Training Modules

1. CNC Machining Center Operation with CAD & CAM

Target Duration / Category: 3–4 Months / (ASSET, Regular)

• **Module 1: Technical Blueprint Reading & GD&T Standards:** Engineering drawing interpretation, orthographic projection, surface finish symbols, Geometric Dimensioning & Tolerancing (GD&T) feature control frames, datums, and material specifications.

• **Module 2: 2D & 3D Parametric CAD Modeling:** 2D sketch creation, geometric constraints, parametric 3D solid modeling, surface creation, assembly modeling, and CAD file format interchange (STEP, IGES, DXF) using SolidWorks.

• **Module 3: Cutting Tool Mechanics, Speeds & Feeds:** Selecting insert geometry and carbide grades based on ISO material groups (P, M, K, N, S, H), calculating cutting speed, spindle RPM, feed per tooth, and chip load.

• **Module 4: 2D & 3D CAM High-Speed Tool Pathing:** Face milling, dynamic motion roughing, 2D contouring, adaptive pocketing, 3D surfaces high-speed finishing, stepover optimization, and cutter engagement control using Mastercam.

.• **Module 5: Post-Processing & Virtual Machine Simulation:** NC post-processor configuration, G-code/M-code generation, canned cycle programming (G81, G83, G73, G76), toolpath verification, gouge checking, and dry-run 3D simulation.

• **Module 6: CNC Hardware Architecture & Controller Setup:** Haas VMC VF Series / Lathe controller layout, Automatic Tool Changer (ATC) presetting, Work Coordinate Systems setup (G54–G59), tool length offset (G43/G44), and cutter radius compensation (G41/G42).

• **Module 7: Live Shop-Floor Machining Execution:** Manual Data Input (MDI) execution, workpiece clamping using precision vices and fixtures, zero-point alignment using edge finders, and live cutting of mild steel, stainless steel, and aluminum billets.

• **Module 8: 3D CMM Metrology, Quality Control & OHS:** First-article quality inspection using Mitutoyo 3D CNC CMM, Vernier calipers, micrometers, height gauges, surface roughness testing, chip management, and strict shop-floor OHS compliance.

2. Certificate Course in PLC (Programmable Logic Controller)

Target Duration / Category: 3-4 Months / (ASSET, SICIP BEIOA, Regular)

• **Module 1: Industrial Electrical Control & Switchgear:** Power distribution, circuit protection (MCB, MCCB, ELCB, Thermal Overload Relays), contactors, push buttons, emergency stops, indicator lamps, and industrial control panel wiring.

• **Module 2: Hardwired Relay Logic Circuit Design:** Relay fundamentals, latching and unlatching logic, electrical interlocking, Direct-On-Line (DOL) starters, Forward-Reverse starters, and Automatic Star-Delta motor starters.

• **Module 3: Siemens S7-1200 PLC Hardware & I/O Wiring:** PLC CPU architecture, digital/analog I/O expansion modules, power supply wiring, sinking/sourcing (NPN/PNP) field sensor connections, and signal conditioning.

• **Module 4: TIA Portal Software & Ladder Logic Development:** TIA Portal environment setup, memory addressing (Inputs, Outputs, Memory bits, Data Blocks), bit logic instructions, Timers (TON, TOF, TP), Counters (CTU, CTD), and comparison operations.

• **Module 5: Advanced Structured Programming & Function Blocks:** Organization Blocks (OB), Functions (FC), Function Blocks (FB), analog signal scaling (0–10V, 4–20mA), mathematical operations, and structured data arrays.

• **Module 6: HMI Screen Design & VFD Motor Speed Control:** Siemens HMI panel layout design, tag memory linking, dynamic graphical navigation, alarm logging, Siemens V20 VFD parameterization, Modbus RTU/Profinet communication, and AC drive speed control.

• **Module 7: Industrial Automation Projects & System Diagnostics:** Conveyor belt system automation, pneumatic cylinder sequencing, sensor integration (photoelectric, inductive, capacitive), fault diagnosis, multimeter testing, and safety interlocks.

3. CAD-CAM Design and Programming

Target Duration / Category: 3-4 Months / (SICIP BEIOA, Regular)

• **Module 1: Advanced Parametric 3D CAD Modeling:** Complex part modeling, multi-body solid manipulation, equation-driven dimensions, advanced sketch relations, and parametric design tables in SolidWorks.

• **Module 2: Freeform Surface Modeling & Reverse Engineering:** Class-A surface modeling, lofting, sweeping, surface trimming/knitting, mold cavity and core splitting techniques, point cloud data import, and mesh reconstruction.

