HYTECH DIDACTIC

ROBOTICS

MIG Welding

MIG Welding Robot Training Cell with PLC, HMI and IIOT

www.hytechdidactic.com

Industrial Welding Robocell with PLC, HMI & IIOT

The **Industrial Welding Robocell** developed by **Hytech Didactic** is a comprehensive training and industrial simulation setup featuring:

- An **industrial welding robot** with a **minimum reach of 1000 mm**, integrated with a **Central Control Unit** equipped with **PLC, HMI, and IIOT.**
- The robot can be programmed using a **teach pendant** or via **offline programming software** that also functions as a **digital dynamic twin**, providing real-time simulation and control.

A **dedicated TV screen** displays the digital twin for enhanced visualization and training. The setup includes:

- **Three individual experiment tables**, each made of **mild steel** with an **aluminum top** to facilitate easy removal of welding splatter.
- A **mobile control unit** (aluminum extrusion frame) housing the **welding controller, stepdown transformer**, and **robot controller.**
- A **trolley for the gas cylinder** and **mounting for the feeder cable**, ensuring complete mobility and safety.

Equipped with an **industrial welding source** (e.g., **Fronius**), the system provides real-world welding capabilities.

Additional industrial features include:

- **I/O link communication** with **smart light indicators**, enhancing hands-on learning.
- **Profinet-based communication** between the robot controller and the machine control panel, replicating real industrial environments.

This robocell is ideal for **technical institutions, vocational training centers**, and **Industry 4.0 labs**, offering practical experience in robotic welding, automation, and smart manufacturing systems.

Key Features - MIG Welding Robocell

Robotic Setup

- Industrial Welding Robot (e.g., Fanuc Arc Mate) with:
  - Minimum 1000 mm reach
  - 12 kg payload capacity
- Robot programming via Teach Pendant and Offline Programming (OLP) software
- Supports Digital Dynamic Twin for real-time 3D simulation

Control & Automation

- Central Control Unit with:
  - (Siemens S7-1200 / Mitsubishi FX5)
  - HMI (IIOT-based; Siemens KTP 700 / Mitsubishi GS)
- Profinet and I/O Link communication with Smart Lights
- Integration with Servo Motors and Pneumatic Valves for automated workflows

Offline Programming & Simulation

- Compatible with: Fanuc Roboguide, Siemens Technomatix
- Enables offline programming and testing without halting live production

Experiment Tables (3)

- Table 1 – Basic Weld Joints Table
  - Welds: Butt, Corner, Edge, Lap, T-joint
  - Equipped with mechanical clamping arrangements
- Table 2 – Automated Welding Table (Setup 1)
  - Includes indexing table with AC servo motor
  - Robot welds sequential jobs indexed by PLC command
- Table 3 – 3D Circular Welding Table (Setup 2)
  - Pneumatically actuated pick-and-place unit inserts pipe into pipe
  - Robot performs 3D circular welding of hollow pipes

