QUALIFICATION FILE-Standalone NOS

Essentials of Automation and Process Control in Semiconductor Manufacturing

☐ Horizontal/Generic ☐ Vertical/Specialization

☐ Upskilling ☐ Dual/Flexi Qualification ☐ For ToT ☐ For ToA

☐General ☐ Multi-skill (MS) ☐ Cross Sectoral (CS) ☒ Future Skills ☐ OEM

NCrF/NSQF Level: 4.5

Submitted By:

National Institute of Electronics and Information Technology (NIELIT)
NIELIT Bhawan,
Plot No. 3, PSP Pocket, Sector-8,
Dwarka, New Delhi-110077,
Phone: - 91-11-2530 8300
e-mail: - contact@nielit.gov.in

Table of Contents

Section 1: Basic Details

<table>
<tr><td>1.</td><td>NOS-Qualification Name</td><td colspan="2">Essentials of Automation and Process Control in Semiconductor Manufacturing</td></tr>
<tr><td>2.</td><td>Sector</td><td colspan="2">Electronics</td></tr>
<tr><td>3.</td><td>Type of Qualification ☒ New ☐ Revised</td><td>NQR Code & version of the existing /previous qualification: NA</td><td>Qualification Name of the existing/previous version: NA</td></tr>
<tr><td>4.</td><td>National Qualification Register (NQR) Code & Version</td><td>NG-4.5-EH-03737-2025-V1-NIELIT</td><td>5. NCrF/NSQF Level: 4.5</td></tr>
<tr><td>6.</td><td>Brief Description of the Standalone NOS</td><td colspan="2">This NOS provides a foundational understanding of automation and process control in semiconductor manufacturing environments. It explores how automated systems are used to ensure precision, consistency, and efficiency in highly complex and cleanroom-based production processes. The course covers key components such as sensors, actuators, PLCs (Programmable Logic Controllers), SCADA systems, and real-time monitoring tools. Emphasis is placed on process stability, control loops (PID), defect reduction, and integration with Manufacturing Execution Systems (MES) and Enterprise Resource Planning (ERP) platforms. Students will also learn how automation contributes to yield improvement, data collection, and compliance with industry standards in a rapidly evolving, high-tech manufacturing landscape.</td></tr>
<tr><td>7.</td><td>Eligibility Criteria for Entry for a Student/Trainee/Learner/Employee</td><td colspan="2">a. Entry Qualification & Relevant Experience:
<table>
<tr><th>S. No.</th><th>Academic/Skill Qualification (with Specialization - if applicable)</th><th>Required Experience (with Specialization - if applicable)</th></tr>
<tr><td>1</td><td>3-Years Diploma in Electronics and Communication Engineering/ Electrical Engineering/ allied branches after class 10th</td><td>NA</td></tr>
<tr><td>2</td><td>3rd year of 3-Years Diploma in Electronics and Communication Engineering/ Electrical Engineering/ allied branches after class 10th</td><td>NA</td></tr>
<tr><td>3</td><td>1st year of UG in Electronics Engineering/Physics/ allied fields</td><td>NA</td></tr>
</table></td></tr>
</table>

<table>
<tr><td></td><td></td><td>
<table>
<tr><td>4</td><td>12th Pass</td><td>1.5-year experience in ESDM Sector.</td></tr>
<tr><td>5</td><td>10th pass plus 2-year NTC in relevant field of Electronics Sector</td><td>1.5-year experience in ESDM Sector.</td></tr>
</table>
</td></tr>
<tr><td>8.</td><td>Credits Assigned to this NOS-Qualification, Subject to Assessment (as per National Credit Framework (NCrF))</td><td>3 Credits
9. Common Cost Norm Category (I/II/III) (wherever applicable): Category-I</td></tr>
<tr><td>10.</td><td>Any Licensing Requirements for Undertaking Training on This Qualification (wherever applicable)</td><td>NA</td></tr>
<tr><td>11.</td><td>Training Duration by Modes of Training Delivery (Specify Total Duration as per selected training delivery modes and as per requirement of the qualification)</td><td>☒Offline ☐Online ☐Blended

