SAMSUNG AUSTIN SEMICONDUCTOR

PEOPLE | TECHNOLOGY | A BRIGHTER TOMORROW

CMP Equipment Technician 2 Training & Lesson Plan

Build Knowledge › Develop Skills › Support Fab Operations

From Fundamentals to Fab Readiness

Learn › Practice › Apply › Grow

Your Journey
Step by Step to Success

1. **Orientation** — Week 1
2. **Semiconductor Fundamentals** — Weeks 2–3
3. **Technical Foundations** — Weeks 4–6
4. **CMP Equipment Knowledge** — Weeks 7–10
5. **Hands-On Training & OJT** — Weeks 11–14
6. **Qualification & Continuous Growth** — Weeks 15+

1. New Employee Orientation

- **Welcome to Samsung Austin** — Culture, Values, and Expectations
- **Site Safety & ESH** — Safety Rules, Emergency Response, LOTO Awareness
- **Security & Access** — Badge, Areas, Data Security
- **HR & Benefits** — Policies, Timekeeping, Leave, Support Resources
- **Introduction to Fab** — Overview of Austin Site and Products
- **Tools for Success** — IT Systems, Training Platforms, Communication Channels

2. Semiconductor Fundamentals

- **Semiconductor Industry Overview** — Market, Products, Applications
- **Semiconductor Devices** — Wafer, Die, IC Basics
- **Manufacturing Process Flow** — Front End, Back End, Where CMP Fits
- **Cleanroom Fundamentals** — Gowning, Contamination Control, Behavior
- **Fab Terminology** — Common Acronyms and Terms
- **Yield, Quality & Reliability** — Why It Matters
- **Introduction to Equipment Roles** — Lithography, Etch, Deposition, CMP, Metrology, etc.

3. Technical Foundations

Basic Electronics
- Voltage, Current, Resistance
- Ohm's Law
- DC vs AC
- Series vs Parallel Circuits
- Power Supplies (24VDC, 120/208VAC)
- Multimeter Use & Troubleshooting
- Fuses, Breakers, Relays, Sensors

Basic Mechanics
- Mechanical Systems & Motion
- Bearings, Belts, Gears, Couplings
- Pneumatics (Air Systems)
- Vacuum Systems
- Hydraulics (if applicable)
- Mechanical Drawings
- Torque, Alignment, Preventive Maintenance

Instrumentation & Controls
- Sensors (Pressure, Flow, Level, Temperature)
- Actuators (Pneumatic, Electric)
- PLC Basics
- Interlocks and Safety Circuits
- Introduction to PID Control

4. CMP Equipment Knowledge

- **CMP Process Overview** — Purpose, Outcomes, Where It Fits
- **CMP Equipment Architecture** — Main Modules and Functions

Key CMP Components
- Platen & Carrier
- Conditioner
- Slurry Delivery System
- Pad System
- Wafer Handling/Transfer
- Sensors and End Point Monitor

Utilities & Subsystems
- DI/UPW (Deionized Water)
- Slurry System
- Chemical Delivery
- Vacuum
- Pneumatic
- Exhaust and Ventilation

Maintenance & Troubleshooting
- PM Procedures
- Common Failures and Alarms
- Log Review and Documentation
- Parts Handling and Replacement

Safety & Environmental
- Chemical Safety (Slurry, DIW)
- Hazardous Materials
- Spill Response
- Waste Systems
- LOTO for CMP Equipment

5. Hands-On Training & OJT

- **Equipment Walkdown** — Identify and Locate Components
- **Standard Operating Procedures (SOPs)** — Startup, Shutdown, PM
- **Troubleshooting Practice** — Guided and Independent
- **Use of Diagnostic Tools** — Tool Software, Alarm Logs, Trending
- **Hands-On Maintenance** — PMs, Part Replacement, Alignment, Calibration
- **Cross-team Collaboration** — Process, Integration, and Handoffs
- **OJT Checklist** — Demonstrate Competency Sign-off by Mentor

6. Qualification & Continuous Growth

- **Skills Assessment** — Written, Practical, and Scenario-based
- **Certification** — Internal Qualification for Technician 2
- **Independent Troubleshooting** — Handle Assigned Tools/Modules
- **Continuous Learning** — Advanced Topics, New Tool Installs, Process Changes
- **Career Development** — PMs to Senior Technician, Specialization Opportunities
- **Stay Current** — Read Manuals, Tech Updates, Industry Trends

Digital I/O (DIO)
- Digital Signals and Logic
- Inputs (Switches, Sensors)
- Outputs (Relays, Solenoids)
- PLC I/O Modules
- Wiring and Troubleshooting
- Use of Schematics
- Interlocks and Safety I/O

Analog I/O (AIO)
- Analog Signals (4–20mA, 0–10V)
- Sensors and Transmitters
- Signal Conditioning
- A/D and D/A Conversion
- PLC Analog Modules
- Troubleshooting Analog Loops
- Calibration and Verification

Pumps & Fluid Systems
- Pump Types (Centrifugal, Diaphragm, Peristaltic)
- Principles of Operation
- Slurry Pumps
- DIW Pumps
- Chemical Pumps
- Flow, Pressure, and NPSH
- Maintenance and Troubleshooting
- Associated Piping and Valves

Recommended Reading & Resources
- Equipment Manuals (OEM)
- Process Guides
- Safety Data Sheets (SDS)
- Internal Training Materials
- SEMI Standards (e.g., E10, E37, E84)
- Basic Electricity and Electronics Texts
- Pneumatics and Hydraulics Fundamentals
- PLC and Industrial Controls Basics
- CMP Technology and Process Integration Articles

Training Methods
- Classroom Training
- eLearning Modules
- Hands-On Practice
- OJT with Mentor
- Assessments & Quizzes
- Real Equipment Experience

Success Metrics
- Knowledge Checks
- Practical Skills Demonstration
- OJT Sign-off
- Qualification Test
- Readiness for Independent Work

Your Future
- Skilled Technician 2
- Greater Opportunities
- Contribute to World-Class Manufacturing
- Be Part of Innovation

Our Goal

Develop a safe, skilled, and confident CMP Equipment Technician 2 who contributes to Samsung Austin's mission of advancing semiconductor technology.

Better Chips | A Brighter Tomorrow | Together

hub.gravelcloud.com
Rigel G Arcayan, 2026.

AI-04706 CMP Equipment Technician Lesson Plan

Multiple B I U S A

#cmp

Create a comprehensive entry level Samsung Austin Semiconductor CMP Equipment Technician 2 Training and Lesson Plan. Start from the New Employee Orientation, Semiconductor Lessons, CMP Specific knowledge, Basic Electronics, Basic mechanical and DIO/AIO and pumps and related topic to read. The new employee is new to semiconductor with a Fabrication/Machinist background of 7 years.

Samsung Austin Semiconductor

CMP Equipment Technician 2 — Entry-Level Training & Lesson Plan

Designed for: A new CMP Equipment Technician 2 entering semiconductor manufacturing with **7 years of fabrication/machining experience**, but little or no semiconductor-fab experience.

Training objective: Develop a technician who can safely operate within a semiconductor fab, understand the wafer-fabrication process, identify the major subsystems of CMP equipment, perform assigned preventive maintenance, troubleshoot systematically, interpret equipment data, and work independently within Samsung's procedures and escalation structure.

> **Important scope note:** This is a comprehensive **industry-aligned training curriculum**, not an official Samsung internal training document. Samsung's actual equipment models, chemical recipes, maintenance procedures, alarm codes, qualification requirements, and DIO/AIO terminology must be learned from current SAS-controlled documentation and qualified trainers. No proprietary SOPs or process parameters should be substituted with material from this plan.

Samsung's publicly described CMP Equipment Technician role includes preventive maintenance, alarm troubleshooting, recovery planning, collaboration with process technicians and engineering, equipment calibration/support, failure analysis, SOP compliance, and process-quality support. (My Workday Jobs)

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1. Training Philosophy

The new employee already has a valuable foundation:

Existing fabrication/machining experience	Semiconductor skill to develop
Mechanical drawings and tolerances	Semiconductor equipment drawings, P&IDs, schematics
Precision measurement	Wafer-level metrology and process-control concepts
Machine maintenance	High-volume manufacturing equipment maintenance
Pumps, motors, bearings, pneumatics	CMP-specific fluid, vacuum, motion, and chemical systems
Troubleshooting mechanical faults	Fault isolation across mechanical, electrical, software, and process systems
Tool discipline and workholding	Contamination control and wafer-handling discipline
Preventive maintenance	PM execution with process-impact awareness

Manufacturing safety	Fab chemical, gas, electrical, radiation, ergonomic, and contamination safety

The central transition

> **From:** “Repair the machine until it runs.”
> **To:** “Restore the equipment to a controlled, qualified condition without creating a wafer, safety, contamination, or process problem.”

A good CMP technician must understand that **equipment uptime is not the only objective**. The equipment must return to production in a state that protects **yield, reliability, repeatability, and wafer quality**.

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2. Recommended Training Structure

16-Week Core Program + Continued Qualification

This program assumes a full-time employee receiving classroom instruction, supervised hands-on work, and structured on-the-job training.

Phase	Weeks	Focus	Expected outcome
0. Pre-arrival preparation	Before Day 1	Math, terminology, safety mindset	Ready for orientation
1. New Employee & Fab Orientation	1–2	Samsung, fab culture, EHS, contamination, workflow	Safe fab behavior
2. Semiconductor Fundamentals	3–4	Wafer, materials, process flow, yield, cleanroom	Understand what the tool produces
3. Equipment Technician Foundations	5–6	Electrical, electronics, mechanical, pneumatics, vacuum, pumps	Understand major subsystems
4. CMP Fundamentals	7–8	CMP process, consumables, modules, defects, cleaning	Understand the CMP process
5. CMP Equipment Systems	9–10	Tool architecture, slurry, DI water, motion, pressure, sensors, DIO/AIO	Map the equipment
6. Maintenance & Troubleshooting	11–12	PM, alarms, fault isolation, calibration, recovery	Execute supervised maintenance
7. Process/Equipment Integration	13–14	SPC, metrology, defects, post-CMP, process impact	Connect equipment health to wafer results
8. Qualification & Independent Work	15–16	Practical demonstrations, certification, supervised ownership	Entry-level independent capability
9. Ongoing development	Months 5–12	Advanced troubleshooting, projects, cross-training	Technician 2 growth

Training ratio

A practical balance is:

- **25% classroom / self-study**
- **25% equipment walkdown / lab / simulation**
- **40% supervised on-tool training**
- **10% assessment, documentation, and feedback**

Actual time should be adjusted based on the employee's demonstrated competence and the site's qualification requirements.

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3. Competency Framework

The technician should progress through four levels:

Level 1 — Understand

Can explain the system, identify components, and describe normal operation.

Level 2 — Demonstrate

Can perform a task in a controlled environment using the SOP and proper PPE.

Level 3 — Perform Under Supervision

Can execute the task on production equipment with a qualified trainer observing.

Level 4 — Qualified / Independent

Can perform the approved task independently, document it correctly, recognize abnormal conditions, and escalate appropriately.

No technician should be considered qualified merely because they completed a lesson. Qualification requires demonstrated performance under site-approved criteria.

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4. Phase 0 — Pre-Arrival Preparation

Suggested reading and study

A. Basic mathematics

Review:

- Fractions, decimals, percentages
- Scientific notation
- Unit conversions
- Metric prefixes: nano, micro, milli, kilo, mega
- Pressure conversions
- Flow-rate units
- Temperature conversions
- RPM and linear speed
- Force, torque, and pressure
- Basic algebra
- Reading graphs and trends
- Mean, range, standard deviation

- Basic probability and statistical variation

B. Basic technical vocabulary

Learn the meaning of:

Fab, wafer, die, lot, carrier, cassette, FOUP, process, recipe, module, chamber, tool, equipment, PM, CM, BM, alarm, interlock, qualification, calibration, SPC, excursion, defect, yield, uptime, downtime, MTBF, MTTR, ESD, PPE, DI water, slurry, pad, platen, carrier, retaining ring, endpoint.