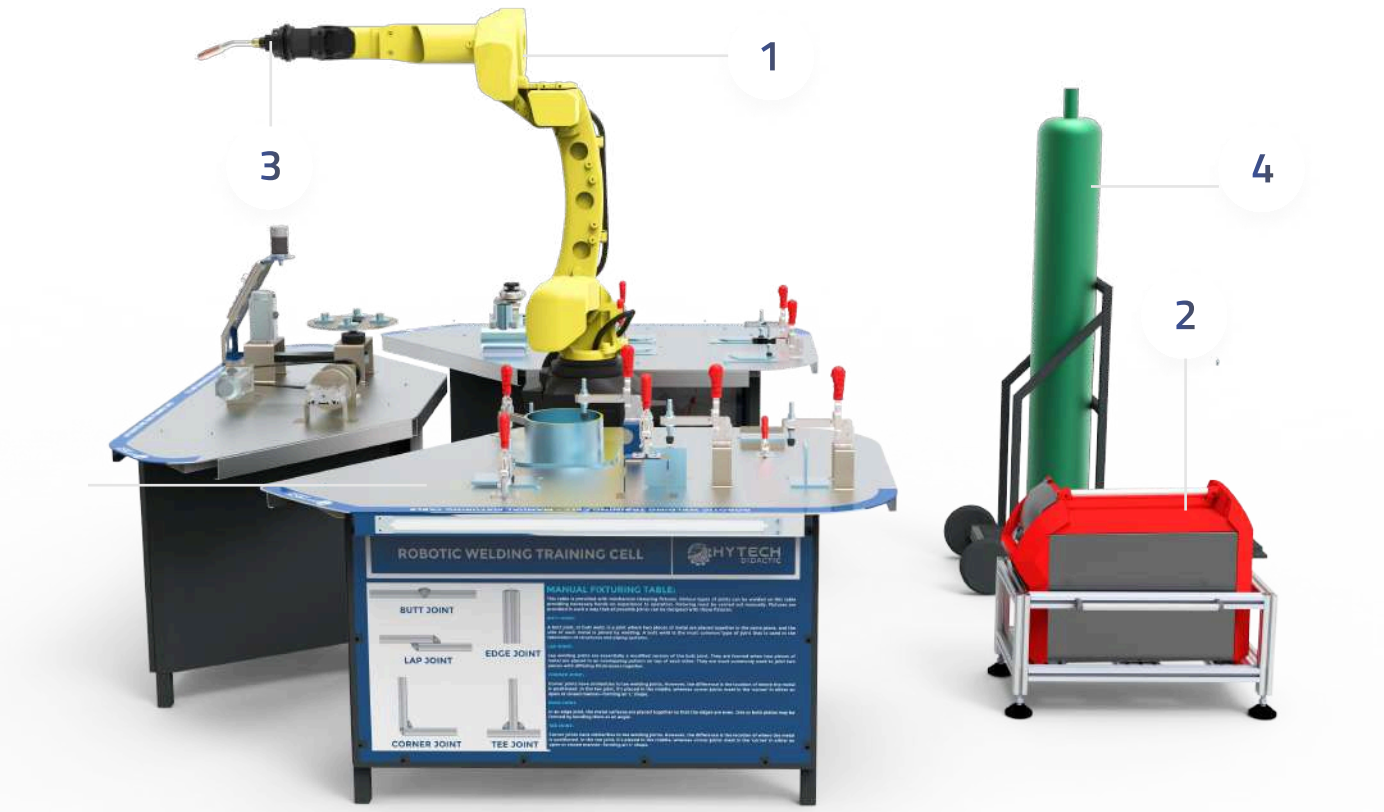
Hardware & Accessories

- Fronius / Lincoln Welding Source
- Mobile control unit with: Robot Controller, Welding Controller, Stepdown Transformer
- Aluminum extrusion frame, gas cylinder trolley, and feeder cable mounts.
- Aluminum sheet top on all tables for easy removal of weld splatter

Smart & Industry 4.0 Features

- IIOT Integration
- Real-time process visibility through TV screen displaying digital twin
- Designed for Industrial Training, Skill Development, and Smart Manufacturing Labs

Core Components That Drive Performance



1. FANUC Arc Mate Robot:

The FANUC Arc Mate Robot is a 6-axis articulated industrial robot specifically designed for arc welding applications. It offers precise control of movement, speed, and position, making it ideal for performing repeatable, high-quality welds on various components. Its flexibility allows it to follow complex welding paths, and its integration capabilities make it compatible with leading welding systems like Fronius. The robot enhances productivity, reduces human error, and ensures consistent weld quality in automated welding setups.

2. Welding Controller:

The Welding Controller is a high-performance digital controller that regulates the welding process. It controls critical welding parameters like voltage, current, wire feed speed, and waveform in real-time. The controller supports various welding modes, including MIG/MAG and pulsed arc, and ensures optimal arc stability and penetration. It communicates seamlessly with the robot, enabling synchronized motion and welding control for superior weld results.

3. Welding Gun:

The Welding Gun is the end-of-arm tool that delivers the welding current and wire directly to the weld joint. It is designed to withstand high temperatures and repetitive motion, ensuring durability and performance.

4. O_2 Gas Cylinder with Regulator:

The CO_2 Gas Cylinder, connected via a regulator, supplies shielding gas to the welding area. The gas (typically CO_2 or a CO_2-argon mix) forms a protective envelope around the arc and molten weld pool, preventing contamination from atmospheric gases like oxygen and nitrogen. This results in cleaner, stronger welds with minimal spatter.

Core Components That Drive Performance

5. Cabinet for Robot Controller:

This cabinet securely houses the FANUC robot controller, ensuring safe operation and organized wiring. It includes proper ventilation and protection features to maintain optimal performance and longevity of the controller. The cabinet supports easy access for maintenance while keeping the work area tidy and secure.

6. HMI (Human Machine Interface – 7" MTP):

The 7-inch MTP HMI allows users to easily select and execute welding programs. It provides a user-friendly interface to monitor system status, adjust basic settings, and access diagnostics. Operators can start or stop robot operations directly from the HMI, ensuring smooth and safe control of the arc welding process.

7. I/O Link Master:

An I/O-Link Master serves as the interface between a programmable logic controller (PLC) and I/O-Link-enabled devices such as sensors, actuators, and modules. It plays a pivotal role in modern robotics and automation by ensuring efficient communication, seamless integration, and enhanced functionality.