<table>
<tr><th>Training Delivery Modes</th><th>Theory (Hours)</th><th>Practical (Hours)</th><th>Total (Hours)</th></tr>
<tr><td>Classroom (offline)</td><td>27</td><td>63</td><td>90</td></tr>
</table>
</td></tr>
<tr><td>12.</td><td>Assessment Criteria</td><td>
<table>
<tr><th>Theory (Marks)</th><th>Practical (Marks)</th><th>Project (Marks)</th><th>Viva (Marks)</th><th>Total (Marks)</th><th>Passing %age</th></tr>
<tr><td>100</td><td>60</td><td>20</td><td>20</td><td>200</td><td>50</td></tr>
</table>
The centralized online assessment is conducted by the Examination Wing, NIELIT Headquarters.

*Assessment strategy shall be as per NIELIT Norms prevailing at times.</td></tr>
<tr><td>13.</td><td>Is the NOS Amenable to Persons with Disability</td><td>☒ Yes ☐ No
Leprosy Cured Person, Dwarfism, Thalassemia, Hemophilia, Hearing Impairment(Hard of Hearing), Acid Attack Victims.</td></tr>
<tr><td>14.</td><td>Progression Path After Attaining the Qualification, wherever applicable (Please show Professional and Academic progression)</td><td>MEMS Backend Fabrication Engineer -> Semiconductor Fabrication Engineer</td></tr>
</table>

15.	**How participation of women will be encouraged?**	Participation by women can be ensured through Government Schemes. Occasionally, exclusive batches for women would be run for the proposed courses. Funding is available for women's participation under other schemes launched by the Government from time to time.	
16.	**Other Indian languages in which the Qualification & Model Curriculum are being submitted**	Qualification file is available in English and Hindi languages.	
17.	**Is similar NOS available on NQR-if yes, justification for this qualification**	**☐ Yes ☒ No URLs of similar Qualifications:**	
18.	**Name and Contact Details Submitting / Awarding Body SPOC** *(In case of CS or MS, provide details of both Lead AB & Supporting ABs)*	**Name:** Sh. Saurabh Kesari **Email:** saurabhk@nielit.gov.in **Contact No.:** 0240-2982021 **Website:** https://www.nielit.gov.in **Name:** Sh. Shashank Kumar Singh **Email:** shashank@nielit.gov.in **Contact No.:** 0240-2982021 **Website:** https://www.nielit.gov.in **Name:** Sh. Ravi Ranjan Kumar **Email:** raviranjan@nielit.gov.in **Contact No.:** 0240-2982021 **Website:** https://www.nielit.gov.in	
19.	**Final Approval Date by NSQC: 18.02.2025**	**20. Validity Duration: 3 Years**	**21. Next Review Date: 18.02.2028**

Section 2: Training Related

1.	**Trainer's Qualification and experience in the relevant sector (in years)** *(as per NCVET guidelines)*	B.E./B. Tech in Electronics/ Electronics & Communication/ Electrical/ Electrical and Electronics/Instrumentation/ Electronics & Instrumentation / Instrumentation & Control and allied branches with 2 years of relevant experience in the field of Semiconductor Manufacturing / Semiconductor Fabrication and Packaging/VLSI Design. Or M.Sc. in Physics/Electronics/Material Science and allied branches; with 2 years of relevant experience in the field of Semiconductor Manufacturing / Semiconductor Fabrication and Packaging/VLSI Design.
2.	**Master Trainer's Qualification and experience in the relevant sector (in years)** *(as per NCVET guidelines)*	B.E./B. Tech in Electronics/ Electronics & Communication/ Electrical/ Electrical and Electronics/Instrumentation/ Electronics & Instrumentation / Instrumentation & Control and allied branches with 3 years of relevant experience in the field of Semiconductor Manufacturing / Semiconductor Fabrication and Packaging/VLSI Design. Or M.Sc. in Physics/Electronics/Material Science and allied branches; with 3 years of relevant experience in the field of Semiconductor Manufacturing / Semiconductor Fabrication and Packaging/VLSI Design.
3.	**Tools and Equipment Required for Training**	☒ Yes ☐No Available at Annexure-II
4.	**In Case of Revised Qualification, Details of Any Upskilling Required for Trainer**	NA

