe pre-power testing	☐	☐	☐
	<p>One thing I will improve next time: _____.</p> <p>5. Application to Real Life</p> <p>In one sentence, explain how today's lesson connects to a real-world job or situation: _____.</p>			
VIII. USE OF GENERATIVE AI	<p>In preparing this Learning Exemplar (LE), the author(s) used DeepSeek in order to structure the assessment framework, generate a realistic industrial mixing scenario, and align the technical requirements with Mechatronics System Installation and Servicing content and performance standards. The author(s) reviewed and finalized the writing of the content. The author(s) take(s) full responsibility for the content of this LE.</p>			

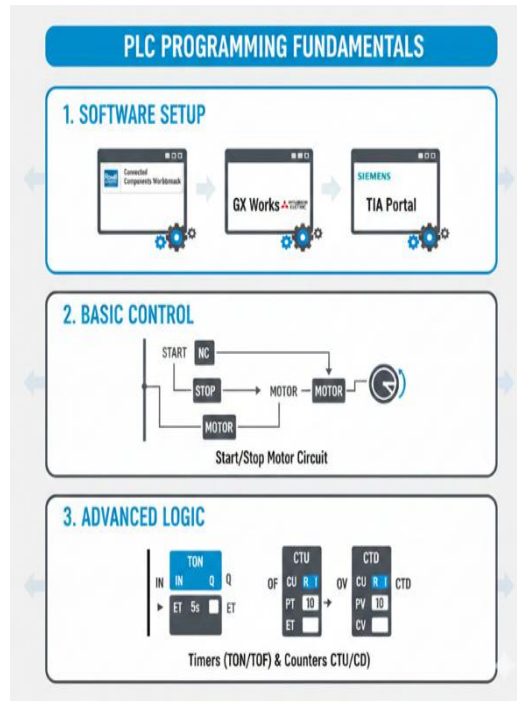
LESSON EXEMPLAR			
Learning Area	MECHATRONICS	Lesson	2

I. OBJECTIVES	
A. Content Standard	The learners demonstrate an understanding of the principles of programmable logic controllers, and control logic programming.
B. Performance Standard	The learners perform procedures in programmable logic controller programming and configuring while ensuring adherence to safety precautions.
C. Learning Competencies	(LC3) Perform programmable logic controller programming.
II. REFERENCES and MATERIALS	<p>Department of Education. “Strengthened SHS Program.” Accessed March 26, 2026. https://www.deped.gov.ph/strengthened-shs-program/.</p> <p>Google Gemini. “PLC Program Implementation & Debugging Infographic.” AI-generated image, February 25, 2026.</p> <p>Google Gemini. “PLC Programming Fundamentals Infographic.” AI-generated image, February 25, 2026.</p> <p>Google Gemini. “PLC System Configuration & Safety Infographic.” AI-generated image, February 25, 2026.</p> <p>Omron. <i>CSM_PLC Basic_TG_E_1_1: Technical Guide for PLCs</i>. Accessed March 26, 2026. https://www.ia.omron.com/data_pdf/guide/26/plc_tg_fi.pdf.</p> <p>Siemens. <i>SIMATIC S7-200 SMART System Manual</i>. Accessed March 26, 2026. https://assets.new.siemens.com/siemens/assets/api/uuid:aa045b50-b9f4-4e46-a4c4-ca882c5f00ec/s7-200-smart-system-manual-en-us.pdf.</p> <p>Technical Education and Skills Development Authority (TESDA). <i>Training Regulations: Mechatronics Servicing NC II</i>. Taguig City: TESDA.</p>