8. I/O Link Smart Light:

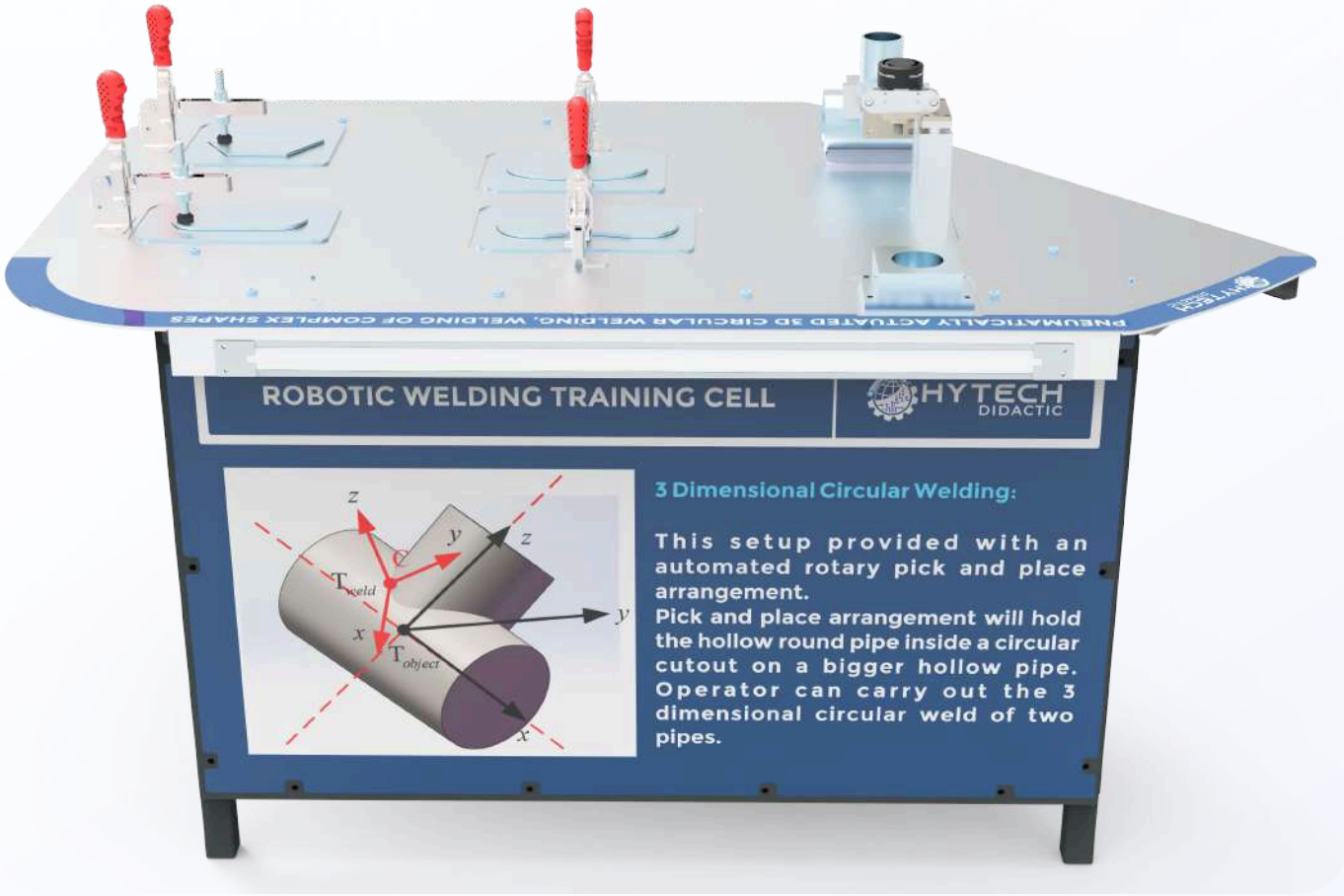
I/O-Link-enabled smart lights serve as advanced signalling devices in robotics and automation systems, providing real-time visual feedback, enhanced communication, and increased operational efficiency. Their integration with robots and PLCs makes them an indispensable tool for monitoring and managing industrial processes.

Welding Table 1: Manual Fixturing Table

This Manual Fixturing Table is used for positioning and clamping workpieces manually before welding. It provides a stable platform for small-scale or prototype welding tasks where parts can be manually set up. This table is ideal for training, manual adjustments, or situations requiring flexible fixturing without automation.

Table 1 - Basic Weld Joints Table	
	Welding Toggle Clamps for Workpiece mounting (Qty: Minimum 5)
	Butt Joint, Corner Joint, Edge Joint, Lap Joint, TEE Joint
	Fixture for Internal and External welding of hollow pipe on flat plate
	Aluminum Sheet on the Zinc plated work surface
	Three Colour integrated LED Strip indicating operation status

Welding Table 2: Complex Shapes Table



The Complex Shapes Table is designed to hold irregular, angled, or multi-surfaced components that require precise orientation for robotic welding. It often includes adjustable jigs or fixtures to accommodate different geometries. This table is essential for teaching the robot to weld on non-standard parts and enhancing its path-planning capabilities.

Automated 3 Dimensional Circular Welding Table	Fixture for Pick and place of hollow pipe inside a hollow pipe
	Guided Cylinder with minimum stroke of 15mm
	5/2 Way Double Acting Solenoid Valve
	Fixtures for welding of complex shapes
	Aluminum Sheet on the Zinc plated work surface
	Three Colour integrated LED Strip indicating operation status

Welding Table 3: Automated Welding Table

The Automated Welding Table is equipped with integrated fixtures, sensors, and sometimes motion systems to support fully automated welding operations. It allows the robot to work with minimal human intervention, increasing productivity and repeatability. This table is typically used for batch production or complex welding cycles where automation maximizes efficiency and consistency.

