MATRIX | INDUSTRIAL MAINTENANCE

Troubleshooting & Fault-Finding
Closed Loop Industrial Control Systems

MATRIX

CP6773

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INTRODUCTION

Welcome to the **Industrial Maintenance for Closed Loop Systems Curriculum**. This program is designed to provide a comprehensive understanding of the components, principles, and troubleshooting techniques essential for maintaining closed-loop systems. Whether you are a student, technician, or engineer, this curriculum equips you with the skills and knowledge to confidently diagnose and resolve issues in industrial control systems.

This is the second curriculum, please complete the **Worksheets** curriculum first before starting this **Fault Scenarios** one.

Curriculum

This curriculum is divided into 8 fault-finding & troubleshooting scenarios. Each scenario requires you to write down your observations, highlight the troublesome component and rectify or reset the issue in the software.

Your training system is designed to simulate various faults commonly encountered in industrial environments. These faults range from emergency stops to incorrect sensor readings, requiring you to diagnose and correct each issue. We encourage you to approach each scenario with curiosity and diligence. Flick through the screens and look for what's changed. These are often a key giveaway in the real world.

Let's get started!

FAULT SCENARIOS

Fault Scenarios

Fault Scenarios

You have already encountered many faults if you've worked through our worksheets.

Effective fault finding relies on observation, logic, and understanding system behaviour. Faults can stem from sensor errors, incorrect responses, or unstable conditions. Your role is to spot anomalies and find the root cause.

Industrial systems depend on many components working together. Failures to start, poor performance, or fluctuating readings are chances to build your troubleshooting skills. Faults may be consistent or intermittent, so identifying patterns and using diagnostic tools is essential.

This training presents varied challenges—some obvious, others requiring deeper analysis of system inputs and outputs.

You will need to:

- Assess system behaviour and identify deviations from normal operation.
- Examine sensor readings and determine if they accurately reflect real-world conditions.
- Recognize intermittent signals and fluctuations that could indicate a hidden issue.
- Analyse control logic to verify if the system responds correctly to input changes.
- Identify cases where incorrect scaling, offsets, or forced values affect system performance.

Important Note

There is no requirement for you to "fix" anything with this system as all the faults are software based, i.e. the system will not be ejecting any wires or destroying any components, it will simply trick the controller into thinking there's a problem. You merely need to reset the fault in software.