	<p>Warden's Corner. "Warden's Corner YouTube Channel." YouTube. Accessed March 26, 2026. https://www.youtube.com/@WardensCorner.</p> <p><i>(The materials/equipment required for this lesson exemplar are aligned with and can be found in the prescribed Curriculum Guide. These resources are officially identified to support the delivery of the lesson and ensure consistency with the standards and competencies set by the curriculum.)</i></p>	
III. CONTENT	<p>To develop this understanding, you are expected to teach the following topic:</p> <ul style="list-style-type: none"> • PLC Programming: Control Logic Programming and Simulation. <p>As you teach this topic, learners will clearly distinguish among the related processes of control logic programming, and system simulation. These will help learners organize their thinking and better understand how the transition from digital code to physical device communication ensures the development of reliable, flexible, and efficient automation systems.</p>	
IV. OBJECTIVES	<p>At the end of the lesson, the learners should be able to:</p> <ol style="list-style-type: none"> 1. create a ladder logic program based on given industrial control logic conditions; 2. modify existing ladder logic rungs by integrating additional input and output devices; 3. simulate ladder logic programs using PLC simulation software; and 4. demonstrate diligence and accuracy in checking program modifications before simulation. 	
V. PROCEDURES		ANNOTATIONS
A. Activating Prior Knowledge	<p>1. Activating Prior Knowledge</p> <p>Activity 1 Think It, Write It</p> <p>Students are asked to write down the exact logic steps for a common automated task, such as a Household Toaster or a Smart Crosswalk Signal.</p> <p>Example: IF (Bread is in) AND (Lever is down) THEN (Heater = ON).</p> <p>2. Establishing the Purpose of the Lesson</p> <p>The Hook: "The World Without PLCs"</p>	<p>Facilitation Notes:</p> <p>Activity 1 Think It, Write It</p> <p>Circulate and challenge their "AND/OR" logic. If a student says "The toaster starts when I push the button," ask, "What if the toaster isn't plugged in?" This introduces the concept of Permissive (conditions that must be met before an output turns on) in a way that feels like common sense rather than complex engineering.</p>

	<ul style="list-style-type: none"> Present a high-speed video of a modern Amazon fulfillment center or a Tesla assembly line. Suddenly pause the video. 	<p>Facilitation Notes:</p> <p>The Hook</p> <p>Ask the class: "If we had to replace this one controller with 1,000 people flipping manual switches, could we maintain this speed or safety?" Use this to define the PLC as the multiplier of human intent.</p>
B. Instituting New Knowledge	<p>1. Presenting Examples</p> <p>Activity 2 Watch and Learn</p> <p>The teacher will discuss/show instructional videos for Programmable Logic Controllers (introduction to ladder logic programs).</p> <p>#ArduinoPLC PLC Ladder Simulator Version 2.0 OVERVIEW - https://www.youtube.com/watch?v=QiUb5XdqF3Q&t=23s</p> <p>Concept of Latches/Sealing Circuits (Start/Stop Control) SIEMENS PLC PROGRAMMING TUTORIAL START-STOP CONTROL - https://www.youtube.com/watch?v=FHGcPJifyos</p>	<p>Facilitation Notes:</p> <p>Activity 2 Watch and Learn</p> <ul style="list-style-type: none"> Before video: Ask students what devices they know that work automatically (e.g., traffic light, vending machine). Introduce PLC as the "brain" of a machine. Explain ladder logic as a graphical programming language that looks like electrical diagrams. Tell students to watch for basic symbols (input, output, rung). During video: Play short video (max 5 minutes). Pause when symbols appear. Ask quick questions like "Is this an input or output?" Play second video showing a simple simulation. Ask students to predict what happens when a button is pressed.

2. Discussing New Concept



PLC Programming: Quick Guide

Software Setup

Before coding, you must match your digital environment to your physical hardware.

- **Pick Your Platform:** Use TIA Portal (Siemens), GX Works (Mitsubishi), or CCW (Rockwell).
- **Configure Hardware:** Define your CPU model and I/O modules so the software knows where the physical wires are connected.
- **Establish Comm-Link:** Set up the IP address or USB driver to "talk" to the PLC.

- **After video:** Draw one simple rung on the board (normally open contact + output coil). Ask students to name the symbols shown. Connect back to their earlier toaster logic example. Clarify that ladder logic is scanned repeatedly, not a real circuit.

- **Transition:** Announce that students will now create their own ladder diagram based on logic conditions.

Instructional video links from Youtube Channel: Warden's Corner originally owned by Mark Andrew L. Yague

Facilitation Notes:

Set up the PLC software, create a start/stop logic circuit with timers and counters, download the program to the PLC, monitor its online operation, and test and debug any errors in the ladder logic.