Table 3 – Automated Welding Table - Servo Motor Based Automated Welding Module	AC Servo Motor
	Belt Driven Indexing Table
	Inductive Sensor for referencing application
	Aluminum Sheet on the Zinc plate work surface
	Three Colour integrated LED Strip indicating operation status
Table 3 – Automated Welding Table - Servo Motor Based Circular Welding Module	AC Servo Motor
	Belt Driven Indexing Table
	Inductive Sensor for referencing application
	Aluminum Sheet on the Zinc plate work surface
	Three Colour integrated LED Strip indicating operation status
	Guided Cylinder with minimum stroke of 15mm
	5/2 Way Double Acting Solenoid Valve

Technical Specifications:

Central Control Unit	Separate Structure with CPU (i5) and Dual Monitors
	Hardware Operation Panel
	PLC: Siemens S7 1200 / Mitsubishi FX5
	HMI: 7 inch IIOT based HMI
	IIOT: 7 inch HMI with minimum 20,000 datapoints perpetual cloud space and remote screen control
	Connectivity: I/O Link based Profinet Connectivity
	I/O Link based Smart Light
Welding Source	Fronius or Lincoln or Equivalent
	IIOT Based Connectivity

Technical Specifications:

Robot	Fanuc ARC Mate 100iD or Equivalent
	Minimum reach: 900mm
	Minimum Payload: 10KG
	Position Repeatability: +/- 0.03mm
Robot Operations	Fanuc / Robot OEM Teach Pendant
	Operation panel on welding controller for welding source
	Minimum 43 inch TV Screen to display Dynamic twin / teach pendant
Structure	Three separate tables for welding applications. Mild steel based pedestal for robot mounting
Pneumatics	FRL Unit
	Compressor with minimum capacity of 43 Ltr

Relevance Of PLC And HMI Integration In Welding Robot Training Cells

Centralized Control with PLC and HMI Integration

- The MIG Welding training cells feature a separate Central Control Unit comprising a PLC (Programmable Logic Controller) and HMI (Human-Machine Interface).
- Robots are seamlessly integrated with the PLC and HMI, enabling trainees to operate complete robotic cycles within an industrial automation context.
- This setup provides comprehensive exposure to industrial welding robotic architecture and hands-on experience with state-of-the-art robotics.

In modern manufacturing, robotic welding is rarely a standalone process. Instead, it functions as part of a larger, integrated automation system. Therefore, a training cell that includes PLC and HMI integration plays a critical role in preparing students and technicians for real industrial environments.

1. Industrial Realism & System-Level Understanding

- In actual production setups, welding robots are integrated with PLCs to control fixtures, positioners, indexing tables, pneumatic actuators, and safety systems.
- HMI panels allow operators to monitor system status, control subsystems, select programs, and view error logs.
- A training cell that mimics this integration gives learners a holistic view of how robotic welding fits into a larger automation workflow.

2. Multi-Component Synchronization

- Using a PLC, learners can program sequenced operations such as:
  - Job clamping
  - Positioning via servo motor
  - Welding sequence initiation
  - Quality feedback from sensors
- This teaches them how to synchronize robot motion with mechanical systems, a key industry skill.

3. Real-Time Monitoring & Diagnostics via HMI

- HMIs provide a graphical interface to:
  - View welding parameters
  - Monitor sensor inputs
  - Trigger start/stop sequences
  - Display error messages or alerts
- This mirrors industrial practices, where real-time diagnostics are essential for productivity and safety.

4. IIOT & Industry 4.0 Readiness

- PLC-HMI systems integrated with IIOT features allow data from the welding process to be:
  - Logged for traceability
  - Analyzed for predictive maintenance
  - Connected to MES/SCADA systems
- Training on such systems prepares students for roles in smart factories and digital manufacturing environments.