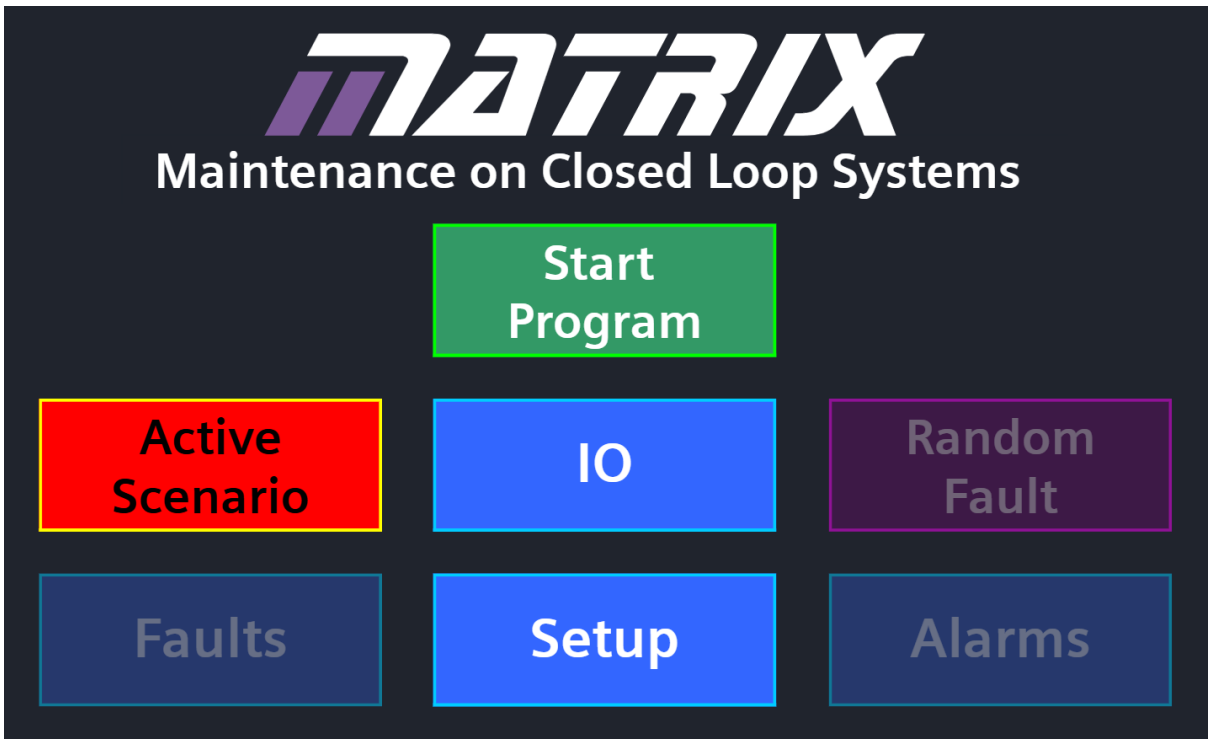
Fault Scenarios

Alarms & Faults Pages Disabled

During all fault scenarios, the Alarms and Faults pages on the HMI are deliberately disabled.

This simulates real-world conditions where automated diagnostic tools are often limited or unclear, and the reason a system won't run is not immediately obvious. In many industrial settings, engineers must rely on live IO feedback, system behaviour, and prior knowledge to identify and resolve issues without the aid of clear alarm messages.

This approach encourages deeper analysis, reinforcing the importance of understanding the system's logic and interpreting raw data during fault diagnosis.



Fault Scenarios

Fault Scenario 1: Titanium Forging

Navigate to the Main Menu and select the “Fault Scenarios” page then select Scenario 1. Press the Reset button to clear any previous faults, to avoid confusion.

You work night shifts in a titanium forging factory that produces frames for Boeing aeroplanes. As you start your shift, you're told the system won’t run, and no one knows why. The day shift maintenance engineer tells you they had a problem earlier in the day because the oil was too cold. Harry, the Marketing Manager, thinks it’s just the Wi-Fi acting up again.

Observations:

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Problem:

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Solution:

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Fault Scenarios

Fault Scenario 2: Pharmaceutical Plant

Navigate to the Main Menu and select the “Fault Scenarios” page then select Scenario 2. Press the Reset button to clear any previous faults, to avoid confusion.

You work in a pharmaceutical plant that produces sterile liquid solutions for IV bags. The flow system is critical for maintaining precise fluid levels in mixing tanks. As your shift starts, the production team reports a low-flow alarm preventing the system from running. The supervisor mentions that the flow was fine earlier, but now the pump seems to be running at full speed with barely any flow.

Tip: Try pressing the reset button a few times and try running the pump.

Observations:

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Problem:

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Solution:

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Fault Scenarios

Fault Scenario 3: CNC Machines Factory Cooling

Navigate to the Main Menu and select the “Fault Scenarios” page then select Scenario 3. Press the Reset button to clear any previous faults, to avoid confusion.

You maintain the cooling system for CNC machines in an automotive parts plant. The system circulates temperature-controlled coolant to prevent overheating. The night shift operator flags you down. No alarms. No fault codes. Everything on the HMI looks normal. But he’s certain something is off. He points to the return line. Coolant is splashing aggressively into the reservoir, creating turbulence he’s never seen before. A few machines have developed slight condensation near the cooling blocks – **“This is not normal”** he shouts.

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Problem:

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Solution:

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Fault Scenarios

Fault Scenario 4: Marketing

Navigate to the Main Menu and select the “Fault Scenarios” page then select Scenario 4. Press the Reset button to clear any previous faults, to avoid confusion.

A large beverage factory depends on your flow system to mix syrup concentrations. The maintenance team left early. You get called in. The system starts, runs for a few seconds then slams to a halt. Management have had consultants on the phone who reckon it’s an electrical noise issue. The maintenance manager had a quick look for a few seconds and everything looks good, you’ve been asked to investigate further.

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Problem:

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Solution:

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Fault Scenarios

Fault Scenario 5: Potash Mine

Navigate to the Main Menu and select the “Fault Scenarios” page then select Scenario 5. Press the Reset button to clear any previous faults, to avoid confusion.

Your company has installed a new oil level monitoring system into a Potash mine in Yorkshire. This system monitors the oil level of two mining shafts that carry workers and potash minerals up a shaft. This system was known for having many huge leaks, which would lead to miners being stuck down in the mine. Your company installed a system to monitor if the oil is too high or too low. They’ve asked you to come out and fix the system as it won’t start. There’s an alarm active on the system, the system LED is red, but the alarm screen shows nothing. You’re told the oil level is normal.