For further information on these topics, refer to the following:

YT Channel: Warden's Corner

Basic Control (The Start/Stop)

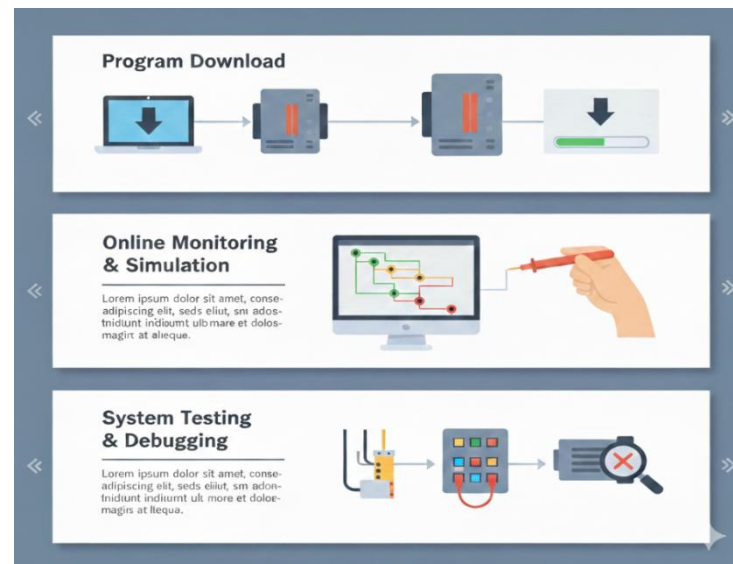
The foundation of industrial logic, ensuring a motor stay running after a momentary button press.

- The "Seal-In" Logic: You place a contact from the Motor Output in parallel with the Start Button.
- The Result: Once the motor starts, it "holds itself on" until the Stop Button breaks the circuit.

Timers & Counters

These add intelligence to the sequence.

- Timers (TON/TOF): * TON (On-Delay): Waits \$X\$ seconds before starting (e.g., a warning siren before a belt moves).
 - TOF (Off-Delay): Keeps a device running for \$X\$ seconds after the signal stops (e.g., a cooling fan).
- Counters (CTU/CTD): * CTU (Count Up): Counts parts on a belt.
 - CTD (Count Down): Tracks remaining items in a hopper.



- SIEMENS | PLC PROGRAMMING TUTORIAL | PLC SET-UP - <https://www.youtube.com/watch?v=EwaLZFNI7Og&t=6s>
- SIEMENS | PLC PROGRAMMING TUTORIAL | Creating Ladder Logic Program - https://www.youtube.com/watch?v=OeVii_Q_EAw&t=76s
- OMRON PLC | HOW TO CREATE A LADDER PROGRAM - <https://www.youtube.com/watch?v=xxTmvdZf8PU&t=6s>
- MITSUBISHI PLC PROGRAMMING | GX-DEVELOPER 8 SOFTWARE - <https://www.youtube.com/watch?v=nxMSA1R8QWc&t=19s>
- OMRON CJ1M | PLC I/O CARDS SET-UP | ID211 | OD211 - <https://www.youtube.com/watch?v=L3phTJ5L0bI&t=35s>

Facilitation Notes:

Activity 3 | Logic Challenge Before Activity

- Read the logic condition to the class.
- Ask: "How many inputs and outputs are needed?"