Section 3: Assessment Related

1.	**Assessor's Qualification and experience in relevant sector (in years)** *(as per NCVET guidelines)*	B.E./B. Tech in Electronics/ Electronics & Communication/ Electrical/ Electrical and Electronics/Instrumentation/ Electronics & Instrumentation / Instrumentation & Control and allied branches with 3 years of relevant experience in the field of Semiconductor Manufacturing / Semiconductor Fabrication and Packaging/VLSI Design. Or M.Sc. in Physics/Electronics/Material Science and allied branches 3 years of relevant experience in the field of Semiconductor Manufacturing / Semiconductor Fabrication and Packaging/VLSI Design.
2.	**Proctor's Qualification and experience in relevant sector (in years)** *(as per NCVET guidelines)*	The assessor carries out theory online assessments through the remote proctoring methodology. Theory examination would be conducted online, and the paper comprise of MCQ. Conduct of assessment is through trained proctors. Once the test begins, remote proctors have full access to the candidate's video feeds and computer screens. Proctors authenticate the candidate based on registration details, pre-test image captured and I- card in possession of the candidate. Proctors can chat with candidates or give warnings to candidates. Proctors can also take screenshots, terminate a specific user's test session, or re-authenticate candidates based on video feeds.
3.	**Lead Assessor's/Proctor's Qualification and experience in relevant sector (in years)** *(as per NCVET guidelines)*	External Examiners/ Observers (Subject matter experts) are deployed including NIELIT scientific officers who are subject experts for evaluation of Practical examination/ internal assessment / Project/Presentation/ assignment and Major Project (if applicable). Qualification is generally B.Tech.
4.	**Assessment Mode** *(Specify the assessment mode)*	Centralized online examination will be conducted
5.	**Tools and Equipment Required for Assessment**	☒ Same as for training ☐ Yes ☐ No *(details to be provided in Annexure-if it is different for Assessment)*

Section 4: Evidence of the Need for the Standalone NOS

1.	Government /Industry initiatives/ requirement (Yes/No): Yes
2.	Number of Industry validation provided: The course has been developed in collaboration with TATA Electronics to support the development of skilled manpower for the upcoming semiconductor industry.
3.	Estimated number of people to be trained: 500
4.	Evidence of Concurrence/Consultation with Line/State Departments (In case of regulated sectors): NIELIT is recognized as AB and AA under Government Category. NIELIT is an HRD arm of MeitY, therefore, the Line Ministry Concurrence is not required.

Section 5: Annexure & Supporting Documents Check List

Specify Annexure Name / Supporting document file name

1.	**Annexure:** NCrF/NSQF level justification based on NCrF level/NSQF descriptors *(Mandatory)*	Available at Annexure-I: Evidence of Level
2.	**Annexure:** List of tools and equipment relevant for qualification *(Mandatory, except in case of online course)*	Available at Annexure-II: Tools and Equipment
3.	**Annexure:** Industry Validation	Available at Annexure-III: Industry Validation
4.	**Annexure: Training Details**	Available at Annexure-IV: Training Details
5.	**Annexure:** Blended Learning *(Mandatory, in case selected Mode of delivery is "Blended Learning")*	Available at Annexure-V: Blended Learning
6.	**Annexure/Supporting Document:** Standalone NOS- Performance Criteria Details Annexure/Document with PC-wise detailing as per NOS format (Mandatory- Public view)	Available at Annexure-VI: Standalone NOS- Performance Criteria details
7.	**Annexure:** Detailed Assessment Criteria *(Mandatory)*	Available at Annexure-VII: Assessment Criteria
8.	**Annexure:** Assessment Strategy *(Mandatory)*	Available at Annexure-VIII: Assessment Strategy
9.	**Annexure:** Acronym and Glossary *(Optional)*	Available at Annexure-IX: Acronym and Glossary
10.	**Supporting Document:** Model Curriculum *(Mandatory – Public view)*	Available at Annexure-A: Model Curriculum