5. Essential for Automation Design & Troubleshooting Skills

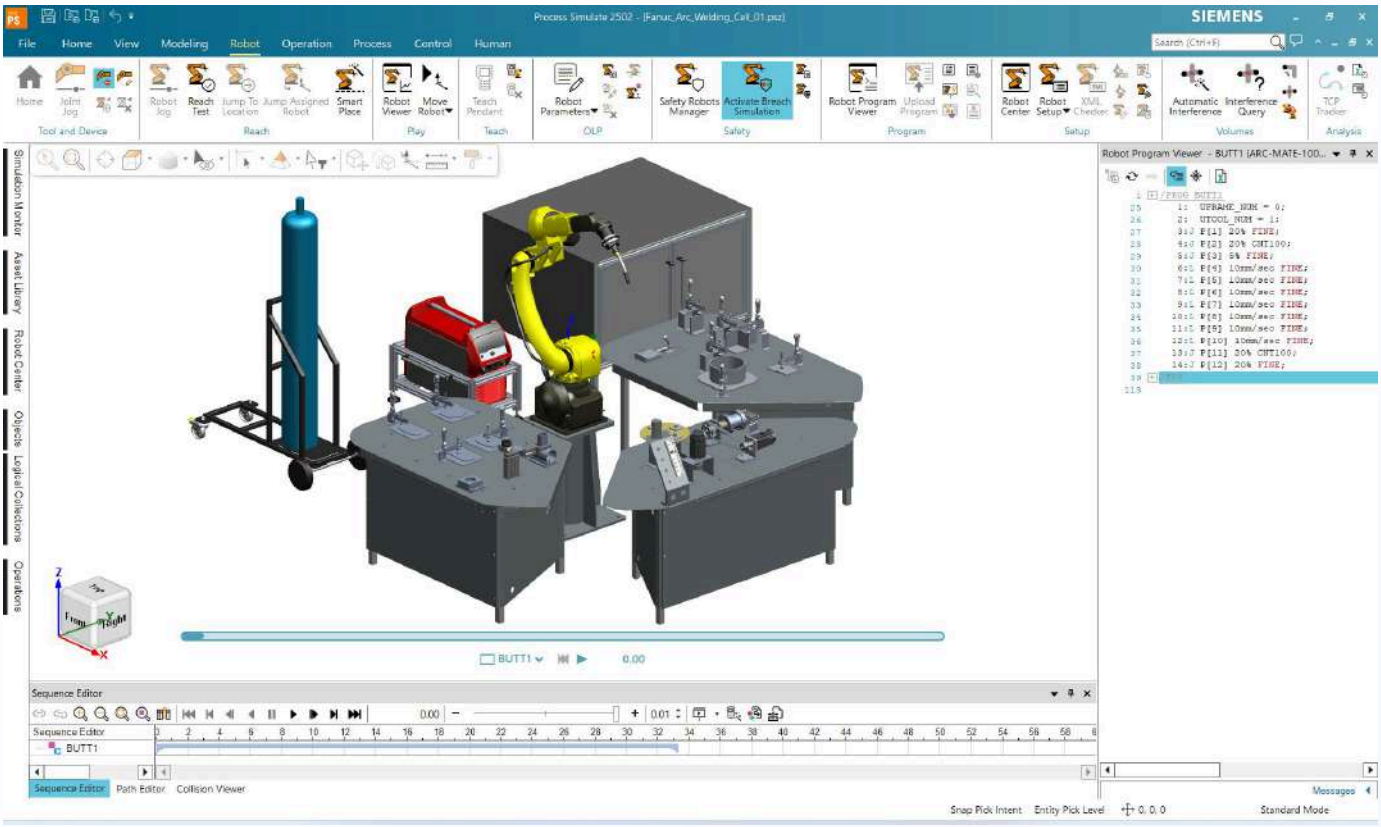
- Understanding PLC-HMI logic is critical for:
  - Designing automation cells
  - Debugging integration issues
  - Commissioning new robotic lines
- Without PLC-HMI knowledge, robotic training remains incomplete and disconnected from actual industrial practice.

PLC and HMI integration in a robotic welding training cell is not just an add-on — it is essential to reflect the true nature of modern manufacturing systems. It ensures that learners develop the ability to:

- Program coordinated automation tasks
- Monitor and control complex systems
- Troubleshoot and optimize robotic processes

This integration bridges the gap between **classroom training and industry expectations**, making trainees **job-ready for smart manufacturing environments**.

Importance Of Digital Twin And Offline Programming In Robotic Welding Training Cells



In modern technical education, robotic welding training cells are no longer just physical setups — they are platforms to teach smart manufacturing, automation, and Industry 4.0 concepts. Two critical components that elevate the effectiveness of these cells are Digital Twin and Offline Programming.

1. Safe & Realistic Skill Development

- A Digital Twin replicates the physical robot and welding process in a 3D virtual environment, allowing students to interact with the system without physical risks.
- Students can visualize and simulate welding paths, torch angles, and part positioning before executing real welds, making learning more engaging and mistake-tolerant.