	<p>Program Download This is the transfer of your logic from the development environment to the PLC's brain.</p> <ul style="list-style-type: none"> • The Process: You connect your PC to the PLC (via Ethernet or USB) and "Download" the compiled code. • The State: The PLC is usually placed in STOP or PROGRAM mode during the transfer and then switched to RUN mode to execute the logic. <p>Online Monitoring Once the program is running, you "Go Online" to watch the logic live.</p> <ul style="list-style-type: none"> • Visual Feedback: In your ladder logic, the "power rails" and energized contacts will change color (usually green or blue) to show current flow. • Real-Time Data: You can see timer values counting up or sensor statuses changing as physical events happen on the factory floor. <p>Testing & Debugging This is the final validation where you ensure the hardware and software work in harmony.</p> <ul style="list-style-type: none"> • I/O Checkout: Manually triggering a sensor to ensure the correct input light turns on in the software. • Forcing Bits: Temporarily "forcing" an output to turn on within the software to test if a motor or lamp is wired correctly. • Troubleshooting: Identifying "bugs" (logical errors) or wiring faults if the system doesn't behave as expected during the trial run. <p>3. Developing Mastery</p> <p>Activity 3 Logic Challenge Task: Design a ladder logic diagram for a system that controls a single pneumatic cylinder based on logic condition below:</p>	<p>During Activity</p> <ul style="list-style-type: none"> • Tell students to list inputs and outputs first. • Remind them: Start (NO), Stop (NC), Limit Switch (NO), Cylinder Output. • Tell them to draw the ladder diagram. • Walk around and check their work. <p>After Activity</p> <ul style="list-style-type: none"> • Call one student to draw their answer on the board. • Show the correct diagram and explain briefly. • Correct any mistakes. <p>Note: Ensure students understand that the cylinder retracts automatically only after the limit switch is activated, not immediately after extending.</p> <p>Additional:</p> <p>Rubric-Guided Debugging Conference</p> <p>During simulation, the teacher conducts short conferencing sessions using observable indicators such as:</p> <ul style="list-style-type: none"> • correct rung sequencing,
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	<ul style="list-style-type: none">When a "Start" button is pressed, the cylinder extends. When it reaches the fully extended position (detected by a limit switch), it automatically retracts. A "Stop" button should halt the process at any point. <p>Steps:</p> <ol style="list-style-type: none">List the physical inputs and outputs required.Draw the ladder logic diagram for this control sequence. <p>Rubrics</p> <table><tr><th>Criteria</th><th>Exemplary (4)</th><th>Proficient (3)</th><th>Developing (2)</th><th>Beginning (1)</th></tr><tr><td>I/O Identification</td><td>All physical inputs (Start, Stop, Limit Switch) and outputs (Solenoid) are correctly identified and addressed.</td><td>Most inputs and outputs are identified, with minor errors in addressing or labeling.</td><td>Only basic inputs (Start/Stop) are listed; missing limit switch or solenoid.</td><td>Failed to list or incorrectly identified the necessary I/O components .</td></tr><tr><td>Logic & Sequencing</td><td>Ladder logic perfectly executes the sequence: Start → Extend → Limit Switch → Retract.</td><td>The sequence is functional but contains minor logic gaps (e.g., erratic retraction).</td><td>The system starts and extends but fails to retract or loop correctly.</td><td>The logic does not initiate the cylinder or follow the required sequence.</td></tr><tr><td>Safety & Control (Stop Function)</td><td>"Stop" button is correctly programmed to halt the process instantly at any point in the cycle.</td><td>"Stop" button works but only at specific stages of the sequence</td><td>"Stop" button is present in the diagram but incorrectly wired in the logic.</td><td>No "Stop" button or safety interlock is included in the design.</td></tr></table>	Criteria	Exemplary (4)	Proficient (3)	Developing (2)	Beginning (1)	I/O Identification	All physical inputs (Start, Stop, Limit Switch) and outputs (Solenoid) are correctly identified and addressed.	Most inputs and outputs are identified, with minor errors in addressing or labeling.	Only basic inputs (Start/Stop) are listed; missing limit switch or solenoid.	Failed to list or incorrectly identified the necessary I/O components .	Logic & Sequencing	Ladder logic perfectly executes the sequence: Start → Extend → Limit Switch → Retract.	The sequence is functional but contains minor logic gaps (e.g., erratic retraction).	The system starts and extends but fails to retract or loop correctly.	The logic does not initiate the cylinder or follow the required sequence.	Safety & Control (Stop Function)	"Stop" button is correctly programmed to halt the process instantly at any point in the cycle.	"Stop" button works but only at specific stages of the sequence	"Stop" button is present in the diagram but incorrectly wired in the logic.	No "Stop" button or safety interlock is included in the design.	<ul style="list-style-type: none">proper latching,accurate timer operation,successful troubleshooting process. <p>This strengthens reflective problem-solving and debugging habits.</p>
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	Circuit Integrity (Latching)	Uses professional latching (seal-in) or SET/RESET logic appropriately for continuous operation.	Latching is used but may require multiple presses or has slight instability.	Attempted latching logic, but the system requires the button to be held down.	No latching logic used; system only operates momentarily .	
	Documentation & Symbols	Standard LD symbols used throughout; rungs are neatly organized and clearly labeled/commented.	Standard symbols used; diagram is legible but lacks some labels or comments.	Non-standard symbols used; diagram is cluttered or difficult to follow.	Diagram is disorganized , missing rungs, or uses incorrect notation.	
C. Demonstrating Knowledge and Skills	<p>2. Finding Practical Application</p> <p>Where is this logic used in real life?</p> <ul style="list-style-type: none"> ○ Conveyor belts ○ Water pumps ○ Factory automation lines ○ Elevators <p>Real-life Application Scenario:</p> <ul style="list-style-type: none"> • Ask: “How does a water pump automatically stop when the tank is full and start again when it’s empty? Could we do that using a PLC?” <p>2. Making Generalization</p> <ul style="list-style-type: none"> • "PLC logic mimics traditional relay control circuits using digital programming." • "Using PLCs allows for greater flexibility, easier troubleshooting, and scalability in automation systems." 					<p>Facilitation Notes:</p> <ul style="list-style-type: none"> • Ask students to name other machines that extend and retract automatically. <p><i>Conveyor belts, Water pumps, Factory automation lines, Elevators:</i></p> <ul style="list-style-type: none"> • Give one real-life example for each and ask students to add more. <p><i>Real-life Application Scenario (Water pump):</i></p> <ul style="list-style-type: none"> • Ask: "How does a PLC use a float switch to start and stop a water pump automatically?"