Annexure I: Evidence of Level

NCrF/NSQF Level Descriptors	Key requirements of the job role/ outcome of the qualification	How the job role/ outcomes relate to the NCrF/NSQF level descriptor	NCrF/NSQF Level
Professional Theoretical Knowledge/Process	Understanding of advanced control principles, automation strategies, and sensor integration in semiconductor manufacturing.	The knowledge applied ensures foundational expertise in process automation at a professional level.	4.5
Professional and Technical Skills/ Expertise/ Professional Knowledge	Ability to design, program, and maintain PLC and SCADA systems for semiconductor production. Proficiency in troubleshooting automation systems.	The skills showcase technical mastery in designing and implementing automation solutions suitable for industrial applications.	4.5
Employment Readiness & Entrepreneurship Skills & Mind-set/Professional Skill	Teamwork to develop automation solutions, fostering efficiency in production environments. Ability to identify and apply process improvements for automation.	Employment readiness is demonstrated through effective team collaboration and the application of automation improvements in production workflows.	4.5
Broad Learning Outcomes/Core Skill and Responsibility	Design process control systems that optimize semiconductor production processes. - Ability to troubleshoot automation systems and ensure continuous improvement.	The learning outcomes prepare individuals to take responsibility for improving production processes through automation.	4.5

Annexure II: Tools and Equipment (Lab Set-Up)

List of Tools and Equipment

Sl. No	Description	Qty.	Specifications
1	Classroom	1	30 Sq. m
2	Student Chair	30	-
3	Student Table	30	-
4	LCD Projector	1	-
5	Trainer Chair & Table	1	-

6	Pin up Board	1	-
7	White Board	1	-
8	Desktop Computer with accessories	30	Processor: Intel Core i5 (sixth generation newer) or equivalent Memory: 16GB RAM, Internal Storage: 500GB
9	Desk jet printer	1	A4

Tools and Equipment:

Process Control Tools

- Programmable Logic Controllers (PLCs)
- Human-Machine Interface (HMI) Panels
- PID Controllers
- Distributed Control Systems (DCS)
- SCADA Systems

Sensors and Instrumentation

- Temperature Sensors
- Pressure Sensors
- Flow Meters
- Signal Conditioners and Data Acquisition Systems
- Calibration Kits

Automation and Communication Systems

- Communication Protocol Tools (Ethernet, Fieldbus, Modbus)
- Automation System Integration Tools
- Industrial Networking Equipment

Advanced Control and Monitoring Tools

- Model Predictive Control (MPC) Software
- Manufacturing Execution Systems (MES) Software
- Real-Time Monitoring and Data Analytics Tools

Safety and Reliability Tools

- Safety Relays and Emergency Stop Systems
- Risk Assessment and Reliability Analysis Software
- Redundancy Systems for Control Systems

General Tools

- Desktop Computers with Automation Programming Software (Ladder Logic, HMI Design)
- Projectors and Whiteboards for Training

Annexure III: Industry Validations Summary

The course has been developed in collaboration with TATA Electronics to support the development of skilled manpower for the upcoming semiconductor industry.

Annexure IV: Training & Employment Details

Training Projections:

Year	Estimated Training # of Total Candidates	Estimated training # of Women	Estimated training # of People with Disability
2025-26	**100**	**50**	**10**
2026-27	**200**	**70**	**15**
2027-28	**200**	**70**	**15**

Data to be provided year-wise for next 3 years.