C. Manufacturing mindset

Read about:

- High-volume manufacturing
- Statistical process control
- Root-cause analysis
- 5S
- Standard work
- Change control
- Corrective and preventive action
- FMEA
- Mistake-proofing
- Equipment reliability

Suggested pre-arrival exercise

Draw a simple block diagram:

Raw material → Machine → Process → Inspection → Next operation

Then compare it with:

Wafer lot → CMP tool → Post-CMP clean → Metrology → Next fab process

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5. Phase 1 — New Employee Orientation & Fab Integration

Weeks 1–2

This phase is not merely administrative. It establishes the behaviors that prevent injuries, contamination, equipment damage, and wafer loss.

Samsung publicly emphasizes formal EHS management and ISO-based environmental, occupational health, energy, and quality systems. The curriculum should therefore treat safety and procedural compliance as core technical competencies—not separate subjects. (Samsung Semiconductor Global)

Lesson 1.1 — Samsung Austin Semiconductor Orientation

Topics

- Samsung Austin Semiconductor organization
- Fab Engineering organization
- Equipment Technician vs. Process Technician vs. Equipment Engineer vs. Process Engineer
- CMP department structure

- Shift organization and handoff
- Escalation chain
- Manufacturing priorities
- Quality and customer impact
- Professional conduct
- Attendance and shift readiness
- Training records and qualification system
- Confidentiality and controlled information
- Work-order and documentation systems

Learning objectives

The trainee can:

- Explain the responsibilities of each major role.
- Identify who to contact for safety, equipment, process, quality, and facilities issues.
- Describe the correct escalation path.
- Explain why undocumented work is unacceptable.
- Understand that production decisions follow authorized procedures.

Practical exercise

Create a **CMP support organization map**:

Technician → Lead / Supervisor → Equipment Engineering → Process Engineering → Manufacturing / Quality / EHS as applicable

Use the actual SAS organizational structure during training.

Lesson 1.2 — Fab Safety and EHS

Topics

- General fab safety
- Chemical safety
- Hazard communication / SDS
- PPE selection
- Chemical exposure response
- Spill response
- Emergency showers and eyewash
- Fire safety
- Electrical safety
- Lockout/Tagout (LOTO)
- Stored energy
- Pneumatic and hydraulic pressure hazards
- Vacuum implosion hazards
- Rotating equipment
- Pinch points
- Ergonomics and lifting
- Slip hazards from fluids
- Waste handling

- Emergency evacuation
- Incident and near-miss reporting

Learning objectives

The trainee can:

- Identify hazards before beginning work.
- Locate required emergency equipment.
- Explain the purpose of LOTO.
- Identify electrical, pneumatic, vacuum, chemical, and mechanical stored energy.
- Stop work when conditions differ from the approved task plan.

Practical exercises

- PPE identification
- SDS retrieval exercise
- Emergency-route walkdown
- LOTO demonstration using training equipment
- Stored-energy identification on a mock CMP subsystem
- Spill-response tabletop exercise

> **Rule:** No hands-on chemical, electrical, vacuum, or energized-equipment work should be performed based on this curriculum alone. Use current Samsung EHS procedures and task-specific authorization.

Lesson 1.3 — Cleanroom Behavior and Contamination Control

Topics

- Why semiconductor fabs require cleanrooms
- Particles and wafer defects
- Molecular contamination
- Metal contamination
- Cross-contamination
- Cleanroom garments and gowning
- Glove discipline
- Material movement
- Tool cleanliness
- Approved wipes and cleaning materials
- Chemical compatibility
- Wafer handling
- FOUP/carrier discipline
- Contamination events
- Foreign material exclusion (FME)
- Cleanroom etiquette

Learning objectives

The trainee can:

- Explain how a microscopic particle can affect a semiconductor device.
- Demonstrate proper gowning and glove practices.

- Identify behaviors that create contamination.
- Explain why ordinary shop habits may be unacceptable in a fab.
- Recognize when a component or material requires contamination review.

Practical exercise

“Machine shop vs. semiconductor fab” comparison

Fabrication shop habit	Fab expectation
Shop rag	Approved cleanroom wipe
Compressed air used casually	Only approved method and location
Oil/grease applied routinely	Approved material and controlled quantity
Parts placed on any clean surface	Controlled placement and FME
Touching surfaces with gloves	Avoid contact with critical surfaces
“Clean enough to look good”	Cleanliness verified by procedure

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Lesson 1.4 — Fab Workflow and Manufacturing Control

Topics

- Wafer lots and carriers
- MES basics
- Tool status
- Available / idle / running / engineering / down
- Hold and release concepts
- Dispatching
- Recipe control
- Product tracking
- Lot genealogy
- Work-in-process (WIP)
- Equipment downtime
- Preventive maintenance windows
- Engineering lots
- Production vs. qualification material

Learning objectives

The trainee can:

- Explain how a wafer lot moves through manufacturing.
- Understand why the wrong recipe or wrong lot state is a serious event.
- Identify the difference between equipment status and production authorization.
- Understand the importance of accurate tool status and downtime coding.

Practical exercise

Trace a **hypothetical wafer lot** through:

Incoming lot → CMP → Post-CMP clean → Metrology → Hold/release → Next operation

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Lesson 1.5 — Technician Documentation and Communication

Topics

- SOPs
- Work instructions
- PM procedures
- Electronic maintenance records
- Shift handoff
- Alarm descriptions
- Failure reports
- Escalation notes
- Technical writing
- "Facts vs. assumptions"
- Photo documentation where authorized
- Revision control
- Change management

Required documentation standard

A good maintenance note answers:

1. **What happened?**
2. **When did it happen?**
3. **What was the equipment state?**
4. **What alarm or symptom occurred?**
5. **What was checked?**
6. **What was changed?**
7. **What was the result?**
8. **What remains unresolved?**
9. **Who was notified?**

Example

> **Poor:** "Tool fixed. Pump issue."
>
> **Better:** "Tool entered down state after slurry supply low-flow alarm. Verified supply pressure and observed intermittent flow indication. Inspected approved external connections; no visible leakage found. Escalated to equipment engineering per SOP. Pump replacement not performed. Tool remains unavailable pending engineering evaluation."

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6. Phase 2 — Semiconductor Fundamentals

Weeks 3–4

The objective is not to turn the technician into a process engineer. It is to provide enough semiconductor knowledge to understand **why CMP equipment must be controlled so precisely**.

Lesson 2.1 — What Is a Semiconductor?

Topics

- Conductors, insulators, semiconductors
- Silicon and semiconductor materials
- Electrical conductivity
- Doping
- N-type and P-type material
- PN junction
- Transistors
- CMOS overview
- Integrated circuits
- Logic chips
- Memory vs. logic
- Why semiconductor devices require precise manufacturing

Learning objectives

The trainee can:

- Explain what makes silicon useful.
- Describe the purpose of doping.
- Explain the basic function of a transistor.
- Describe how many manufacturing steps create one integrated circuit.

Reading

- Introductory semiconductor physics
- Basic electronics textbook chapters on diodes and transistors
- Semiconductor manufacturing overview

Lesson 2.2 — Wafer Fundamentals

Topics

- Silicon ingot
- Wafer slicing
- Lapping and polishing
- Wafer diameter
- Wafer thickness
- Crystal orientation
- Frontside and backside
- Notch / flat
- Die and scribe lines
- Film stacks
- Surface topography
- Wafer bow and warp
- Wafer handling

Learning objectives

The trainee can:

- Identify major wafer features.

- Explain why wafer flatness matters.
- Explain the difference between a wafer, die, and lot.
- Describe why wafer handling must avoid scratches, particles, and contamination.

Exercise

Draw a cross-section of a wafer containing:

- Substrate
- Dielectric layer
- Conductive layer
- Patterned features
- Surface topography

Lesson 2.3 — Semiconductor Manufacturing Flow

Topics

- Wafer preparation
- Oxidation
- Deposition
- Photolithography
- Etch
- Ion implantation
- Diffusion
- Chemical mechanical planarization
- Cleaning
- Metallization
- Inspection
- Metrology
- Packaging overview

Learning objectives

The trainee can:

- Place CMP within the overall process flow.
- Explain why CMP may occur multiple times during wafer fabrication.
- Identify how deposition and etch create topography.
- Explain why planarization is needed for subsequent lithography and interconnect steps.

Core concept

Semiconductor fabrication is a repeated sequence of adding, patterning, removing, cleaning, measuring, and planarizing material.

Lesson 2.4 — Film and Material Fundamentals

Topics

- Silicon
- Silicon dioxide

- Silicon nitride
- Polysilicon
- Copper
- Tungsten
- Cobalt
- Low-k dielectrics
- Barrier layers
- Hard masks
- Conductive films
- Dielectric films
- Selectivity
- Material removal rate
- Surface chemistry

Learning objectives

The trainee can:

- Identify common materials that may be encountered in CMP.
- Explain why different materials require different process conditions.
- Understand that CMP is not simply “polishing silicon.”
- Explain why material selectivity affects process results.

Lesson 2.5 — Yield, Defects, and Process Control

Topics

- Yield definition
- Defect density
- Random vs. systematic defects
- Scratches
- Particles
- Residue
- Corrosion
- Dishing
- Erosion
- Non-uniformity
- Wafer-to-wafer variation
- Lot-to-lot variation
- Tool-to-tool variation
- Process excursions
- Equipment-induced defects

Learning objectives

The trainee can:

- Explain the difference between equipment downtime and process failure.
- Identify how a maintenance action can affect yield.
- Explain why a tool may be mechanically operational but not process-qualified.

- Understand why post-maintenance verification matters.

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7. Phase 3 — Equipment Technician Foundations

Weeks 5–6

This is where the employee's seven years of fabrication experience becomes a major advantage.

Samsung and Austin Community College's public STARS program specifically identifies electro-mechanical systems, electronics, sensors, pneumatics, vacuum systems, gas delivery, and statistical process control as relevant technician-development topics. (**Guidelines and Technical Tutorials**)

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8. Basic Electronics Curriculum

Lesson 3.1 — Electrical Safety and Measurement

Topics

- Voltage
- Current
- Resistance
- Power
- AC vs. DC
- Grounding
- Bonding
- Circuit protection
- Fuses
- Circuit breakers
- Electrical cabinets
- Control voltage
- Safety circuits
- Multimeter safety
- Electrical schematics
- Energized vs. de-energized testing

Key equations

V=IRV = IRP=VIP = VIP=I2RP = I^2RP=V2RP = \frac{V^2}{R}

Learning objectives

The trainee can:

- Explain voltage, current, resistance, and power.
- Use a multimeter safely under authorization.
- Read basic electrical schematics.
- Identify power and control circuits.
- Explain why improper probing can damage equipment or injure personnel.

Practical exercises

- Identify electrical components on a training panel.
- Measure voltage and resistance on a de-energized training circuit.
- Trace a simple control circuit.
- Read a fuse and circuit-protection diagram.
- Identify the difference between signal wiring and power wiring.

Lesson 3.2 — DC Circuits and Components

Topics

- Resistors
- Capacitors
- Inductors
- Diodes
- LEDs
- Relays
- Contactors
- Transformers
- Solenoids
- Switches
- Circuit protection
- Series and parallel circuits
- Voltage dividers
- Pull-up and pull-down concepts

Learning objectives

The trainee can:

- Identify common components.
- Explain the function of relays and solenoids.
- Recognize a failed fuse, relay, or loose connection as possible fault causes.
- Use a schematic to identify component relationships.

Lesson 3.3 — Sensors and Instrumentation

Topics

- Proximity sensors
- Photoelectric sensors
- Limit switches
- Pressure sensors
- Vacuum sensors
- Flow sensors
- Temperature sensors
- Level sensors
- Position encoders
- Load cells
- Current sensors

- Analog vs. digital signals
- 4–20 mA concepts
- 0–10 V concepts
- Sensor calibration
- Sensor contamination and drift

Learning objectives

The trainee can:

- Identify sensor types and typical applications.
- Explain normally open vs. normally closed.
- Distinguish a sensor fault from a mechanical condition.
- Understand the difference between a sensor reading and the actual physical condition.
- Explain why calibration and sensor mounting matter.