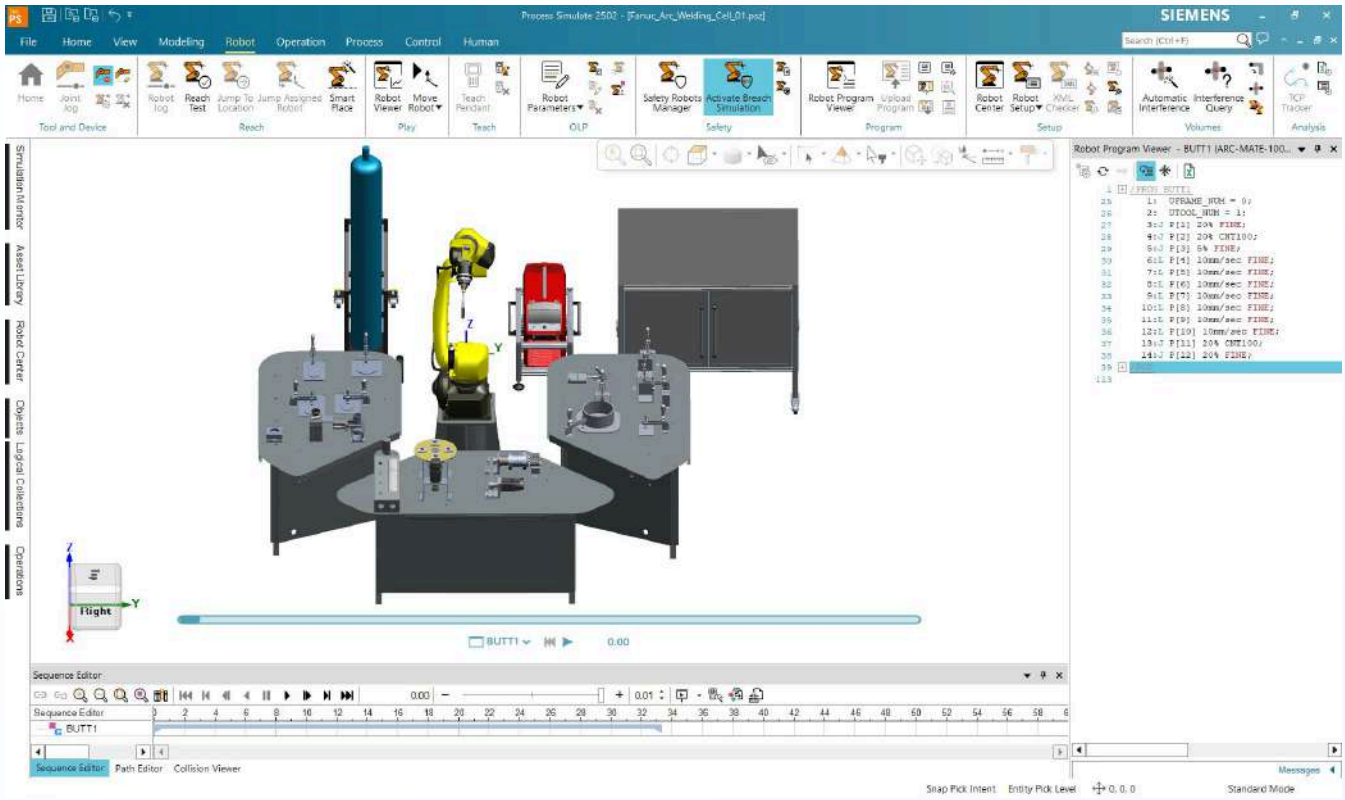
2. Offline Programming Builds Industry-Ready Skills

- With Offline Programming (OLP), trainees can learn how to write, test, and debug robot welding programs on a PC without interrupting ongoing operations.
- This mimics the way programming is done in actual factories, preparing students for real-world job roles in automation and robotics.

3. Minimizes Hardware Wear And Cost

- By using the digital model for training, hardware fatigue and consumable use are minimized, which reduces maintenance and operational costs in educational institutions.
- Reduces the need for repeated trial welds, saving on welding wire, gas, and base material.

Importance Of Digital Twin And Offline Programming In Robotic Welding Training Cells



4. Faster Learning With Real-Time Feedback

- The digital environment offers instant feedback on errors such as wrong weld paths, unreachable positions, or potential collisions.
- Enhances understanding of robot kinematics, joint limits, safety zones, and optimal weld sequences.

5. Bridges The Gap Between Simulation And Execution

- Once the program is tested and validated in the virtual twin, it can be directly uploaded to the real robot, helping learners understand how theory translates into practice.
- Encourages a project-based learning approach, where students can develop and demonstrate complete welding cycles digitally and physically.

6. Promotes Industry 4.0 Exposure

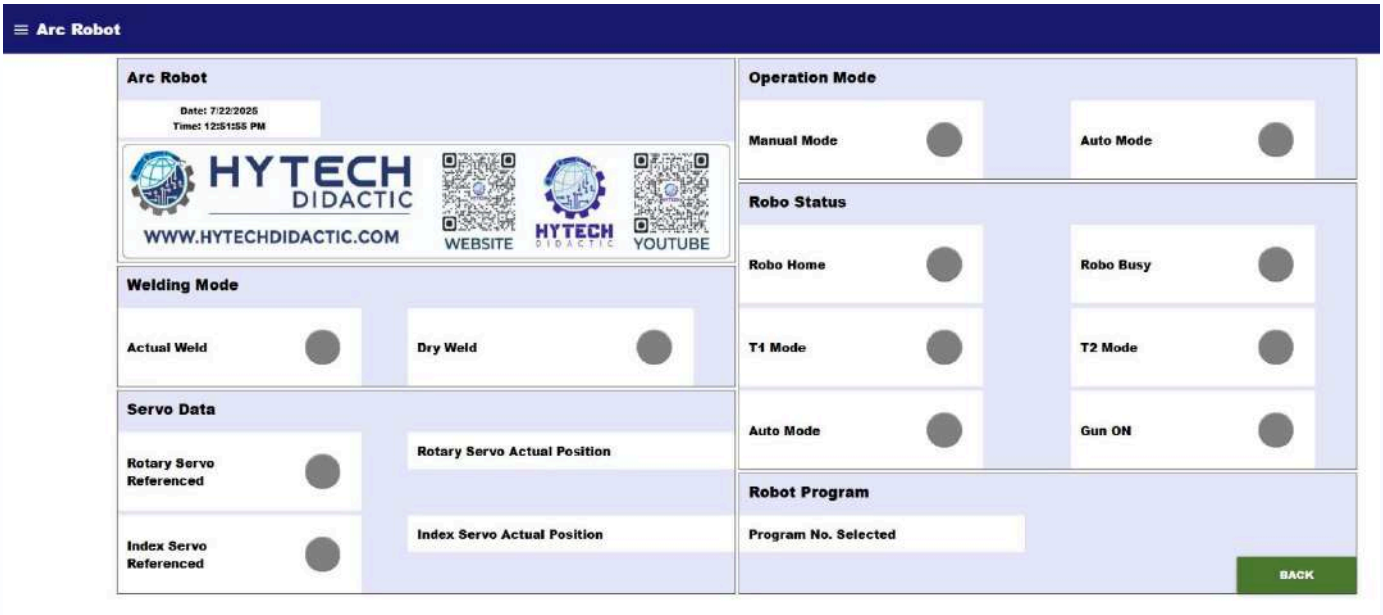
- Integration with IIOT, PLC, and smart sensors through the Digital Twin trains students in data-driven manufacturing.
- Students learn how to monitor performance, analyze digital signals, and implement predictive maintenance strategies — essential for smart factories.