	<p>3. Evaluating Learning</p> <p>Assessment Methods:</p> <p>1. Written Quiz:</p> <ul style="list-style-type: none"> ○ Define the purpose of a Start and Stop button in control systems. ○ Describe the latching function in PLC logic. ○ Identify input/output addresses in a PLC ladder diagram. <p>2. Practical Test:</p> <ul style="list-style-type: none"> ○ Students create and simulate a Start-Stop ladder diagram. ○ Download it to a PLC and demonstrate functionality. <p>4. Additional Activities</p> <p>For Application:</p> <ul style="list-style-type: none"> • Challenge Activity: Add an emergency stop and indicator light to the PLC Start-Stop circuit. <p>For Remediation:</p> <ul style="list-style-type: none"> • Peer tutoring or step-by-step programming practice. • Simulated activities using drag-and-drop PLC software for students needing conceptual reinforcement. 	<p>Facilitation Notes:</p> <p>For Application (Challenge Activity):</p> <ul style="list-style-type: none"> • Tell students to add an emergency stop button (NC) in series and a red indicator light parallel to the output. <p>For Remediation (Peer Tutoring):</p> <ul style="list-style-type: none"> • Pair struggling students with more advanced classmates for guided ladder logic practice. <p>For Remediation (Simulated Activities):</p> <ul style="list-style-type: none"> • Let students use drag-and-drop PLC software to build basic circuits before writing actual code.
VI. ASSESSMENT	<p>Part 1: Technical Knowledge (Content Standard)</p> <p>Objective: Demonstrate understanding of PLC logic programs and control circuit condition.</p> <p>1. Logic Conversion: Convert the AND circuit into a standard Ladder Logic (LAD) program.</p>	