Practical exercise

Build a fault tree for:

“Pressure low” alarm

Possible branches:

- Actual low pressure
- Empty supply
- Closed valve
- Restricted line
- Leaking connection
- Faulty pressure sensor
- Wiring issue
- PLC / control issue
- Incorrect setpoint or configuration

Lesson 3.4 — Motors, Drives, and Motion Control

Topics

- AC motors
- DC motors
- Servo motors
- Stepper motors
- Variable-frequency drives
- Servo drives
- Encoders
- Feedback loops
- Speed control
- Torque
- Position control
- Acceleration/deceleration
- Motor overload

- Mechanical binding
- Alignment
- Vibration

Learning objectives

The trainee can:

- Explain open-loop vs. closed-loop control.
- Identify the relationship between motor, drive, encoder, and mechanical load.
- Recognize common symptoms of mechanical binding vs. electrical drive faults.
- Understand why motion systems require controlled homing and calibration.

Lesson 3.5 — PLC, HMI, and Equipment Control

Topics

- PLC fundamentals
- Inputs and outputs
- Digital I/O
- Analog I/O
- Interlocks
- Permissives
- Sequences
- State machines
- HMI screens
- Alarm history
- Recipe interfaces
- Networked equipment
- Industrial communication basics
- Control-system troubleshooting boundaries

Learning objectives

The trainee can:

- Explain how sensors and actuators connect to a PLC.
- Understand the difference between an alarm, interlock, and permissive.
- Read a basic I/O list.
- Use HMI information to guide troubleshooting.
- Know when to escalate software, PLC, or network-related issues.

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9. Basic Mechanical Curriculum

Lesson 3.6 — Mechanical Principles

Topics

- Force
- Torque

- Friction
- Work
- Power
- Pressure
- Stress and strain
- Thermal expansion
- Tolerance and fit
- Alignment
- Flatness
- Parallelism
- Perpendicularity
- Runout
- Concentricity
- Surface finish
- Vibration
- Resonance
- Wear

Learning objectives

The trainee can:

- Explain how misalignment affects equipment performance.
- Identify the difference between wear, looseness, and misalignment.
- Understand how thermal expansion can affect precision equipment.
- Read basic mechanical drawings and tolerance callouts.

Lesson 3.7 — Fasteners, Bearings, Seals, and Motion Components

Topics

- Fastener types
- Torque specifications
- Torque sequence
- Thread damage
- Thread locking
- Bearings
- Bushings
- Linear bearings
- Linear guides
- Lead screws
- Ball screws
- Belts
- Pulleys
- Couplings
- Shafts
- O-rings
- Gaskets

- Mechanical seals
- Chemical compatibility
- Lubrication control

Learning objectives

The trainee can:

- Select the correct approved tool and method for a maintenance task.
- Explain why torque sequence matters.
- Recognize common seal failure modes.
- Understand that material compatibility is critical in chemical systems.
- Explain why “tight enough” is not an acceptable substitute for a specified torque.

Practical exercises

- Read a mechanical assembly drawing.
- Identify bearing and seal failure symptoms.
- Practice torque-tool use on a training assembly.
- Inspect an O-ring for damage using approved methods.
- Identify potential particle-generating wear points.

Lesson 3.8 — Precision Maintenance

Topics

- Clean assembly practices
- Alignment
- Leveling
- Flatness
- Parallelism
- Runout measurement
- Dial indicators
- Torque tools
- Feeler gauges
- Calipers and micrometers
- Surface plates
- Reference standards
- Calibration status
- Tool control
- Foreign material exclusion

Learning objectives

The trainee can:

- Explain why mechanical precision affects wafer processing.
- Use basic measurement tools correctly.
- Distinguish measurement error from equipment error.
- Understand why tools and standards must be calibrated.

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10. Pneumatics, Vacuum, and Fluid Systems

Lesson 3.9 — Pneumatics

Topics

- Compressed air
- Pressure vs. flow
- Regulators
- Filters
- Lubricators, where applicable
- Solenoid valves
- Pneumatic cylinders
- Actuators
- Pressure switches
- Tubing and fittings
- Leaks
- Exhaust restrictions
- Pneumatic logic
- FRL systems
- Cylinder cushioning
- Pneumatic safety

Learning objectives

The trainee can:

- Read a basic pneumatic schematic.
- Identify major components.
- Explain why pressure can be normal while flow is restricted.
- Identify common causes of slow or incomplete actuator motion.
- Understand stored-energy hazards.

Lesson 3.10 — Vacuum Fundamentals

Topics

- Atmospheric pressure
- Vacuum terminology
- Absolute vs. gauge pressure
- Vacuum units
- Rough vacuum
- High vacuum overview
- Vacuum pumps
- Vacuum gauges
- Vacuum valves
- Vacuum chambers
- Vacuum leaks
- Outgassing

- Conductance
- Pump-down curves
- Venting
- Vacuum interlocks

Learning objectives

The trainee can:

- Explain what vacuum means physically.
- Identify major vacuum components.
- Interpret a basic pump-down curve.
- Understand the difference between a leak and a pump-performance problem.
- Recognize why contamination and outgassing matter.

Practical exercise

Analyze a hypothetical vacuum fault:

Symptom: Chamber does not reach expected vacuum.

Potential causes:

- Door seal issue
- Valve not opening
- Valve not closing
- Leak
- Pump issue
- Gauge issue
- Contamination
- Incorrect sequence
- Vent valve not fully closed

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11. Pumps and Fluid-Handling Systems

Lesson 3.11 — Pump Fundamentals

Topics

- Positive-displacement pumps
- Centrifugal pumps
- Diaphragm pumps
- Peristaltic pumps
- Gear pumps
- Metering pumps
- Vacuum pumps
- Pump curves
- Head pressure
- Flow rate
- Cavitation
- Priming

- NPSH concepts
- Seal failure
- Diaphragm failure
- Bearing failure
- Motor failure
- Dry running
- Fluid compatibility

Learning objectives

The trainee can:

- Identify common pump types.
- Explain the relationship between pressure and flow.
- Recognize symptoms of cavitation, air ingestion, restriction, and seal failure.
- Understand why pump selection depends on fluid and process requirements.
- Identify when a pump problem may actually be a valve, sensor, or line problem.

Lesson 3.12 — CMP Fluid Systems

Topics

- DI water systems
- Slurry supply
- Slurry mixing and distribution
- Chemical supply
- Chemical dilution concepts
- Filters
- Valves
- Tubing
- Fittings
- Pressure regulation
- Flow control
- Tank levels
- Agitation
- Recirculation
- Drain systems
- Waste collection
- Leak detection
- Chemical compatibility
- Particle generation
- Slurry settling
- Line blockage
- Pump wear
- Supply interruptions

Learning objectives

The trainee can:

- Trace the path of a fluid from source to point of use.
- Identify pumps, filters, valves, sensors, and drains.
- Explain how a restriction affects flow.
- Recognize why slurry condition and delivery stability affect process results.
- Understand why a fluid-system maintenance error can create contamination or process excursions.

Practical exercise

Draw a **generic CMP slurry delivery system**:

Slurry source → Tank / supply → Pump → Filter → Valve → Flow measurement → Point of use → Return / drain

Use actual equipment documentation to replace the generic blocks.

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12. Phase 4 — CMP-Specific Semiconductor Knowledge

Weeks 7–8

CMP is a combination of **chemical reaction and mechanical abrasion** used to remove material and create a flatter wafer surface.

Professional CMP training commonly covers the CMP module, tools, pads, slurries, process control, dielectric CMP, conductive-material CMP, and post-CMP cleaning. (**PT International**)

Lesson 4.1 — What Is Chemical Mechanical Planarization?

Core definition

Chemical Mechanical Planarization (CMP) uses a chemically active slurry and mechanical contact between a wafer and a polishing surface to remove material in a controlled manner.

The process is designed to achieve:

- Material removal
- Surface planarization
- Controlled film thickness
- Low defectivity
- Acceptable within-wafer uniformity
- Repeatability across wafers and lots

Topics

- Chemical action
- Mechanical abrasion
- Relative motion
- Pressure
- Slurry chemistry
- Pad contact
- Material removal
- Planarization
- Selectivity
- Endpoint

- Over-polish
- Under-polish

Learning objectives

The trainee can:

- Explain the difference between chemical and mechanical contributions.
- Explain why CMP is sensitive to pressure, speed, slurry, pad condition, and time.
- Explain why equipment stability affects wafer quality.
- Describe CMP at a conceptual level without changing process parameters.

Lesson 4.2 — CMP Tool Architecture

A generic CMP system may include:

- Wafer loading/unloading
- Wafer transfer system
- Carrier head
- Retaining ring
- Platen
- Polishing pad
- Slurry delivery
- DI water delivery
- Conditioning system
- Pressure control
- Motion systems
- Post-polish cleaning
- Drying
- Waste and drain systems
- Sensors and instrumentation
- Control system
- Safety interlocks
- Utilities interface

Learning objectives

The trainee can:

- Identify each major module on the actual tool.
- Explain the function of each subsystem.
- Trace wafer movement through the tool.
- Identify which systems are mechanical, electrical, fluid, pneumatic, software, and process-related.

Practical exercise

Create a **CMP tool map** with five layers:

1. **Wafer path**
2. **Mechanical path**
3. **Fluid/chemical path**
4. **Electrical/control path**

5. **Safety/interlock path**

Lesson 4.3 — CMP Consumables

Topics

Polishing pads

- Pad construction
- Pad hardness
- Pad texture
- Pad conditioning
- Pad wear
- Pad glazing
- Pad break-in
- Pad replacement
- Pad-related defects

Slurry

- Abrasive particles
- Chemical additives
- pH concepts
- Oxidizers
- Inhibitors
- Selectivity
- Stability
- Settling
- Contamination
- Shelf life and handling controls

Retaining rings

- Wafer retention
- Wear
- Material compatibility
- Contact effects
- Replacement criteria

Conditioners

- Conditioning mechanism
- Diamond or approved conditioning surfaces
- Conditioning wear
- Conditioning uniformity
- Conditioning-related defects

Learning objectives

The trainee can:

- Identify major CMP consumables.
- Explain how consumable condition affects process performance.
- Recognize why consumable replacement requires qualification or verification.

- Understand that consumables are part of the process—not ordinary wear parts.

Lesson 4.4 — CMP Process Variables

Topics

- Downforce
- Backside pressure
- Platen speed
- Carrier speed
- Relative velocity
- Slurry flow
- Slurry temperature
- Pad condition
- Polish time
- Conditioning rate
- Wafer loading
- Endpoint detection
- Over-polish
- Under-polish
- Selectivity
- Removal rate
- Uniformity

Conceptual relationship

A simplified conceptual model is:

$\text{Material Removal Rate} \propto \text{Pressure} \times \text{Relative Velocity}$\text{Material Removal Rate} \propto \text{Pressure} \times \text{Relative Velocity}

This is associated with the general Prestonian concept, but actual CMP behavior is much more complex and depends on chemistry, pad, materials, conditioning, temperature, and equipment-specific conditions.

Learning objectives

The trainee can:

- Explain why changes in mechanical or chemical conditions may affect removal rate.
- Understand that process parameters are controlled and not casually adjusted.
- Identify equipment conditions that can cause process drift.
- Explain why calibration and repeatability matter.

Lesson 4.5 — CMP Applications

Topics

- Dielectric CMP
- Oxide CMP
- Tungsten CMP
- Copper CMP

- Barrier CMP
- Cobalt CMP
- Multi-step CMP
- Post-CMP cleaning
- Corrosion control
- Residue removal
- Metal contamination control

Learning objectives

The trainee can:

- Explain why different films require different CMP approaches.
- Understand the distinction between dielectric and conductive-material CMP.
- Recognize why post-CMP cleaning is essential.
- Understand how corrosion, residue, and particles can affect downstream processing.

