QUALIFICATION FILE-Standalone NOS

Essentials of Semiconductor Production and Quality

☐ 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:

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Section 1: Basic Details

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<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-03738-2025-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 standalone NOS is designed to provide students with a solid foundation in semiconductor manufacturing processes and quality management techniques. It covers the key stages of production, including wafer fabrication, assembly, testing, and defect analysis, emphasizing both theoretical understanding and practical skills. Students will gain hands-on experience through lab sessions and project work, enabling them to apply quality assurance methods, optimize production processes, and troubleshoot production issues effectively. This course also introduces advanced trends in semiconductor production and quality standards, preparing students to excel in modern manufacturing environments.</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>
<tr><td>4</td><td>12th Pass</td><td>1.5-year experience in ESDM Sector.</td></tr>
</table></td></tr>
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		5	10th pass plus 2-year NTC in relevant field of Electronics Sector	1.5-year experience in ESDM Sector.
8.	**Credits Assigned to this NOS-Qualification, Subject to Assessment** *(as per National Credit Framework (NCrF))*	**2 Credits**	**9. Common Cost Norm Category (I/II/III)** *(wherever applicable)***: Category-I**	
10.	**Any Licensing Requirements for Undertaking Training on This Qualification** *(wherever applicable)*	NA		
11.	**Training Duration by Modes of Training Delivery** *(Specify **Total Duration** as per selected training delivery modes and as per requirement of the qualification)*	**☒Offline ☐Online ☐Blended**		

Training Delivery Modes	Theory (Hours)	Practical (Hours)	Total (Hours)
Classroom (offline)	**18**	**42**	**60**

12.	**Assessment Criteria**				

Theory (Marks)	Practical (Marks)	Project (Marks)	Viva (Marks)	Total (Marks)	Passing %age
100	**60**	**20**	**20**	**200**	**50**

The centralized online assessment is conducted by the Examination Wing, NIELIT Headquarters.

*Assessment strategy shall be as per NIELIT Norms prevailing at times.

13.	**Is the NOS Amenable to Persons with Disability**	**☒ Yes ☐ No** Leprosy Cured Person, Dwarfism, Thalassemia, Hemophilia, Hearing Impairment(Hard of Hearing), Acid Attack Victims.
14.	**Progression Path After Attaining the Qualification, wherever applicable** *(Please show Professional and Academic progression)*	MEMS Backend Fabrication Engineer -> Semiconductor Fabrication Engineer
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. Anand N, Scientist C, NIELIT **Email:** anand.n@nielit.gov.in **Contact No.:** 0240 2982021 **Website:** https://www.nielit.gov.in **Name:** Sh. Shashank Kumar Singh, Scientist B, NIELIT **Email:** shashank@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	Awareness of Essentials of Semiconductor Production and Quality with Understanding of basic semiconductor manufacturing processes (lithography, etching, deposition) and Familiarity with EDA tools used for layout analysis and design checks.	Provides foundational theoretical knowledge required to identify and address manufacturability challenges in semiconductor design and production processes.	4.5
Professional and Technical Skills/ Expertise/ Professional Knowledge	Familiarity with industry semiconductor testing methods and tools for defect analysis and operate EDA tools for manufacturability analysis and defect detection.	The outcomes demonstrate the ability to understand and apply principles and procedures for ensuring quality and process optimization in manufacturing.	4.5
Employment Readiness & Entrepreneurship Skills & Mind-set/Professional Skill	Develop an entrepreneurial mindset by understanding manufacturability challenges and proposing basic solutions and to develop skill in using fabrication equipment, performing defect analysis, adjusting process parameters, and troubleshooting issues.	Course outcomes prepare learners for immediate employability, focusing on teamwork and structured task completion as per NSQF Level 4 expectations. The job involves cognitive abilities and practical skills to troubleshoot production issues, implement corrective actions, and optimize processes.	4.5
Broad Learning Outcomes/Core Skill and Responsibility	Use basic mathematical and analytical skills for defect and yield analysis. Documentation of defect analysis and preparing quality management reports and to communicate effectively with team members and supervisors about task requirements and findings with responsibility for maintaining quality in production.	The outcomes align with the need for clear communication, technical reporting, and problem-solving in semiconductor production environments. The role requires accountability for assigned tasks and collaborative work on projects, aligning with the NSQF Level 4 descriptor of responsibility.	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:

Assembly and Packaging Tools
- Die Attach Machines
- Wire Bonding Machines
- Encapsulation and Moulding Equipment

Testing and Quality Assurance Tools
- Semiconductor Test Systems (Parametric and Functional Testers)
- Burn-In Test Chambers
- Statistical Process Control (SPC) Software

Defect Analysis Tools
- Scanning Electron Microscope (SEM)
- Transmission Electron Microscope (TEM)
- X-ray Inspection Systems

Advanced Production and Quality Tools
- Data Analytics Software (e.g., Python, MATLAB)
- IoT Sensors for Real-Time Monitoring

- AI and Machine Learning Platforms

General Equipment

- Desktop Computers with Process and Quality Management Software
- Whiteboards and Projectors for Training

Consumables

- Silicon Wafers
- Encapsulation Materials
- Cleaning Solvents (Isopropyl Alcohol, Acetone)

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:

This standalone NOS provides a strong foundation in semiconductor manufacturing and quality management. It covers key production stages—wafer fabrication, assembly, testing, and defect analysis—combining theory with practical lab work and projects. Students will learn to apply quality assurance methods, optimize processes, and troubleshoot issues, while gaining insight into advanced trends and industry standards.