Annexure-V: Blended Learning

Blended Learning Estimated Ratio & Recommended Tools: NA

Annexure VI: Performance Criteria details

1. Description:

The Essentials of Automation and Process Control in Semiconductor Manufacturing course introduces core automation principles and control techniques, with both theoretical knowledge and practical hands-on experience. It covers PLC programming, sensor utilization, PID control, system integration, and real-time monitoring, while emphasizing safety, reliability, and optimization in semiconductor production environments. Students gain the skills to apply automation systems effectively in manufacturing processes.

2. Scope:

The scope covers the following:

- The Introduction to Automation and Process Control course covers automation systems, PLC programming, sensor integration, control loop theory, and advanced control strategies for semiconductor manufacturing
    - .
- Students gain practical experience in designing and optimizing automation systems using industry-standard tools, while ensuring efficiency, consistency, and quality through safety and reliability principles.

3. Elements and Performance Criteria:

To be competent, the user/individual on the job must be able to:

Elements	Assessment Criteria for Performance Criteria/Learning Outcomes
Introduction to Automation and Process Control	**PC1.** Distinguish between discrete and continuous automation systems and describe their relevance in semiconductor fabs. **PC2.** Explain the importance of real-time feedback and closed-loop control in maintaining process stability and quality.

Process Control Fundamentals	**PC3**: Identify the advantages and limitations of each system in terms of responsiveness, stability, and control accuracy. **PC4:** Analyze process dynamics (e.g., time delay, gain,process lag) and apply appropriate control strategies based on system response.
Automation Systems and PLCs	**PC5:** Understand how PLCs interact with sensors, actuators, and control systems in semiconductor fabs. **PC6**: Demonstrate the ability to modify and simulate PLC programs to meet specified automation requirements.
Sensors and Instrumentation	**PC7:** Explain the application of each sensor type in monitoring and controlling critical process parameters. **PC8**: Interpret sensor signals and diagnose faults using signal processing techniques and system diagnostics.
Advanced Process Control Technologies	**PC9:** Analyze how these techniques improve precision, efficiency, and responsiveness in dynamic semiconductor processes. **PC10:** Demonstrate the integration of control systems with Manufacturing Execution Systems (MES) for seamless data flow and operational visibility.
Automation Systems Integration	**PC11:** Demonstrate the ability to design or interpret system architecture that combines multiple control platforms. **PC12:** Recognize typical challenges in integrating heterogeneous systems, including compatibility, data exchange, and latency issues.
Safety and Reliability in Automation Systems	**PC13:** Conduct basic risk assessments and safety analyses to identify and mitigate potential hazards in automation systems. **PC14:** Design or assess systems with redundancy (e.g., dual controllers, backup sensors) to maintain continuous operation during faults.

4. Knowledge and Understanding (KU):

The individual on the job needs to know and understand:

KU1: Understand the fundamental processes in semiconductor manufacturing and the role of automation in enhancing production efficiency.
KU2: Comprehend the basic principles of process control, including open-loop and closed-loop systems, and the application of PID control theory.

KU3: Gain knowledge of various automation systems, including PLCs, SCADA, and DCS, and their integration into semiconductor manufacturing.

5. **Generic Skills (GS):**

The user/individual on the job needs to know how to:

GS1: Develop the ability to identify potential manufacturability issues in semiconductor designs and apply critical thinking to find effective solutions, optimizing designs for higher yield and cost efficiency.
GS2: Improve their skills in effectively communicating technical information, collaborating with cross-functional teams (e.g., design, manufacturing, and testing), and presenting findings or design optimizations clearly.
GS3: Enhance attention to detail, ensuring that every aspect of the semiconductor design process from layout to material selection is carefully considered for manufacturability, quality, and process compatibility.