Lesson 4.6 — CMP Defects and Failure Modes

Topics

- Scratches
- Particles
- Residue
- Staining
- Corrosion
- Dishing
- Erosion
- Non-uniformity
- Edge defects
- Slurry marks
- Pad-related defects
- Conditioning-related defects
- Retaining-ring-related defects
- Wafer breakage
- Backside contamination
- Drying defects

Learning objectives

The trainee can:

- Identify common CMP defect categories.
- Explain possible equipment-related contributors.
- Understand why defect signatures matter.
- Escalate process-impacting symptoms without making unauthorized recipe changes.

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13. Phase 5 — CMP Equipment Systems

Weeks 9–10

This phase converts CMP theory into **equipment understanding**.

The trainee should create an equipment knowledge binder or digital notebook containing approved diagrams, terminology, component identification, alarm examples, and maintenance references.

Lesson 5.1 — CMP Tool Walkdown

Walkdown checklist

For the actual tool, identify:

- Tool name and model
- Tool ID
- Major modules
- Wafer entry point
- Wafer exit point
- Carrier heads
- Platens
- Pads
- Conditioning modules
- Slurry supply points
- DI water points
- Drain points
- Pneumatic supply
- Vacuum supply
- Electrical cabinets
- Control cabinets
- Sensors
- Pumps
- Filters
- Valves
- Interlocks
- Emergency stops
- Maintenance access points
- Hazardous-energy sources

Deliverable

One-page CMP equipment architecture drawing, reviewed by a qualified trainer.

Lesson 5.2 — Wafer Handling and Transfer

Topics

- FOUP/carrier interface
- Load ports
- Wafer mapping
- Robot arms

- End effectors
- Aligners
- Wafer centering
- Wafer presence sensors
- Wafer orientation
- Wafer edge handling
- Wafer breakage prevention
- Transfer timing
- Interlocks
- Misalignment
- Robot teach points
- Position verification
- Wafer drop response

Learning objectives

The trainee can:

- Trace wafer movement through the tool.
- Identify sensors and actuators involved in transfer.
- Explain common causes of transfer faults.
- Understand why robot adjustments require authorization and qualification.

Lesson 5.3 — Platen, Carrier, and Motion Systems

Topics

- Platen rotation
- Carrier rotation
- Oscillation / sweep
- Carrier head motion
- Downforce mechanism
- Backside pressure
- Retaining ring
- Pad support
- Motor and drive systems
- Encoder feedback
- Alignment
- Vibration
- Mechanical wear
- Motion interlocks

Learning objectives

The trainee can:

- Explain how the motion system contributes to polishing.
- Identify major components.
- Recognize abnormal vibration, noise, or motion.
- Explain why alignment and calibration affect process repeatability.

Lesson 5.4 — Pad Conditioning System

Topics

- Conditioner assembly
- Conditioning arm
- Conditioning disk
- Conditioning motion
- Contact force
- Conditioning rate
- Pad texture
- Pad glazing
- Conditioning wear
- Conditioning water / fluid
- Conditioning-related alarms
- Replacement and verification

Learning objectives

The trainee can:

- Explain the purpose of pad conditioning.
- Identify the conditioning subsystem.
- Recognize symptoms of conditioning problems.
- Understand why pad condition is a process-critical variable.

Lesson 5.5 — Slurry and Chemical Delivery

Topics

- Supply tanks
- Mix / dilution systems
- Pumps
- Filters
- Valves
- Pressure regulators
- Flow meters
- Level sensors
- Recirculation
- Point-of-use delivery
- Waste handling
- Leak detection
- Chemical compatibility
- Line flushes
- Supply verification
- Slurry contamination prevention

Learning objectives

The trainee can:

- Trace slurry from supply to pad.
- Identify the major components.
- Explain possible causes of low flow, high flow, pressure loss, or unstable delivery.
- Understand why slurry-related maintenance requires strict procedural control.

Lesson 5.6 — DI Water and Post-CMP Cleaning

Topics

- DI water properties
- Rinse systems
- Brush cleaning
- Megasonic cleaning overview
- Spray cleaning
- Chemical cleaning
- Drying
- Spin drying
- Marangoni drying overview
- Watermarks
- Residue
- Brush wear
- Nozzle alignment
- Drain restrictions
- Chemical compatibility

Learning objectives

The trainee can:

- Explain why cleaning is part of the CMP process.
- Identify the major cleaning subsystems.
- Recognize common cleaning-related equipment faults.
- Understand how poor cleaning can create downstream defects.

Lesson 5.7 — DIO/AIO Systems

Important terminology note

DIO/AIO is not a universally standardized acronym across all semiconductor equipment platforms. Its exact meaning, architecture, and scope must be confirmed using the specific Samsung tool's documentation, I/O list, controls architecture, and department terminology.

Depending on the equipment platform, the terms may refer to concepts involving **digital I/O, analog I/O, or equipment I/O interfaces**, but the trainee must not assume that interpretation without verification.

Recommended DIO/AIO lesson structure

Part A — Digital I/O

Topics:

- Digital input

- Digital output
- 24 VDC control concepts
- Normally open / normally closed
- Sensor states
- Solenoid control
- Relay outputs
- Interlock signals
- Permissive signals
- Input/output modules
- PLC rack / remote I/O concepts
- I/O diagnostics
- Wiring diagrams
- Signal tracing

Part B — Analog I/O

Topics:

- Analog input
- Analog output
- Voltage signals
- Current signals
- Pressure signals
- Flow signals
- Temperature signals
- Level signals
- Scaling
- Engineering units
- Sensor calibration
- Signal noise
- Open circuit
- Short circuit
- Out-of-range values
- Control-loop concepts

Part C — Equipment-specific DIO/AIO

The trainee should learn:

- Actual DIO/AIO cabinet or module locations
- I/O naming conventions
- I/O addressing
- Electrical drawings
- PLC/HMI relationship
- Signal source and destination
- Normal state
- Fault state
- Interlock behavior
- Diagnostic screens
- Approved troubleshooting procedure

- Replacement and verification requirements

Practical exercises

1. Trace a **digital input** from sensor → I/O module → PLC → HMI.
2. Trace a **digital output** from PLC → I/O module → solenoid/actuator.
3. Trace an **analog pressure signal** from sensor → input module → PLC → HMI.
4. Compare actual pressure with displayed pressure using approved test equipment.
5. Diagnose a simulated open-circuit sensor fault.
6. Identify whether a fault is likely:
   - Field device
   - Wiring
   - I/O module
   - PLC logic
   - HMI display
   - Actual process condition

Qualification boundary

The technician should **not force I/O states, bypass interlocks, modify PLC logic, or change scaling** unless specifically authorized, trained, and working under the approved procedure.

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14. Phase 6 — Preventive Maintenance and Troubleshooting

Weeks 11–12

This phase is the heart of the Equipment Technician role.

Samsung's public CMP technician description emphasizes PM execution, tool-alarm troubleshooting, recovery planning, work with process technicians, and engineering collaboration. (My Workday Jobs)

Lesson 6.1 — Preventive Maintenance Fundamentals

Topics

- Why PM exists
- PM vs. corrective maintenance
- PM frequency
- Time-based PM
- Usage-based PM
- Condition-based maintenance
- PM checklists
- Parts and consumables
- Calibration requirements
- Tool downtime planning
- Pre-task planning
- Post-maintenance verification
- PM quality
- Maintenance-induced failures

- FME
- Documentation

Learning objectives

The trainee can:

- Explain the purpose of PM.
- Follow a PM procedure without skipping steps.
- Identify when a PM task is outside their qualification.
- Recognize the difference between replacing a part and restoring a qualified system.
- Document PM completion accurately.

Lesson 6.2 — CMP PM Categories

Actual PM tasks depend on the tool model and SAS procedures, but the curriculum should cover the following categories.

Mechanical

- Inspect fasteners
- Inspect motion components
- Inspect bearings and guides
- Inspect belts and couplings
- Inspect seals
- Inspect retaining-ring condition
- Inspect pad/plate interfaces
- Check alignment where specified
- Inspect wear components

Fluid and chemical

- Inspect tubing
- Inspect fittings
- Inspect valves
- Inspect filters
- Inspect pumps
- Inspect drains
- Inspect leak sensors
- Verify approved connections
- Inspect chemical delivery components

Electrical and controls

- Inspect cables and connectors
- Inspect sensors
- Inspect electrical cabinets as authorized
- Check approved connections
- Verify alarms
- Check cooling or cabinet environmental conditions
- Inspect grounding/bonding as specified

Process-support systems

- Inspect conditioning components
- Inspect cleaning components
- Verify sensor condition
- Check approved calibration status
- Verify post-PM equipment state

Learning objective

The technician understands that **PM is a controlled restoration activity, not a collection of informal maintenance habits**.

Lesson 6.3 — Troubleshooting Methodology

The troubleshooting sequence

1. **Make the situation safe.**
2. **Define the symptom.**
3. **Preserve the evidence.**
4. **Check the tool state and history.**
5. **Identify the affected subsystem.**
6. **Form a hypothesis.**
7. **Perform the lowest-risk authorized test.**
8. **Isolate the fault.**
9. **Correct the problem.**
10. **Verify normal operation.**
11. **Confirm process/equipment qualification as required.**
12. **Document and communicate.**

Topics

- Symptom vs. root cause
- Fault isolation
- Evidence-based troubleshooting
- Alarm history
- Trend data
- Repeatability
- Intermittent faults
- “No fault found”
- Substitution testing
- Divide-and-conquer
- Five Whys
- Fishbone diagram
- Fault tree analysis
- Verification vs. assumption

Lesson 6.4 — CMP Alarm Troubleshooting

Create training cases around alarm categories rather than relying only on memorizing alarm codes.

Alarm category matrix

Alarm category	Possible subsystem areas
Low slurry flow	Supply, pump, filter, valve, tubing, flow sensor, control
High slurry flow	Pump, valve, sensor, control, restriction downstream
Low DI water pressure	Utility supply, valve, filter, sensor, leak
High drain level	Drain restriction, pump, sensor, waste system
Platen motion fault	Motor, drive, encoder, mechanical binding, interlock
Carrier pressure fault	Pneumatic supply, regulator, valve, seal, sensor
Vacuum fault	Pump, valve, leak, gauge, seal, sequence
Robot transfer fault	Sensor, alignment, actuator, encoder, obstruction, interlock
Conditioner fault	Motor, arm, sensor, disk, alignment, pressure
Temperature fault	Sensor, heater/cooler, flow, control, insulation
Chemical leak alarm	Tubing, fitting, valve, pump, tank, sensor
Door/interlock fault	Switch, actuator, sensor, wiring, actual unsafe state

Learning objectives

The trainee can:

- Use alarm history and equipment state to narrow the search.
- Avoid replacing parts based only on an alarm label.
- Identify when an alarm is a symptom rather than a root cause.
- Escalate appropriately when the issue affects product or safety.

Lesson 6.5 — Root Cause Analysis

Topics

- 5 Whys
- Fishbone / Ishikawa
- Fault tree analysis
- Pareto charts
- Failure mode and effects analysis
- Repeated failure analysis
- Bad actor identification
- MTBF
- MTTR
- Recurrence prevention
- Corrective action vs. containment

Example

Symptom: Slurry flow alarm repeatedly occurs.

Bad troubleshooting:

> Replace pump → alarm returns → replace sensor → alarm returns.

Better troubleshooting:

- Review alarm timing.
- Compare commanded and actual flow.
- Check supply level.
- Check filter differential pressure.
- Check pump condition.
- Check tubing and fittings.
- Check valve command and feedback.
- Check sensor calibration/status.
- Determine whether the issue is intermittent or continuous.
- Confirm root cause through evidence.
- Verify after repair.