Incorporating Digital Twin and Offline Programming into robotic welding training cells transforms them into next-generation skill development platforms. These technologies:

- Make learning safer and more effective
- Provide hands-on experience aligned with modern industry needs
- Reduce operational costs and downtime
- Equip students with tools used in actual industrial environments

Such training cells don't just teach welding — they teach the future of welding.

Industrial IoT (IIoT) Integration



Connecting Machines to Intelligence

Our MIG Welding integrates Siemens Industrial Edge technology to enable real-time connectivity, data-driven insights, and intelligent automation. This IIoT-enabled environment equips trainees with cutting-edge skills in digital manufacturing and connected industry solutions.

Key Features:

- **Siemens Industrial Edge:** Bridges OT and IT by processing data directly at the machine level for faster decision-making.
- **Real-Time Data Acquisition:** Captures operational data from sensors, PLCs, and machines.
- **Edge-To-Cloud Connectivity:** Securely transfers relevant data to cloud platforms for deeper analytics.
- **Dashboard & Analytics Tools:** Enables visualization of trends, performance metrics, and predictive insights.

Training Highlights:

- Learn to **collect, process, and analyze industrial data** from real-time sources.
- Understand **remote monitoring**, condition-based maintenance, and production optimization.
- Work with **IIoT protocols** such as MQTT, OPC UA, and edge computing concepts.
- Prepare for **Industry 4.0** roles in smart manufacturing environments.

MIG Welding Robot Training Cell with Hytech Learning Management System

MIG welding robotics is an advanced and rapidly evolving field in industrial automation. Training of trainers is essential to ensure they are equipped to deliver effective and industry-relevant instruction. The Hytech MIG Welding Robot Training Cell comes integrated with a powerful Learning Management System (LMS) designed to elevate the training experience for both trainers and learners.