	<ol style="list-style-type: none"> 2. Addressing & Memory: Explain the difference between a Physical I/O address (e.g., %I0.1) and an Internal Marker/Bit (e.g., %M0.1). When would you use a Marker instead of a direct output? 3. Scan Cycle: Briefly describe the three stages of the PLC scan cycle. What happens if a sensor state changes while the PLC is in the "Execute Program" phase? <p>Part 2: The Design Challenge (Performance Standard)</p> <p>Scenario: The Industrial Mixing Station</p> <p>You are tasked with programming a system that mixes two liquids. The process follows these requirements:</p> <ul style="list-style-type: none"> • Start/Stop: A momentary Start button begins the process; a Stop button terminates all operations immediately. • Filling: When started, Valve A opens until Level Sensor High is reached. • Agitation: Once full, a Mixer Motor runs for 15 seconds to blend the liquids. • Drainage: After mixing, Valve B opens to drain the tank. It closes once Level Sensor Low is triggered. • Safety: If the Emergency Stop is pressed, a Red Pilot Light must flash at a 2Hz frequency. <p>Your Deliverables:</p> <ol style="list-style-type: none"> 1. I/O Wiring Map: Create a table listing all Inputs and Outputs with their assigned addresses. 2. Ladder Logic Diagram: Develop the code to meet the scenario requirements. Ensure you use a Seal-in Circuit or Latch for the system run state. 3. Validation: Explain how you would use a "Watch Table" or "Force Table" to test the Agitation timer without waiting for the tank to fill.
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	Criteria	Exemplary (4)	Proficient (3)	Developing (2)	Beginning (1)
	I/O Identification	Correctly identifies and assigns all required inputs and outputs with accurate addresses	Minor errors in labels or addresses	Several missing or incorrect I/O assignments	Unable to identify required I/O devices
	Logic Development	Constructs complete and accurate ladder logic sequence with proper control flow	Logic sequence functions with minimal errors	Partial sequence works but contains logic inconsistencies	Logic sequence does not operate correctly
	Safety and Control Logic	Integrates functional Stop and safety interlocks correctly throughout the sequence	Safety logic works with minor issues	Safety devices included but improperly programmed	Safety logic absent or nonfunctional
	Latching and Sequencing	Implements stable and correct seal-in/latching logic independently	Latching logic functional with minor corrections	Latching unstable or incomplete	No functioning latching logic
	Troubleshooting and Debugging	Independently identifies, explains, and corrects logic errors before simulation	Identifies most errors with minimal guidance	Requires assistance in locating errors	Unable to debug or correct logic errors
	Documentation and Organization	Uses complete labels, comments, and standard PLC symbols consistently	Minor omissions in labeling or organization	Inconsistent labels and cluttered layout	Diagram lacks organization and standard notation

VII. REFLECTION	<p>Reflection Activity:</p> <div><div>1. What is the most common point of confusion for students when they first learn to connect a PLC program address (e.g., I:0/1) to a physical wire on a terminal block? What is one analogy or demonstration you could use to clarify this concept?</div><div>2. Considering budget and safety constraints, describe a simple, low-cost project that would allow every student to practice the programming and configuration. Think beyond just simulators. What simple inputs and outputs could be used?</div></div> <p>For Students (Reflection):</p> <p>Self-Assessment Checklist</p> <table><tr><th>Skills</th><th>I Can Do Independently</th><th>I Need Assistance</th><th>I Need More Practice</th></tr><tr><td>Create ladder logic rungs</td><td>☐</td><td>☐</td><td>☐</td></tr><tr><td>Assign PLC addresses correctly</td><td>☐</td><td>☐</td><td>☐</td></tr><tr><td>Simulate and test ladder logic</td><td>☐</td><td>☐</td><td>☐</td></tr><tr><td>Troubleshoot logic errors</td><td>☐</td><td>☐</td><td>☐</td></tr><tr><td>Apply safety logic in programming</td><td>☐</td><td>☐</td><td>☐</td></tr></table>	Skills	I Can Do Independently	I Need Assistance	I Need More Practice	Create ladder logic rungs	☐	☐	☐	Assign PLC addresses correctly	☐	☐	☐	Simulate and test ladder logic	☐	☐	☐	Troubleshoot logic errors	☐	☐	☐	Apply safety logic in programming	☐	☐	☐
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VIII. USE OF GENERATIVE AI	<p>In preparing this Learning Exemplar (LE), the author(s) used Gemini and DeepSeeker in order to structure the assessment framework, generate a realistic industrial mixing scenario, and align the technical requirements with PLC programming content and performance standards. The author(s) reviewed and finalized the writing of the content. The author(s) take(s) full responsibility for the content of this LE.</p>																								