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15. Phase 7 — Process and Equipment Integration

Weeks 13–14

The technician must learn to answer:

> **“How can I tell whether the equipment is healthy, and how do I know my maintenance did not create a process problem?”**

Lesson 7.1 — Process Control and SPC

Topics

- What SPC means
- Control charts
- Mean
- Standard deviation
- Control limits
- Specification limits
- Centering
- Variation
- Drift
- Trends
- Outliers
- Western Electric rules overview
- Process capability
- Cpk/Ppk concepts
- Tool matching
- Tool-to-tool variation
- Lot-to-lot variation

Learning objectives

The trainee can:

- Explain the difference between specification limits and control limits.
- Identify a trend vs. a single outlier.

- Understand why stable equipment produces more consistent results.
- Recognize when equipment behavior may contribute to process variation.

Lesson 7.2 — CMP Metrology

Topics

- Film thickness
- Removal rate
- Within-wafer uniformity
- Wafer-to-wafer uniformity
- Surface roughness
- Defect inspection
- Optical metrology overview
- Profilometry overview
- Ellipsometry overview
- Sheet resistance overview
- Endpoint data
- Post-CMP inspection
- Metrology correlation

Learning objectives

The trainee can:

- Explain what CMP-related measurements indicate.
- Understand how equipment conditions influence metrology results.
- Interpret basic trend charts.
- Recognize why a tool can pass a mechanical check but fail a process check.

Lesson 7.3 — Equipment Health vs. Process Health

Example comparison

Equipment observation	Possible process impact
Unstable slurry flow	Removal-rate variation
Worn pad	Non-uniformity or defectivity
Conditioner wear	Pad-condition drift
Carrier pressure instability	Removal variation
Platen speed variation	Process repeatability issue
Poor DI rinse	Residue or contamination
Sensor drift	Incorrect control behavior
Misaligned wafer transfer	Wafer damage or process positioning issue
Drain restriction	Cleaning or chemical-handling problems
Temperature instability	Chemical/process variation

Learning objective

The trainee understands:

> **A tool is not “good” simply because it powers on, moves, and clears its alarms.**

Lesson 7.4 — Post-Maintenance Verification

Topics

- Visual inspection
- FME inspection
- Leak check
- Utility verification
- Sensor verification
- Motion verification
- Alarm verification
- Calibration check
- Dummy wafer / test wafer, where authorized
- Engineering qualification
- Process verification
- Release criteria
- Documentation

Learning objectives

The trainee can:

- Explain why post-maintenance verification is required.
- Follow the approved recovery and qualification sequence.
- Understand when a tool must remain down.
- Recognize that production release is an authorized decision.

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16. Phase 8 — Qualification and Certification

Weeks 15–16

This phase should not be treated as a final exam only. It is a structured demonstration of safe, repeatable performance.

Public descriptions of Samsung-related technician training emphasize a combination of technical instruction, hands-on exposure, fab protocol, safety, and entry-level certification/qualification. (SkillBridge Search)

A. Written Knowledge Assessment

Suggested passing standard: **80–85%**, or the site's actual requirement.

Exam categories

Category	Suggested weight
Safety / EHS / contamination	15%

Semiconductor fundamentals	10%
CMP process knowledge	15%
Mechanical systems	15%
Electrical / electronics / DIO/AIO	15%
Pumps / fluid / pneumatic / vacuum	15%
Troubleshooting / documentation / SPC	15%
Total	**100%**

B. Practical Skills Assessment

The trainee should demonstrate, under authorized supervision:

Safety

- Proper PPE and gowning
- Pre-task planning
- Hazard identification
- LOTO awareness
- FME discipline
- Chemical safety awareness

Equipment knowledge

- Identify major CMP modules
- Trace wafer path
- Trace slurry path
- Identify major pumps and valves
- Identify sensors
- Identify electrical/control subsystems
- Explain interlocks and permissives

Technical skills

- Read a mechanical drawing
- Read a basic electrical schematic
- Identify DIO/AIO signal paths
- Interpret a pressure/flow trend
- Use approved measurement tools
- Perform a basic fault-isolation exercise
- Execute a supervised PM task
- Complete maintenance documentation

Troubleshooting

Given a simulated or approved real fault, the trainee should:

1. Make the situation safe.
2. Define the symptom.
3. Review available data.

4. Identify likely subsystems.
5. Form a testable hypothesis.
6. Perform authorized checks.
7. Identify the probable cause.
8. Explain the corrective action.
9. Verify recovery.
10. Document and escalate appropriately.

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17. Detailed Weekly Schedule

Week 1 — Orientation, Safety, and Fab Culture

Day	Lessons	Practical activity
Mon	Samsung orientation, organization, technician role	Facility/fab orientation
Tue	EHS, PPE, emergency response	Safety demonstrations
Wed	Chemical safety, SDS, LOTO	Safety practicals
Thu	Cleanroom behavior, contamination control	Gowning and FME practice
Fri	Documentation, communication, shift handoff	Write sample maintenance reports

Gate: Safe entry, proper conduct, basic documentation.

Week 2 — Fab Workflow and Manufacturing Systems

Day	Lessons	Practical activity
Mon	Fab workflow and wafer lots	Follow a simulated lot
Tue	MES, tool states, recipes	Tool-status exercise
Wed	WIP, dispatch, downtime	Manufacturing workflow map
Thu	Quality, yield, defects	Defect case study
Fri	Review and assessment	Written quiz

Gate: Explain how equipment work affects manufacturing.

Week 3 — Semiconductor Fundamentals

Day	Lessons	Practical activity
Mon	Semiconductor materials	Material identification
Tue	Silicon wafers and die	Wafer diagram
Wed	Transistors and CMOS overview	Device cross-section

Thu	Fabrication process flow	Build process flow
Fri	Review	Quiz and teach-back

Week 4 — Semiconductor Process Integration

Day	Lessons	Practical activity
Mon	Deposition and film stacks	Film-stack exercise
Tue	Lithography and etch	Process-flow exercise
Wed	CMP placement and purpose	CMP integration map
Thu	Defects and yield	Defect case studies
Fri	Review	Assessment

Week 5 — Basic Electronics

Day	Lessons	Practical activity
Mon	Electrical safety and Ohm's law	Training circuit
Tue	Components and circuits	Component identification
Wed	Sensors and instrumentation	Sensor exercises
Thu	Motors, drives, encoders	Motion-system walkdown
Fri	Electrical troubleshooting	Fault-isolation lab

Week 6 — Mechanical, Pneumatics, Vacuum, Pumps

Day	Lessons	Practical activity
Mon	Mechanical principles	Drawing/tolerance exercise
Tue	Fasteners, bearings, seals	Component inspection
Wed	Pneumatics	Schematic and component lab
Thu	Vacuum systems	Vacuum-system walkdown
Fri	Pumps and fluid systems	Pump and flow case studies

Week 7 — CMP Fundamentals

Day	Lessons	Practical activity
Mon	CMP overview and mechanisms	CMP process diagram
Tue	Pads and slurry	Consumable identification
Wed	Pressure, speed, flow, time	Variable-impact exercise
Thu	Dielectric and metal CMP	Process comparison
Fri	CMP defects	Defect case studies

Week 8 — CMP Process and Cleaning

Day	Lessons	Practical activity
Mon	Platen and carrier systems	Tool walkdown
Tue	Conditioning	Conditioning-system map
Wed	Slurry delivery	Fluid-system trace
Thu	Post-CMP clean	Cleaning-system map
Fri	Review	CMP knowledge assessment

Week 9 — CMP Equipment Architecture

Day	Lessons	Practical activity
Mon	Actual tool overview	Full equipment walkdown
Tue	Wafer transfer	Wafer-path mapping
Wed	Motion systems	Motor/encoder identification
Thu	Pressure and fluid systems	Utility tracing
Fri	Equipment architecture review	Trainer evaluation

Week 10 — DIO/AIO and Controls

Day	Lessons	Practical activity
Mon	Digital I/O fundamentals	Signal tracing
Tue	Analog I/O fundamentals	Sensor scaling exercise
Wed	PLC/HMI/interlocks	Control architecture
Thu	Actual tool I/O architecture	Tool-specific walkdown
Fri	DIO/AIO fault scenarios	Troubleshooting assessment

Week 11 — Preventive Maintenance

Day	Lessons	Practical activity
Mon	PM fundamentals	PM procedure review
Tue	Mechanical PM	Supervised PM
Wed	Fluid/chemical PM	Approved inspection
Thu	Electrical/sensor PM	Authorized inspection
Fri	PM documentation	Complete PM record

Week 12 — Troubleshooting

Day	Lessons	Practical activity
Mon	Troubleshooting methodology	Fault-tree exercise
Tue	Alarm analysis	Alarm-history cases
Wed	Pumps/flow/pressure faults	Fluid-system troubleshooting
Thu	Motion/sensor/interlock faults	Controls troubleshooting
Fri	Root-cause analysis	Case presentation

Week 13 — SPC and Metrology

Day	Lessons	Practical activity
Mon	SPC fundamentals	Control-chart exercise
Tue	CMP metrology	Measurement interpretation
Wed	Equipment health indicators	Trend review
Thu	Defect and excursion response	Case study
Fri	Process-equipment integration	Teach-back

Week 14 — Recovery and Qualification

Day	Lessons	Practical activity
Mon	Post-maintenance verification	Recovery checklist
Tue	Calibration and qualification	Verification exercise
Wed	Equipment/process handoff	Handoff simulation
Thu	Engineering collaboration	Pre-task plan exercise
Fri	Integrated troubleshooting	Practical assessment

Week 15 — Supervised Independent Work

Suggested activities

- Perform selected PM tasks under observation.
- Respond to low-risk equipment abnormalities.
- Complete shift handoff documentation.
- Identify equipment subsystems.
- Perform approved inspections.
- Review alarm history.
- Participate in engineering recovery activities.
- Demonstrate proper escalation.

Week 16 — Final Qualification

Activities

- Written assessment
- Equipment identification
- Safety practical
- DIO/AIO knowledge demonstration
- Mechanical/electrical troubleshooting
- CMP process explanation
- PM demonstration
- Documentation review
- Final trainer evaluation
- Individual development plan

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18. Recommended Reading Curriculum

The following is a **reading roadmap**, not a requirement to purchase every book.

A. Semiconductor Fundamentals

1. *The Science and Engineering of Microelectronic Fabrication*

Author: Stephen A. Campbell

Read for:

- Semiconductor materials
- Fabrication process flow
- Deposition
- Lithography
- Etch
- CMP
- Process integration

Priority: High

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2. *Fundamentals of Semiconductor Manufacturing and Process Control*

Authors: Gary S. May and Costas J. Spanos

Read for:

- Semiconductor manufacturing
- Process control
- Yield
- Variability
- Manufacturing systems
- Statistical concepts

Priority: High

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3. *Semiconductor Manufacturing Technology*

Author: Michael Quirk and Julian Serda

Read for:

- Semiconductor manufacturing overview
- Wafer processing
- Cleanroom practices
- Manufacturing equipment
- Process integration

Priority: High

B. CMP-Specific Reading

4. *Chemical Mechanical Planarization of Semiconductor Materials*

Editors: M. R. Oliver / relevant CMP reference editions

Read for:

- CMP mechanisms
- Materials
- Polishing
- Consumables
- Process control

Priority: High

Note: Confirm the exact edition and availability before purchasing; CMP reference texts vary by title and editor.

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5. *Chemical Mechanical Planarization for Semiconductor Manufacturing*

Look for university, industry, or professional CMP training material covering:

- CMP fundamentals
- Pad and slurry behavior
- Dielectric CMP
- Metal CMP
- Defectivity
- Post-CMP cleaning
- Process control

Priority: High

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6. Professional CMP Training Topics

A useful external curriculum should include:

- CMP overview
- CMP tool architecture
- Pads and slurries
- Process parameters
- Dielectric CMP
- Conductive-material CMP
- Post-CMP cleaning
- Defect mechanisms
- Process control

- EHS

These are consistent with the subject areas described in professional CMP training programs. (PT International)

C. Electronics

7. *Practical Electronics for Inventors*

Authors: Paul Scherz and Simon Monk

Read for:

- Electrical fundamentals
- Components
- Circuits
- Sensors
- Motors
- Troubleshooting

Priority: High

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8. *The Art of Electronics*

Authors: Paul Horowitz and Winfield Hill

Read for:

- Electronics fundamentals
- Analog and digital concepts
- Measurement
- Circuit behavior

Priority: Medium
Excellent reference, but more advanced than required for initial onboarding.