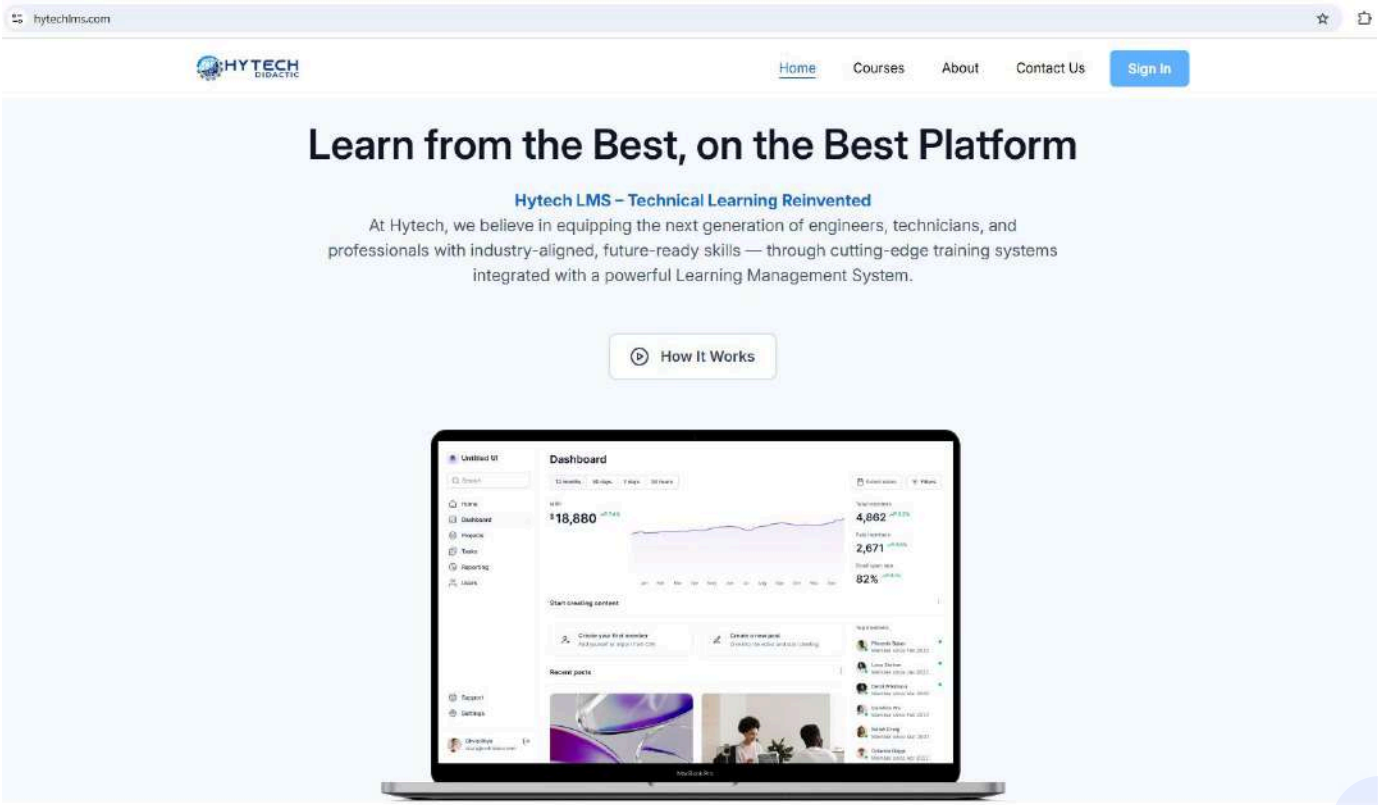
Key Features Of The Hytech LMS:

- **Step-By-Step Guidance:** : Trainers receive structured, step-by-step instructions to master MIG welding robot operation, programming, and safety protocols.
- **Up-To-Date Training Content:** LMS content is regularly updated to reflect the latest trends and technologies in MIG robotic welding.
- **Customizable Content:** Trainers can develop custom modules, conduct online assessments, and issue digital certifications directly through the LMS platform.
- **Support For Management:** The LMS helps institutions manage trainer transitions, maintain consistent teaching quality, and provide continuous support and knowledge handover.

MIG Welding Robot Courses In The LMS:

The Hytech LMS offers in-depth courses combining theoretical fundamentals with practical, hands-on training focused on MIG welding automation. These courses empower trainers and students with the skills needed for real-world applications in robotic welding.

Contact us today for a free demonstration of the Hytech LMS and see how it can revolutionize MIG Welding Robot Training at your institution.



MIG Welding Robot Courses in the LMS:

Day 1	Introduction to Training Cell, Welding Basics, Components & Power Layout	8 Hours
Day 2	Basic Electrical Wiring, Field Wiring, PLC & HMI Communication (Profinet, Ethernet)	8 Hours
Day 3	PLC Design: TIA Portal, Inputs/Outputs, Basic Programming, Timers & Counters	8 Hours
Day 4	HMI Design: PIStudio, Screen Layout, Navigation, Tag Mapping	4 Hours
	PLC–HMI Integration: Communication, Mapping, Pneumatic Table Simulation	4 Hours
Day 5	IO-Link Master Integration with PLC & HMI	4 Hours
	Sensor Integration: Proximity, Reed, Pressure, Digital/Analog with PLC–HMI	4 Hours
Day 6	Servo Motor Operations: Basics, Referencing, Positioning, HMI Feedback	4 Hours
	Pneumatics: Solenoids, Reed Switches, PLC Timers & Counters	4 Hours
Day 7	Welding Source: UI, Parameters, Job Creation	4 Hours
	Robot Operations: Components, Teach Pendant, Movement Modes	4 Hours
Day 8	Robot Coordinate Systems, I/O Mapping, Teach Pendant Operation	8 Hours
Day 9	Integration: Robot–Welding Source, Robot–PLC–HMI, Program Calling via HMI	8 Hours
Day 10	Manual Fixturing Table – Welding Joints (Overlap, Corner)	4 Hours
	Manual Fixturing Table – T, Butt, Circular Pipe Joints	4 Hours
Day 11	Complex Shape Programming – Hexagon, Discorectangle	4 Hours
	Complex Shape Programming – Oval, Dumbbell, 3D Pipe	4 Hours
Day 12	Automation Table Programming – Rotary Setup & Indexing	6 Hours
	Free Robot Practice & Review	2 Hours
Day 13	PLC–HMI–Robot–Source Full System Dry Run	4 Hours
	Troubleshooting Integration	4 Hours
Day 14	Advanced Robot Welding Techniques (Multi-pass welding, weaving) Torch alignment and tip maintenance	8 Hours
Day 15	Final Assessment, Viva, Certification	8 Hours

Thank You For Exploring MIG Welding by Hytech Didactic!

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