Annexure VII: Assessment Criteria

Detailed assessment criteria for each NOS/Module are as follows:

Elements	Assessment Criteria for Performance Criteria/Learning Outcomes	Theory Marks	Practical Marks	Project Marks	Viva Marks
Introduction to Automation and Process Control	**PC1.** Distinguish between discrete and continuous automation systems and describe their relevance in semiconductor fabs. **PC2.** Explain the importance of real-time feedback and closed-loop control in maintaining process stability and quality.	15	9	-	-
Process Control Fundamentals	**PC3**: Identify the advantages and limitations of each system in terms of responsiveness, stability, and control accuracy. **PC4:** Analyze process dynamics (e.g., time delay, gain,process lag) and apply appropriate control strategies based on system response.	15	9	-	-
Automation Systems and PLCs	**PC5:** Understand how PLCs interact with sensors, actuators, and control systems in semiconductor fabs. **PC6**: Demonstrate the ability to modify and simulate PLC programs to meet specified automation requirements.	15	9	-	-
Sensors and Instrumentation	**PC7:** Explain the application of each sensor type in monitoring and controlling critical process parameters. **PC8**: Interpret sensor signals and diagnose faults using signal processing techniques and system diagnostics.	15	9	-	-

Advanced Process Control Technologies	**PC9:** Analyze how these techniques improve precision, efficiency, and responsiveness in dynamic semiconductor processes. **PC10:** Demonstrate the integration of control systems with Manufacturing Execution Systems (MES) for seamless data flow and operational visibility.	15	8	-	-
Automation Systems Integration	**PC11:** Demonstrate the ability to design or interpret system architecture that combines multiple control platforms. **PC12:** Recognize typical challenges in integrating heterogeneous systems, including compatibility, data exchange, and latency issues.	15	8	-	-
Safety and Reliability in Automation Systems	**PC13:** Conduct basic risk assessments and safety analyses to identify and mitigate potential hazards in automation systems. **PC14:** Design or assess systems with redundancy (e.g., dual controllers, backup sensors) to maintain continuous operation during faults.	10	8	-	-
GRAND TOTAL		**100**	**60**	**20**	**20**

Annexure VIII: Assessment Strategy

This section includes the processes involved in identifying, gathering, and interpreting information to evaluate the Candidate on the required competencies of the program.

Assessment of the qualification evaluates candidates to ascertain that they can integrate knowledge, skills and values for carrying out relevant tasks as per the defined learning outcomes and assessment criteria.

The underlying principle of assessment is fairness and transparency. The evidence of the outcomes and assessment criteria. Competence acquired by the candidate can be obtained by conducting Theory (Online) examination.

About Examination Pattern:

1. The question papers for the theory exams are set by the Examination wing (assessor) of NIELIT HQS.

2. The assessor assigns roll number.

3. The assessor carries out theory online assessments. Theory examination would be conducted online and the paper comprise of MCQ

4. Pass percentage would be 50% marks.

5. The examination will be conducted in English language only.

Quality assurance activities: A pool of questions is created by a subject matter expert and moderated by other SME. Test rules are set beforehand. Random set of questions which are according to syllabus appears which may differ from candidate to candidate. Confidentiality and impartiality are maintained during all the examination and evaluation processes.

Annexure-IX: Acronym and Glossary

Acronym

Acronym	Description
AA	Assessment Agency
AB	Awarding Body
NCrF	National Credit Framework
NOS	National Occupational Standard(s)
NQR	National Qualification Register
NSQF	National Skills Qualifications Framework

Glossary

Term	Description
National Occupational Standards (NOS)	NOS define the measurable performance outcomes required from an individual engaged in a particular task. They list down what an individual performing that task should know and also do.
Qualification	A formal outcome of an assessment and validation process which is obtained when a competent body determines that an individual has achieved learning outcomes to given standards
Qualification File	A aQualification File is a template designed to capture necessary information of a Qualification from the perspective of NSQF compliance. The Qualification File will be normally submitted by the awarding body for the qualification.
Sector	A grouping of professional activities on the basis of their main economic function, product, service or technology.