Observations:

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Problem:

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Solution:

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Fault Scenarios

Fault Scenario 6: First Day On The Job

Navigate to the Main Menu and select the “Fault Scenarios” page then select Scenario 6. Press the Reset button to clear any previous faults, to avoid confusion.

You start your first day on the job at River Bridge Waste Company and their wastewater system is in bad shape. The maintenance guys are all mechanical and you’re electrical biased so it’s now your job to fix things. They’ve recently swapped out a broken PLC module, repaired the Estop and fixed the temperature sensor wiring. They’ve said the float switches need to be replaced at some point. Even with those repairs, the system keeps shutting down randomly. It’s just happened again, please help.

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Problem:

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Solution:

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Fault Scenarios

Fault Scenario 7: Why's It Always The Temperature?

Navigate to the Main Menu and select the "Fault Scenarios" page then select Scenario 7. Press the Reset button to clear any previous faults, to avoid confusion.

Those CNC machines you fixed in Scenario 3 are down again. The night shift operator has reiterated that he's checked all the offsets on all the inputs and outputs – there's nothing! The system just won't run. You know that the operators like to play with settings so you're sure it's the offsets again.

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Problem:

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Solution:

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Fault Scenarios

Fault Scenario 8: Settings

Navigate to the Main Menu and select the “Fault Scenarios” page then select Scenario 8. Press the Reset button to clear any previous faults, to avoid confusion.

You’re part of the maintenance team at an Aerospace manufacturer. You’re aware that a new colleague has joined the team full of experience and has been tinkering in order to get the system up to full speed quicker. The managers were happy with your colleague’s progress until this morning, when things started behaving more violently. The system can’t maintain the correct flow. Your new colleague suspects it’s the hand valve you replaced a while ago. Management would like to roll the system back but want to also know what the issue is. Go through the HMI and figure out what’s happened.

Observations:

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Problem:

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Solution:

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Safety Note

SAFETY NOTE

As you step into the world of industrial maintenance, **safety must always come first**. Every machine, tool, and system you work with has risks, but following the right procedures keeps you and your team safe.

There are official safety standards and regulations, like the **Machinery Directive 2006/42/EC**, that exist to ensure all maintenance work is carried out correctly and safely. In the **EU** there is the **EN 60204-1** (electrical safety for machinery) and in the **US**, **OSHA 1910** (general industry safety) and **NFPA 70E** (electrical safety for workers). These standards help maintenance engineers work safely, reduce risks, and comply with legal requirements. Once you get into Industry, get a copy of these and learn them. They may save your life. The best engineers aren't just good at fixing machines; they're smart enough to work safely.

1. Lock It Out, Stay Safe

Before you touch any machine, make sure it's isolated from power. Use Lockout/Tagout (LOTO) procedures to lock off energy sources (electricity, hydraulics, pneumatics). Machines can start unexpectedly, so always check before working.

2. Read the Manual, Know the Rules

Every machine has a manufacturer's manual it's there for a reason. Read it. Follow it. Never assume you know how something works without checking first.

3. Wear the Right Gear

Your Personal Protective Equipment (PPE) isn't optional. Safety glasses, gloves, boots, and hearing protection help prevent injuries that could end your career before it starts.

4. Only Work on What You Understand

If you're unsure about something, ask. Rushing in without the right knowledge can be dangerous. Learning the correct procedures now will make you a better and safer engineer in the long run.

Safety Note

5. Keep Your Workspace Clear

Slips, trips, and falls are some of the most common accidents in maintenance. Keep tools, cables, and waste tidy to prevent hazards.

6. Electrical Safety is No Joke

Always turn off and test before working on electrical systems. Use insulated tools and check grounding a bad connection can be deadly.

7. Moving Parts Can Kill

Machines have stored energy, even when turned off. Always block, chock, or brace moving parts before working on them. Never assume something is safe just because it’s not running.

8. Watch Out for Pressure

Hydraulics and pneumatics store energy in pipes, hoses, and tanks.

- Always depressurize systems before working on them.
- Inspect hoses and fittings for leaks never use your hands to check, use cardboard instead.
- A burst hose can cause serious injuries look for signs of wear before starting work.

9. Be Ready for Emergencies

Know where emergency stops, fire extinguishers, and first aid stations are. If something goes wrong, you need to act fast and correctly.

10. Speak Up About Faults

If you find something wrong don’t ignore it. Report faults immediately, and don’t use unsafe equipment. A quick fix now could prevent a serious accident later.

VERSION CONTROL

15 05 25	First Revision Created