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9. *Programmable Logic Controllers*

A current introductory PLC textbook or training course covering:

- PLC architecture
- Inputs/outputs
- Ladder logic
- Interlocks
- Timers/counters
- Analog I/O
- Troubleshooting

Priority: High

D. Mechanical and Maintenance

10. *Machinery's Handbook*

Read for:

- Fasteners
- Tolerances
- Fits
- Threads
- Materials
- Measurement
- Machining references

Priority: High

This should be familiar territory for someone with a fabrication/machining background.

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11. *Maintenance and Reliability Best Practices*

Study topics rather than relying on one title:

- Preventive maintenance
- Predictive maintenance
- Root-cause analysis
- Failure modes
- Reliability-centered maintenance
- MTBF / MTTR
- Precision maintenance

Priority: High

E. Vacuum

12. *Foundations of Vacuum Science and Technology*

Editors: James M. Lafferty

Read for:

- Vacuum fundamentals
- Pumps
- Gauges
- Leaks
- Materials
- Vacuum-system design

Priority: Medium–High

F. Pumps and Fluid Systems

13. Pump Manufacturer Training Manuals

Read manufacturer documentation for the **actual pumps installed on the CMP tool**, covering:

- Pump operation
- Installation
- Priming
- Pressure/flow

- Maintenance
- Seal and diaphragm replacement
- Chemical compatibility
- Troubleshooting

Priority: Very High

The actual tool documentation is more valuable than generic pump theory once the employee reaches on-tool training.

G. SPC and Quality

14. *Introduction to Statistical Quality Control*

Author: Douglas C. Montgomery

Read for:

- Control charts
- Variation
- Process capability
- Statistical thinking
- Root-cause analysis

Priority: High

H. Safety and Cleanroom

15. Site-Controlled Documents — Highest Priority

The trainee should read and be tested on applicable:

- Samsung EHS training
- Chemical hygiene procedures
- SDS documents
- LOTO procedures
- Cleanroom procedures
- PPE requirements
- FME procedures
- Equipment-specific SOPs
- Emergency procedures
- Waste-handling procedures
- Maintenance authorization procedures

Priority: Mandatory

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19. CMP Technician Knowledge Notebook

Require the trainee to maintain a structured notebook or approved digital knowledge base.

Section 1 — Fab Fundamentals

- Semiconductor glossary

- Wafer anatomy
- Process flow
- Materials
- Defect types
- Yield concepts

Section 2 — Equipment Architecture

- Tool overview
- Module map
- Wafer path
- Fluid path
- Electrical/control path
- Safety/interlock path

Section 3 — CMP Process

- CMP mechanism
- Pads
- Slurry
- Conditioning
- Carrier
- Platen
- Cleaning
- Defects
- Metrology

Section 4 — Electronics

- Electrical symbols
- Basic circuits
- Sensors
- Motors
- Drives
- PLC
- DIO/AIO
- Interlocks

Section 5 — Mechanical

- Drawings
- Tolerances
- Bearings
- Seals
- Fasteners
- Torque
- Alignment
- Precision measurement

Section 6 — Fluid Systems

- DI water
- Slurry
- Pumps
- Valves
- Filters
- Tubing
- Pressure
- Flow
- Drains
- Vacuum

Section 7 — Maintenance

- PM concepts
- PM checklists
- Parts identification
- Tool history
- Troubleshooting methods
- Alarm categories
- Recovery verification

Section 8 — Quality

- SPC
- Metrology
- Defects
- Excursions
- Process qualification
- Documentation

Section 9 — Personal Development

- Lessons completed
- Skills demonstrated
- Trainer sign-offs
- Questions
- Mistakes and lessons learned
- Improvement ideas
- Future certifications

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20. Suggested Practical Projects

These projects help connect theory to equipment work.

Project 1 — CMP Tool Architecture Map

Deliverable: A labeled diagram of the actual tool.

Must include:

- Wafer path
- Platen
- Carrier
- Conditioner
- Slurry system
- DI water
- Cleaning system
- Pumps
- Sensors
- Controls
- Utilities
- Safety systems

Project 2 — Slurry Flow Troubleshooting Tree

Deliverable: A fault tree for a low-flow alarm.

Include:

- Supply
- Tank level
- Pump
- Filter
- Valve
- Tubing
- Sensor
- Electrical signal
- Control logic
- Actual process condition

Project 3 — DIO/AIO Signal Trace

Deliverable: Trace one digital and one analog signal through the tool.

Example:

Pressure sensor → wiring → analog input → PLC → HMI

And:

PLC output → digital output module → solenoid → actuator

Project 4 — CMP Defect-to-Equipment Analysis

Deliverable: Select a hypothetical defect and identify possible equipment contributors.

Example:

Scratch defect → pad condition, particle source, wafer handling, retaining ring, contamination, mechanical alignment

The trainee must distinguish **possible contributors** from **confirmed root causes**.

Project 5 — Preventive Maintenance Improvement

Deliverable: Identify one PM task that could be improved without changing the approved procedure.

Possible improvements:

- Better checklist clarity
- Better parts staging
- Improved FME control
- Better documentation
- Reduced tool-search time
- Improved inspection consistency
- Better handoff information

No unauthorized procedure changes. Submit improvement ideas through the correct engineering or change-control process.

Project 6 — Alarm Trend Analysis

Deliverable: Analyze a sample of equipment alarm history.

Identify:

- Most frequent alarms
- Repeat alarms
- Time-of-day patterns
- Possible common subsystem
- What additional data is needed
- What should be escalated

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21. What the Technician Should Know at the End

Semiconductor knowledge

The technician should be able to explain:

- What a semiconductor is
- How a wafer becomes an integrated circuit
- Why CMP is used
- Why planarization matters
- What common films are processed
- How defects affect yield
- Why contamination control is essential

CMP knowledge

The technician should be able to explain:

- Chemical vs. mechanical removal
- Platen and carrier functions
- Pad and slurry functions
- Conditioning
- Pressure and motion

- Slurry delivery
- Post-CMP cleaning
- Common CMP defects
- Equipment-related process variation

Electrical knowledge

The technician should be able to:

- Read basic schematics
- Explain voltage/current/resistance
- Identify sensors and actuators
- Understand PLC inputs/outputs
- Trace basic DIO/AIO signals
- Understand interlocks and permissives
- Perform authorized electrical troubleshooting

Mechanical knowledge

The technician should be able to:

- Read mechanical drawings
- Understand tolerances and alignment
- Identify bearings, seals, fasteners, and couplings
- Use precision measurement tools
- Understand torque requirements
- Recognize wear, vibration, and misalignment

Pumps and fluid systems

The technician should be able to:

- Identify pump types
- Understand pressure and flow
- Trace slurry and DI water systems
- Identify valves, filters, tubing, and sensors
- Recognize common pump and flow faults
- Understand chemical compatibility and leak hazards

Technician work habits

The technician should consistently:

- Follow SOPs
- Use proper PPE
- Protect the wafer and equipment
- Control contamination
- Use evidence-based troubleshooting
- Document accurately
- Escalate early when necessary
- Avoid unauthorized changes
- Leave the equipment and work area in a controlled state

22. Recommended Development After Initial Qualification

Months 4–6 — Build Independence

Focus on:

- More PM certifications
- More alarm categories
- More equipment modules
- DIO/AIO troubleshooting
- Pumps and fluid systems
- Shift handoff quality
- Basic SPC interpretation
- Repeat-failure analysis

Months 6–9 — Develop Reliability Skills

Focus on:

- Root-cause analysis
- MTBF / MTTR
- Bad-actor tools
- PM optimization
- Sensor calibration
- Equipment matching
- Process/equipment correlation
- Engineering collaboration

Months 9–12 — Technician 2 Growth

Focus on:

- Advanced troubleshooting
- Cross-training on related CMP platforms
- Supporting improvement projects
- Mentoring newer technicians
- Data-driven troubleshooting
- Reliability projects
- Advanced controls
- Advanced vacuum/fluid systems
- Process-impact awareness

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23. Final Training Standard

The ideal entry-level CMP Equipment Technician 2 is **not expected to know everything about semiconductor manufacturing on Day 1**.

They are expected to become:

> **A safe, disciplined, technically curious equipment professional who can connect mechanical, electrical, fluid, control, and process knowledge—and who understands that every maintenance action can affect production, quality, and yield.**

For a person with **seven years of fabrication/machining experience**, the likely advantage is strong mechanical intuition, tool discipline, and hands-on troubleshooting. The biggest learning gaps will usually be:

1. **Semiconductor process integration**
2. **CMP chemistry and consumables**
3. **Cleanroom contamination control**
4. **Equipment-control architecture**
5. **DIO/AIO and sensor systems**
6. **Process impact of equipment conditions**
7. **Fab documentation and qualification discipline**

The training should therefore **avoid spending excessive time reteaching basic mechanical concepts** and instead use that existing experience as the bridge into **semiconductor equipment, CMP process control, and high-volume manufacturing discipline**.

Recommended Core Reference Set

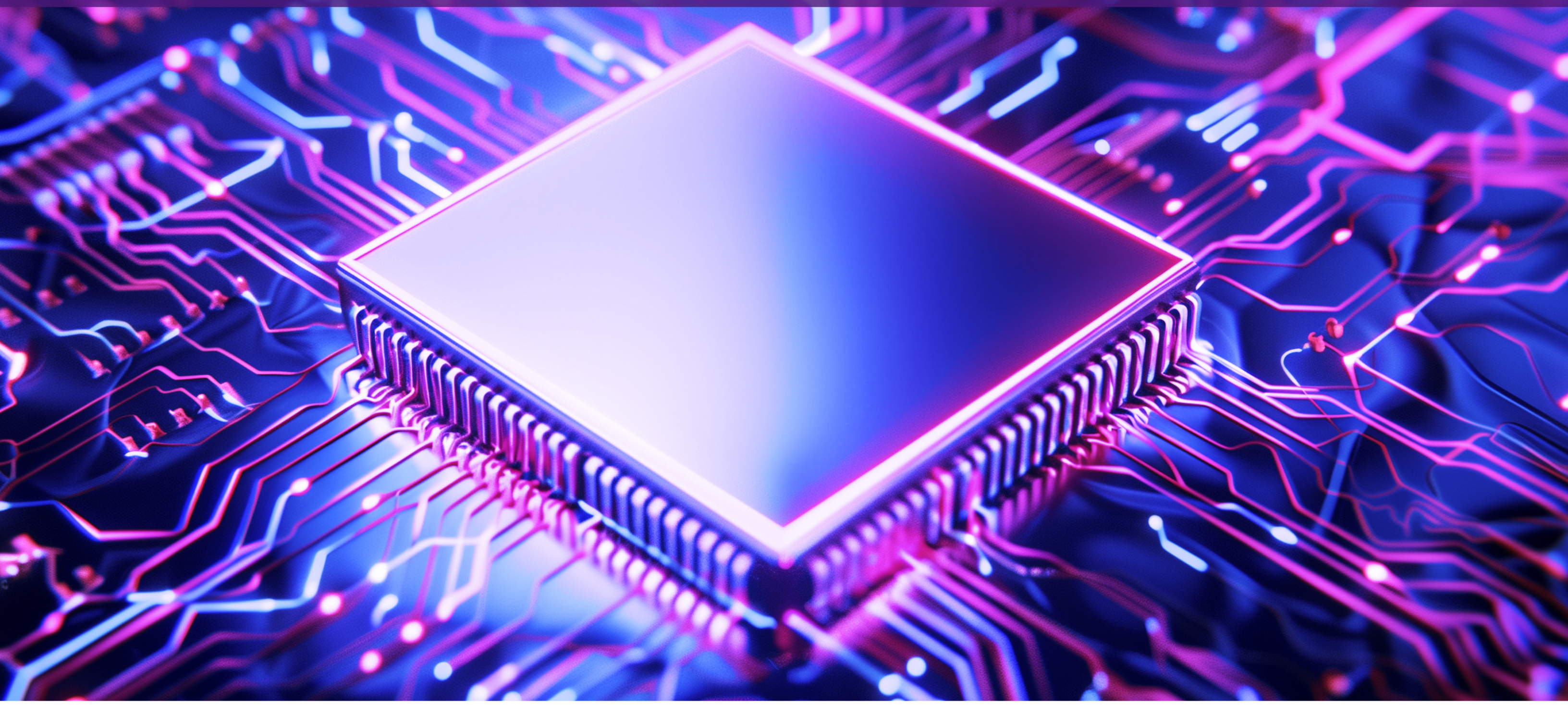
If I were building the actual study package for this new technician, I would prioritize it in this order:

1. **Samsung SAS Orientation, EHS, and Fab SOPs**
2. **Actual CMP Tool Operation and Maintenance Manuals**
3. **CMP Equipment Architecture and Walkdown**
4. **Semiconductor Manufacturing Fundamentals**
5. **Basic Electronics and Sensors**
6. **Pneumatics, Vacuum, and Pumps**
7. **DIO/AIO and PLC Fundamentals**
8. **CMP Process, Pads, Slurry, and Defects**
9. **SPC and Metrology**
10. **Troubleshooting and Root-Cause Analysis**

Samsung and Austin Community College have publicly described technician development as a combination of semiconductor manufacturing knowledge and electro-mechanical skills, including electronics, sensors, pneumatics, vacuum, gas delivery, and SPC. That makes this blended curriculum more appropriate than a purely mechanical maintenance program. (**Guidelines and Technical Tutorials**)

STARS

Semiconductor Technician Advanced Rapid Start



Austin Community College District

Developed in collaboration with:

ARMA Austin Regional Manufacturers Association · Samsung Austin Semiconductor · NXP · TEL Tokyo Electron

A Note from the Participating Companies

The participating companies - Samsung Austin Semiconductor, NXP Semiconductors, Applied Materials, Infineon Technologies, and Tokyo Electron - sponsor many programs to encourage and develop promising talent. However, completion of such programs does not guarantee employment with these companies. All graduates are encouraged to apply to open positions at these companies and must go through the established hiring processes.

Contact Austin Community College

For more information on ACC's semiconductor manufacturing programs, or to connect with an ACC representative, please visit www.austincc.edu/semiconductor. The STARS Program Matrix (including an editable version) can be found at http://www.austincc.edu/stars.

About the License

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INTRODUCTION

The Semiconductor Technician Advanced Rapid Start (STARS) program was developed in 2023 through a highly collaborative process blending industry voice and instructional expertise. Austin Community College District (ACC) and the Austin Regional Manufacturers Association (ARMA) convened representatives from the five major semiconductor companies in the Central Texas region with the goal of solving a common training problem: how could companies quickly upskill incumbent workers with foundational technical knowledge to prepare them for manufacturing technician roles? ACC guided conversations on the development of a training program to meet this specific need, incorporating industry input and gaining consensus on learning outcomes and objectives. The resulting STARS program is a customized blend of theoretical and hands-on training tailored to the regional need for employee upskilling.

We have implemented STARS as an earn-and-learn opportunity. Students are employed and continue to earn their salary while attending STARS full-time. In the current design, students complete the program in four weeks and two days. Our partner companies value the knowledge, skills and abilities students gain through the program. Completers are well-prepared to step into next-level positions as opportunities become available. ACC was awarded a 2023 STEM Talent Challenge grant from the U.S. Department of Commerce's Economic Development Administration (EDA) to support STARS implementation and become an onboarding method to registered apprenticeships.

The STARS curriculum, as outlined here, was developed in collaboration with, and is currently used to train employees of, Samsung Austin Semiconductor, Applied Materials, NXP Semiconductors, Infineon Technologies, and Tokyo Electron. ACC is proud to share the STARS program matrix, and we hope it will contribute to the development of strong, industry-aligned upskilling programs in other regions.

Dr. Laura Marmolejo
Dean, Advanced Manufacturing
Austin Community College District

Program Learning Outcomes

Upon completion of this Program, students will be able to:

1. Analyze various DC and AC electrical circuits and verify calculated values through measurements
2. Distinguish between common sensors found in automation and verify correct operation and limitations
3. Examine common pneumatic circuits found in automation and set up/troubleshoot various configurations
4. Design, integrate, and create working electromechanical systems, and troubleshoot and repair electromechanical system failures
5. Explain the various IC production stages, the IC manufacturing processes, and equipment used
6. Explain vacuum systems, their applications, and common problems
7. Interpret gas panel schematic diagrams and hardware interlock schematics
8. Apply RF theory to system components and discuss common problems in the context of semiconductor equipment
9. Apply the fundamentals of statistics in the manufacturing environment

Target Audience

The ideal STARS student is one with pre-existing foundational technical knowledge. STARS is designed as a rapid upskilling program; students are presented with a significant amount of content in a short amount of time and are challenged to expand upon the knowledge and skills they bring from previous experience. **STARS is not appropriate for entry-level learners**.

Program Format

Schedule

STARS is designed to be delivered in 176 total contact hours. All coursework is completed in class; there are no outside readings or take-home assignments.

To date, we have delivered STARS only in a full-time, 8am - 5pm, schedule over the course of four weeks and two days (176 total contact hours). We have mapped out options to deliver STARS on a part-time basis and believe this type of schedule could still work well, but we have not yet tried it at ACC.

Course Modality

STARS was designed for in-person delivery. Several hands-on labs and activities are included that we do not believe would translate well - or at all - to a fully online environment. That said, we do believe a hybrid delivery format could be effective, as some elements of the curriculum are more heavily dependent on lecture and class discussion. To date, we have not yet delivered STARS in a hybrid modality.

Credit Course Articulation

STARS was designed to articulate for college credit. At ACC, completion of the STARS program articulates to the following two credit courses:

- **CETT 1403 DC Circuits**: A study of the fundamentals of direct current including Ohm's law, Kirchoff's laws and circuit analysis techniques. Emphasis on circuit analysis of resistive networks and DC measurements. Includes steady state analysis of magnetism, electromagnetism, inductance, and capacitance.
- **MFGT 1404 Automated Manufacturing**: Introduction to electrical and electronic principles utilized in automated manufacturing processes.

Required Space & Equipment

Space required: 1800-2000 sq. ft

Students supported: up to 14 at one time

	Item	Cost Per Item	Number Needed	Total
1	Power supplies	$1,000	8	$8,000
2	Function generators	$900	8	$7,200
3	O-Scopes	$800	8	$6,400
4	Pneumatic trainers	$17,000	8	$136,000
5	Universal robots	$50,000	4	$200,000
6	Hand multimeters	$100	8	$800
7	Optical sensors	$600	8	$4,800
8	Proximity sensors	$750	8	$6,000
9	Desktop meters (optional)	$1,000	8	$8,000
10	Compressors	$80	8	$640
11	AC motor trainers	$8,000	8	$64,000
12	Mechatronics trainer (8 sets)	$500,000	2	$1,000,000
Total				**$1,441,840**

Virtual Reality (VR) Labs: The VR Labs used in the STARS program are licensed from Training All People (TAP).

Course 1 Electronics

Description: This course is a study of the fundamentals of direct electrical current (DC), including Ohm's law, Kirchhoff's laws and circuit analysis techniques, as well as AC concepts such as electromagnetism, inductance, and capacitance.

Course Learning Objective: Students will be able to analyze various DC and AC electrical circuits and verify calculated values through measurements.

Estimated Time: 64 Hours

Instructional Strategy: Lecture, Demonstration, Hands-on Labs, Assessments

Topic	Learning Outcomes	Estimated Time	Activities
1. Math for Electronics	1.1 Apply basic Algebra concepts (review) 1.2 Recognize the importance of applying consistent units of measurement 1.3 Use engineering notation to express numerical values	4 HRS	Engineering Notation Activities
2. Electronics Concepts	2.1 Define electricity, resistance, voltage, and current 2.2 Distinguish between conductors, 2.3 semiconductors and insulators Describe how electrons flow in a circuit	4 HRS	Pre- and Post-test Activities
3. Electronic Equipment	3.1 Identify and describe power supplies, multimeters, and other electronics equipment 3.2 Use a multimeter to measure AC and DC voltage	4 HRS	Digital Multimeter Lab
4. Resistors: Fixed and Variable	4.1 Distinguish between fixed and variable resistors 4.2 Determine standard resistor values from color coding	4 HRS	Resistance Measurement Lab
5. Ohm's Law and Electronic Power – Watts Law	5.1 State and apply Ohm's Law to a variety of electrical circuits	8 HRS	Graphing Ohm's Law Lab

	5.2 Interpret and analyze a live circuit using Ohm's Law 5.3 Represent Ohm's Law in graphical form 5.4 State and apply Watt's Law of electrical power 5.5 Explain the concept of "work" being applied in a circuit		Electrical Power Lab
6. Series Circuits, Parallel Circuits, Series-Parallel, and Bridge Circuits	6.1 Distinguish between series, parallel, series-parallel (combination), and bridge circuits 6.2 Describe how Ohm's Law applies to each type of circuit 6.3 State and apply Kirchhoff's Voltage Law (KVL) 6.4 Recognize single- and double-subscript notations for voltage levels of a network 6.5 State and apply Kirchhoff's Current Law (KCL)	12 HRS	Series Circuits Lab Kirchhoff's Voltage Law Lab Parallel Resistance Lab Series-Parallel Resistance Lab Bridge Circuit Lab
7. Switches and Control Devices (in Part 2)	7.1 Identify types of switches and their states 7.2 Describe how switches can be applied as control devices	4 HRS	Switches Application Lab
8. Semiconductors	8.1 Explain the purpose and operation of diodes and Light Emitting Diode 8.2 Explain the Operation of BJT/FET Transistor 8.3 Explain the difference between Sourcing and Sinking 8.4 Explain the difference between Open and Closed loop systems and their applications.	4 HRS	Diode Measurement Lab Light Emitting Diode (LED) Lab (Part 1) Temperature Control Lab Semi-Tool DC Power Supply Troubleshooting VR lab

9. AC Circuits	9.1 Describe the characteristics of alternating current (AC) and direct current (DC) 9.2 Use a function generator to apply an AC signal and an oscilloscope to display the signal 9.3 Explain the role of capacitors and inductors in AC Circuits	8 HRS	AC Signals and Measurement Lab Light Emitting Diode (LED) Lab (Part 2) Half Wave Rectifier Lab
10. Electromechanical Relay	10. 1 Explain the development of electromechanical relays 10. 2 Explain how relays are used to control power	5 HRS	Electromechanical Relay Lab
11. Transformers	11.1 Explain the transformers work and how they are applied 11.2 Describe and analyze the difference between single phase vs. three phase power	3 HRS	Transformer Lab
12. AC Protection Devices	12.1 Explain the difference between fuses, circuit breakers, thermal overload and GFCI protections devices	4 HRS	

Course 2 Sensors

Description: This course introduces the sensors that are commonly found in Industrial settings and reviews the advantages and disadvantages of different sensor types, solid states, and activation methods. Students practice making schematics and wire diagrams.

Course Learning Objective: Students will be able to distinguish between common sensors found in automation and verify correct operation and limitations.