• **Module 3: CAM Tool Pathing:** High-Speed Machining (HSM) dynamic motion, 3+2 positional machining, 5-axis simultaneous contouring, stepover optimization, tool tilt angle control, and deflection reduction.

• **Module 4: Custom Post-Processor Editing & G-Code Optimization:** Understanding post-processor structure, modifying post file variables, manual G-code optimization, subprogram calling (M98/M99), and machine macro programming.

• **Module 5: Virtual Machine Kinematic Simulation:** Full kinematic machine simulation, virtual collision detection, gouge and excess material verification and Mastercam Simulator, and cycle time calculation.

• **Module 6: High-Precision CNC Machine Execution:** Transferring NC files via DNC/Ethernet, machine set-up on Haas 5-Axis VMC / Live Tooling Lathe, work offset calibration, and sub-micron tool length offsets.

• **Module 7: Quality Inspection & Surface Finish Integrity:** Dimensional tolerance verification using Mitutoyo 3D CNC CMM, optical comparator analysis, surface finish roughness testing, and CMM inspection report generation.

4. Mechatronics and PLC

Target Duration / Category: 3 Months / Regular

• **Module 1: Pneumatic Control Systems & Compressed Air:** Air compressors, receivers, air dryers, Service Units (FRL), pneumatic actuators, ISO pneumatic symbols, directional control valves (2/2, 3/2, 5/2, 5/3-way), and throttling circuits.

• **Module 2: Advanced Electropneumatic Circuit Automation:** Electropneumatic hardware, limit switches, proximity sensors (inductive, capacitive, optical), relays, solenoid valves, time-dependent circuits, reset counters, and multi-cylinder sequential logic (A+B+B-A-).

• **Module 3: Mechanical Power Transmission Mechanics:** Power transmission design, belt drive tensioning, spur/helical gear train calculations, chain & sprocket drive alignment, mechanical couplings, bearing selection, and shaft alignment.

• **Module 4: Industrial Hydraulics & Power Units (HPU):** Pascal's law, hydraulic fluid properties, gear/vane/piston pumps, pressure relief valves, flow control valves, counter balance valves, accumulators, and Hydraulic Power Unit (HPU) assembly.

• **Module 5: Electrohydraulic Controls & System Troubleshooting:** Solenoid-operated hydraulic directional valves, proportional valves, cylinder sizing, hydraulic motor circuits, hose crimping, pressure testing, leak detection, and troubleshooting.

• **Module 6: Industrial PLC Architecture & Programming (PLC-1 to PLC-4):** PLC hardware setup, sinking/sourcing I/O, ladder logic development, timer/counter applications, relay logic conversion, and analog input/output scaling (0–10V / 4–20mA).

• **Module 7: Integrated Mechatronic Workstations & Fieldbus:** Assembling integrated mechatronic training rigs, rotary machining station controls, sensor signal conditioning, fieldbus communication, and complete automated system commissioning.

5. 3D Printing (Additive Manufacturing)

Target Duration / Category: 1 Week / Short Course

• **Module 1: Design for Additive Manufacturing (DfAM) Principles:** DFAM rules, overhang angles, supportless design, self-supporting geometry, wall thickness optimization, infill geometry selection, and lattice structure design.

• **Module 2: 3D CAD Export, Mesh Repair & Slicing Setup:** Converting CAD to STL/3MF/OBJ formats, repairing mesh errors using Netfabb/Meshmixer, configuring slicing parameters (layer height, shell count, infill percentage, print speed, retraction).

• **Module 3: FDM 3D Printer Setup & Calibration:** FDM/SLA hardware components, extruder mechanics, manual & auto bed leveling (BLTouch), nozzle gap calibration, bed temperature setup, and filament/resin preparation.

• **Module 4: G-Code Execution, Print Defect Troubleshooting & Maintenance:** G-code execution, real-time print monitoring, identifying and fixing common print flaws (warping, stringing, ghosting, elephant's foot, nozzle clogging), and printer maintenance.

• **Module 5: Post-Processing, Surface Finishing & Testing:** Support structure removal, chemical smoothing (acetone vaporizing for ABS), surface sanding, priming, protective coating, dimensional verification using digital calipers, and tensile testing.

6. Wood Routing Machine Operation

Target Duration / Category: 3 Months / Regular

• **Module 1: 2D Vector Design & Typography for Woodworking:** Vector drawing principles, node editing, curve smoothing, DXF imports, vectorization of bitmap images, typography design, and panel sizing in ArtCAM / VCarve / CorelDRAW.