Estimated Time: 8 Hours

Instructional Strategy: Lecture, Demonstration, Hands-on Labs, Activities

Topic	Learning Outcomes	Estimated Time	Activities
1. Multimeter	1.1 Describe types of sensors found in manufacturing 1.2 Identify multimeter settings needed when working with sensors	1 HR	Light and Audio Level Lab
2. Mechanical Switches	2.1 Identify various mechanically operated switching devices 2.2 Describe the difference between Normally Open push button and Normally Closed push button 2.3 Explain the operation of a magnetic reed switch and its applications	1HR	Reed Switch Lab
3. Transistor Theory	3.1 Explain the difference between PNP and NPN 3.2 Describe the difference between sourcing and sinking	1.5 HRS	
4. Solid State Sensors - Photoelectric Sensors	4.1 Identify wire color codes used in both US and in Europe 4.2 Differentiate between light-operated (LO) and dark-operated (DO) mode 4.3 Differentiate between the various types of photo sensors 4.4 Use a multimeter to troubleshoot sensor operation	2.5 HRS	Diffuse Sensor Lab Retro-Reflective Sensor Lab Through Beam Sensor Lab Challenge Lab – Fiber Optic Sensor

5. Solid State Sensors - Proximity Sensors	5.1 Explain the purpose of an inductive proximity sensor 5.2 Differentiate between shielded and unshielded inductive proximity sensors 5.3 Explain the purpose of a capacitive proximity sensor 5.4 Differentiate between guarded and unguarded capacitive proximity sensors	1 HR	Inductive Proximity Sensor (unshielded) Lab Inductive Proximity Sensor (shielded) Lab Capacitive Proximity Sensor (unguarded) Lab Capacitive Proximity Sensor (guarded) Lab
6. Schematics in Industrial Settings	6.1 Identify your power source wires in a schematic 6.2 Identify schematic symbols for the sensors	1 HR	Schematic Drawing Activities

Course 3 Pneumatics

Description: This course is designed to teach the fundamentals of pneumatics and its application to semiconductor manufacturing. The course introduces fundamental theory which is then practiced and verified through the use on hands-on labs.

Course Learning Objective: Students will be able to examine common pneumatic circuits found in automation and set up/troubleshoot various configurations.

Estimated Time: 16 Hours

Instructional Strategy: Lecture, Demonstration, Hands-on Labs, Activities

Topic	Learning Outcomes	Estimated Time	Activities
1. Safety, Basic Physical Laws, Basic Schematic Symbols	1.1 Describe how pneumatics is used in manufacturing 1.2 Identify safety considerations when working with pneumatic systems 1.3 Describe the basic physical laws and explain what each means 1.4 Identify pneumatic symbols in a schematic	2 HRS	Pneumatic Cylinder Problems Single- and Double-acting Cylinder Drawing Exercises
2. Understanding Control Valves Cylinders Pilot Control	2.1 Describe the purpose of control valves in a pneumatic system 2.2 Identify directional control valves in a schematic 2.3 Describe the types of cylinders used in manufacturing and the recommended valves used with each 2.4 Describe the types of pilot actuated valves used in manufacturing	2.5 HRS	Single Acting Cylinder Lab Dual Acting Cylinder Lab Single Pilot Actuated Lab Double Pilot Actuated Lab
3. Electrical Schematics	3.1 Describe the purpose of electrical diagrams used in pneumatic systems 3.2 Identify electrical schematic symbols	1 HR	Electrical Schematic Lab
4. Solenoid Valve Operation	4.1 Describe the purpose and characteristics of a solenoid valve 4.2 Differentiate between directly-actuated valves and indirectly-actuated valves	2 HR	Solenoid Valves Lab

5. Memory Control Emergency Stops Controlling Speed	5.1 Differentiate between memory and momentary control operations 5.2 Identify the various emergency stop responses in pneumatic systems 5.3 Explain how cylinder speed can be controlled in pneumatic systems 5.4 Explain how a one-way flow control valve works	2 HR	Memory Control Circuit Lab Emergency Stop Lab Speed Control Lab
6. Quick Exhaust Valve Pressure Regulation	6.1 Explain the principles of quick exhaust valves and their application 6.2 Analyze the differences between relieving and non-relieving pressure regulators 6.3 Determine the appropriate type of pressure regulator for regulating specific gasses	2 HR	Quick Exhaust Valve Lab Pressure Regulation Lab
7. Control System Basics Troubleshooting	7.1 Describe the basics of a control system 7.2 Analyze failure modes of various pneumatic components and apply established troubleshooting methods 7.3 Explain the principles of pressure sensors and their application	2 HR	Troubleshooting Lab SDE-1 Pressure Sensor Activities
8. OR and AND Logic Automatic Return Timers	8.1 Describe OR circuits using both "T" connectors and shuttle valves 8.2 Describe AND circuits using both series-connected directional control valves and AND gates 8.3 Explain how limit switches automate sequential movements in pneumatic systems 8.4 Describe pneumatic timer circuits and their function	2.5 HR	OR Logic Lab AND Logic Lab Automatic Return and AND Extend Lab Pneumatic Lab Timer

Course 4 Mechatronics

Description: This course is a study of electromechanical systems found in typical manufacturing environments. Pneumatics, electric motors, valves, sensors, cylinders, PLCs, and other industrial devices are all reviewed.

Course Learning Objective: Students will be able to design, integrate, and create working electromechanical systems, and troubleshoot and repair electromechanical system failures.

Estimated Time: 48 Hours

Instructional Strategy: Lecture, Demonstration, Hands-on Labs, Activities

Topic	Learning Outcomes	Estimated Time	Activities
1. Safety Requirements Definition of an Electromechanical System Electromechanical Subsystems	1.1 Identify potential hazards associated with electromechanical systems and describe appropriate safety measures 1.2 Describe the concept of electromechanical systems 1.3 Identify key subsystems and explain their function in automation 1.4 Identify examples of electromechanical systems, from simple applications to those used in the semiconductor industry	8 HR	Safety checklist, SOP and Operation Labs on: Jogging an Actuator Overriding an Electro-Pneumatic Valve Adjusting Pneumatic Actuator Stroke and Speed Overriding a Motor
2. Logic Circuits Industrial Control Systems	2.1 Identify elements of an industrial control system 2.2 Describe how industrial control systems monitor and control electromechanical processes 2.3 Analyze basic logic gates (AND, OR, NOT) 2.4 Demonstrate how logic circuits are used in mechatronics applications	16 HR	Component Adjustment, Alignment, and/or Troubleshooting Labs on: Adjusting a Limit Switch Adjusting a Sensor

			Adjusting a Vacuum Gripper and Switch
3. Mechatronics System Troubleshooting	3.1 Identify elements needed for a mechatronics system to meet specified performance criteria 3.2 Apply systematic troubleshooting methodologies, to identify and rectify malfunctions in mechatronics systems	24 HR	Review Various PLC Ladder Logic Diagrams During Operation

Course 5 Basic IC Manufacturing

Description: This course introduces students to the semiconductor manufacturing process by reviewing the steps required to create a planar MOSFET device, including technical details on major unit process steps used in a semiconductor fabrication facility. Topics include the equipment used to support each process step.

Course Learning Objective: Students will be able to explain the various IC production stages, the IC manufacturing processes, and equipment used.

Estimated Time: 8 Hours

Instructional Strategy: Lecture

Topic	Learning Outcomes	Estimated Time	Activities
1. Basic IC Technologies Device Operation	1.1 Distinguish the different segments of an integrated circuit (IC) and review the operational process steps. 1.2 Explain the MOSFET semiconductor devices and its operation.	1 HR	
2. Semiconductor Materials IC Process Flow	1.1 Identify the chemicals used in IC fabrication 1.2 Explain each process step used to fabricate an integrated circuit.	3 HR	
3. Process Steps and Equipment Tool in Fabrication	1.1 Describe each unit process used in IC fabrication	4 HR	

Course 6 Vacuum Systems & Principles

Description: This course reviews the basics of vacuum technology as it applies to semiconductor manufacturing equipment, including the details of vacuum measurement devices and basic troubleshooting techniques.

Course Learning Objective: Students will be able to explain vacuum systems, their applications, and common problems.

Estimated Time: 8 Hours

Instructional Strategy: Lecture, Demonstration, Hands-on Labs, Activities

Topic	Learning Outcomes	Estimated Time	Activities
1. Vacuum System Principles	1.1 Explain the fundamental principles of vacuum systems, including the concept of pressure, gas behavior at low pressures 1.2 Explain the significance of vacuum levels	2 HR	View videos illustrating the flow paths in a vacuum system (laminal, turbulent)
2. Vacuum Components & Pumps	2.1 Recognize different components and types of pumps used in vacuum systems 2.2 Describe the functions and operational principles of various types of pumps used in vacuum	3 HR	View pictorial and video examples of various vacuum components
3. Vacuum Measurement	3.1 Recognize appropriate vacuum instruments used to assess vacuum levels in different systems 3.2 Detect and diagnose leaks in vacuum systems and apply troubleshooting strategies	3 HR	Leak Detection & Troubleshooting VR lab

Course 7 Gas Delivery Systems

Description: This course reviews the components found in a gas delivery system, with a focus on gas panels used in the semiconductor industry. Students will discuss common problems and learn to interpret schematics.

Course Learning Objective: Students will be able to interpret gas panel schematic diagrams and hardware interlock schematics.

Estimated Time: 8 Hours

Instructional Strategy: Lecture, Demonstration, Activities

Topic	Learning Outcomes	Estimated Time	Activities
1. Gas System Overview	1.1 Describe the purpose and function of key components in gas delivery systems 1.2 Explain the flow of gasses from sources to end-users 1.3 Identify safety measures associated with gas handling	2 HR	
2. Gas Delivery Components	2.1 Recognize different components used in gas delivery systems 2.2 Explain the roles, functions, and interconnections of these components	2 HR	View videos on different components used in gas delivery systems
3. Gas Panel Configurations	3.1 Analyze and interpret gas panel configurations commonly used in semiconductor manufacturing	2 HR	
4. Gas System Analysis and Troubleshooting	4.1 Apply systematic approaches to analyze gas system performance 4.2 Identify potential faults and techniques for troubleshooting	2 HR	Troubleshooting Activity

Course 8 RF/Plasma Systems

Description: This course reviews RF and plasma systems and their applications in semiconductor manufacturing. Common problems with RF and plasma systems are discussed.

Course Learning Objective: Students will be able to apply RF theory to system components and discuss common problems in the context of semiconductor equipment.

Estimated Time: 8 Hours

Instructional Strategy: Lecture, Demonstration, Activities

Topic	Learning Outcomes	Estimated Time	Activities
1. RF System Hardware and Plasma Process Overview	1.1 Describe basic RF systems and their operation	2 HR	Trace the signal path through an RF generator schematic
2. RF Systems Transmission Line and Grounding	2.1 Analyze the characteristics of transmission lines and grounding system in RF applications	2 HR	
3. Matching Networks	3.1 Describe different types of matching networks and their function 3.2 Explain how matching networks compensate impedance matching between RF sources, transmission lines, and plasma loads	2 HR	
4. RF Plasma Processes and System Troubleshooting	4.1 Examine the physical behavior of RF-induced plasmas. 4.2 Apply systematic troubleshooting methods to diagnose and rectify problems in RF systems.	2 HR	

Course 9 Statistics

Description: This course introduces students to basic statistical analysis concepts, quality improvement tools, and their applications to manufacturing.

Course Learning Objective: Students will be able to apply the fundamentals of statistics in the manufacturing environment.

Estimated Time: 8 Hours

Instructional Strategy: Lecture, Demonstration, Hands-on Labs

Topic	Learning Outcomes	Estimated Time	Activities
1. Statistics in Manufacturing	1.1 Explain how statistics is used in manufacturing and other common applications 1.2 Define the cost of poor quality and its impact on manufacturing 1.3 Explain data types and data collection guidelines 1.4 Describe data distributions and their applications	3 HR	Measures of Central Tendency Exercise Data Distribution Exercise Flow Chart Exercise Cause and Effect Exercise
2. Understanding Control Charts	2.1 Explain how control charts are used to monitor manufacturing processes 2.2 Define common control charts used in manufacturing 2.3 Interpret key patterns that signals process changes 2.4 Explain process capability	3 HR	Process Measurement Exercise Control Chart Pattern-recognition Exercise Process Capability Exercises
3. Intro to Six Sigma	3.1 Describe the principles of Lean and Six Sigma 3.2 Define the 5 main stages of the DMAIC process 3.3 Explain other quality improvement tools used in manufacturing	2 HR	