• **Module 2: 3D Relief Modeling & Artistic Carving Design:** 3D relief modeling from heightmaps, texture design, 3D meshes sculpting, mold relief creation, decorative architectural panel design, and motif generation.

• **Module 3: Woodworking Tooling & CAM Strategy:** Selecting router bits (straight endmills, ball-nose, V-carving 60°/90°, profile cutters), feed rate and spindle RPM calculation for hardwood vs softwood, stepover settings, and multi-pass roughing/finishing.

• **Module 4: CNC Wood Router Machine & Vacuum Table Setup:** Machine axis alignment, vacuum bed zone configuration, sacrificial board preparation, mechanical hold-down clamping, dust collection hood installation, and spindle cooling.

• **Module 5: Workpiece Zeroing, Touch Probe & Tool Calibration:** Setting workpiece origin (X0, Y0), tool length calibration using Z-touch probe, multi-tool change setup, and spindle speed manual overrides.

• **Module 6: Practical Carving Execution, Sanding & Coating:** Executing 3D relief carving, 2.5D V-carving for signage, door panel carving, edge profiling, orbital sanding, wood staining, sealing, and protective varnish/lacquer coating.

7. Intermediate Automation and Control System

Target Duration / Category: 4–8 Weeks / Customized

• **Module 1: Advanced Structured PLC Programming Languages:** Statement List (STL), Structured Text (ST), Function Block Diagram (FBD), sequential function charts (SFC), data structures (Arrays, Structs), and indirect memory addressing.
• **Module 2: Industrial Communication Protocols & Networks:** Configuring Profibus DP, Profinet IO, Modbus TCP/RTU, and Industrial Ethernet for master-slave and peer-to-peer PLC communication.
• **Module 3: Advanced Sensor, Transducer & Encoder Interfacing:** Interfacing incremental/absolute optical encoders, ultrasonic level sensors, thermocouples, RTDs, load cells, LVDTs, and linear encoders with PLC I/Os.
• **Module 4: Proportional Hydraulics & Electro-Pneumatic Positioners:** Proportional solenoid valves, amplifier cards, electro-pneumatic positioners, servo-pneumatic positioning, and electronic pressure regulators.
• **Module 5: Industrial SCADA Architecture & HMI Development:** WinCC / InTouch SCADA design, dynamic graphics creation, recipe management, real-time trend logging, historical data archiving, and multi-level user security access.
• **Module 6: Closed-Loop Feedback Control & PID Loop Tuning:** Mathematical foundations of PID control, proportional gain (Kp), integral time (Ti), derivative time (Td), and practical PID loop tuning for temperature, flow, and speed control.
• **Module 7: Industrial Cyber-Security, Fault Diagnostics & Commissioning:** PLC network security, backup/restore procedures, forced I/O diagnostics, online debugging, system commissioning, and safety integrity level (SIL) compliance.

8. Hydraulics & Pneumatics Engineering

Target Duration / Category: 1–4 Weeks / Short Course

• **Module 1: Fluid Power Fundamentals & Fluid Dynamics:** Pascal's law, continuity equation, Bernoulli's principle, fluid flow types (laminar vs turbulent), fluid viscosity, pressure drops, and power transfer efficiency.

• **Module 2: Pneumatic System Components & Air Conditioning:** Reciprocating and screw compressors, air receivers, pressure switches, refrigerated air dryers, main line filters, and FRL (Filter, Regulator, Lubricator) units.

• **Module 3: Hydraulic Power Units & Pump Technology:** Fixed and variable displacement pumps (gear, vane, radial/axial piston pumps), reservoirs, oil coolers, suction/return line filters, and hydraulic oil contamination standards (ISO 4406).

• **Module 4: Control Valve Mechanics, Actuators & Accumulators:** Direct and pilot-operated directional valves, pressure relief/reducing valves, needle/flow control valves, counter balance valves, cylinders (tie-rod, mill-type), hydraulic motors, and accumulators.

• **Module 5: Fluid Power Circuit Simulation & System Design:** Designing industrial hydraulic and pneumatic circuits using FluidSIM, pump sizing, cylinder force/velocity calculation, heat generation estimation, and accumulator selection.

• **Module 6: Shop-Floor Assembly, Piping, Hose Technology & Fault Diagnosis:** Steel tube bending, flange connections, high-pressure hydraulic hose selection, hose crimping, manifold block assembly, pressure testing, flowmeter diagnostics, and preventative maintenance.