2. Scope:

The scope covers the following:

- Covers all critical stages of semiconductor production, including wafer fabrication, assembly, testing, and defect analysis, ensuring a thorough knowledge of the processes involved.
- Emphasizes hands-on training with equipment and tools for fabrication, quality control, and troubleshooting, bridging the gap between theory and industrial application.
- Equips students with the knowledge of global industry standards (ISO, JEDEC) and quality management techniques, preparing them to meet professional expectations in semiconductor manufacturing.
- Introduces advanced production technologies, trends like Industry 4.0, and sustainable practices, ensuring students are ready to adapt to future innovations in the semiconductor industry.

3. Elements and Performance Criteria:

Elements	Performance Criteria
Introduction to Semiconductor Production	PC1. Explain the key stages of semiconductor production, including wafer fabrication, assembly, and testing. PC2. Describe the role of quality in semiconductor manufacturing and its impact on yield and reliability. PC3. Identify major industry standards and specifications relevant to semiconductor production. PC4. Recognize essential equipment and facilities used in semiconductor fabrication through practical observation.
Wafer Fabrication and Process Control	PC5. Outline major wafer fabrication processes such as deposition, lithography, and etching. PC6. Explain the importance of process control and monitoring in wafer fabrication. PC7. Perform wafer state measurements and interpret results for quality assessment. PC8. Identify common wafer defects and discuss their causes and effects on device performance. PC9. Apply control strategies to optimize fabrication processes based on monitored parameters.

Semiconductor Assembly and Packaging	PC10. Explain key assembly processes including die attach, wire bonding, and encapsulation. PC11. Compare different packaging technologies such as DIP, QFP, BGA, and CSP. PC12. Identify quality control checkpoints in assembly and packaging. PC13. Analyze common defects in assembly and recommend corrective actions.
Testing and Quality Assurance	PC14. Describe testing methods including parametric, functional, and burn-in testing. PC15. Implement quality assurance procedures and use statistical tools like SPC. PC16. Conduct root cause and failure analysis based on test data. PC17. Apply QA techniques to enhance product reliability and yield.
Defect Analysis and Troubleshooting	PC18. Use inspection tools (SEM, TEM, X-ray) to analyze defects in semiconductor devices. PC19 Apply troubleshooting techniques to resolve production-related issues. PC20. Formulate and implement corrective and preventive actions (CAPA). PC21. Analyze case studies and suggest improvements based on defect patterns.
Advanced Topics in Production and Quality	PC22. Discuss recent advancements in semiconductor production technologies. PC23. Identify emerging trends and quality standards in the semiconductor industry. PC24. Evaluate the impact of Industry 4.0 on manufacturing and quality practices. PC25. Design and present innovative strategies for quality management in future production environments.

4. Knowledge and Understanding (KU):

The individual on the job needs to know and understand:

KU1: Fundamentals of Semiconductor Production:
Acquire a deep understanding of semiconductor production stages, including wafer fabrication, assembly, testing, and packaging, along with their impact on product quality.
KU2: Quality Assurance and Industry Standards:
Learn the principles of quality management, defect analysis techniques, and adherence to industry standards such as ISO and JEDEC for ensuring reliable production processes.
KU3: Emerging Trends and Technologies:
Gain insights into advancements in semiconductor production technologies, the impact of Industry 4.0, and strategies for implementing sustainable and efficient manufacturing practices.

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 Semiconductor Production	PC1. Explain the key stages of semiconductor production, including wafer fabrication, assembly, and testing. PC2. Describe the role of quality in semiconductor manufacturing and its impact on yield and reliability. PC3. Identify major industry standards and specifications relevant to semiconductor production. PC4. Recognize essential equipment and facilities used in semiconductor fabrication through practical observation.	17	10	-	-
Wafer Fabrication and Process Control	PC5. Outline major wafer fabrication processes such as deposition, lithography, and etching. PC6. Explain the importance of process control and monitoring in wafer fabrication. PC7. Perform wafer state measurements and interpret results for quality assessment. PC8. Identify common wafer defects and discuss their causes and effects on device performance. PC9. Apply control strategies to optimize fabrication processes based on monitored parameters.	17	10	-	-

Semiconductor Assembly and Packaging	PC10. Explain key assembly processes including die attach, wire bonding, and encapsulation. PC11. Compare different packaging technologies such as DIP, QFP, BGA, and CSP. PC12. Identify quality control checkpoints in assembly and packaging. PC13. Analyze common defects in assembly and recommend corrective actions.	17	10	-	-
Testing and Quality Assurance	PC14. Describe testing methods including parametric, functional, and burn-in testing. PC15. Implement quality assurance procedures and use statistical tools like SPC. PC16. Conduct root cause and failure analysis based on test data. PC17. Apply QA techniques to enhance product reliability and yield.	17	10	-	-
Defect Analysis and Troubleshooting	PC18. Use inspection tools (SEM, TEM, X-ray) to analyze defects in semiconductor devices. PC19 Apply troubleshooting techniques to resolve production-related issues. PC20. Formulate and implement corrective and preventive actions (CAPA). PC21. Analyze case studies and suggest improvements based on defect patterns.	16	10	-	-
Advanced Topics in Production and Quality	PC22. Discuss recent advancements in semiconductor production technologies. PC23. Identify emerging trends and quality standards in the semiconductor industry. PC24. Evaluate the impact of Industry 4.0 on manufacturing and quality practices. PC25. Design and present innovative strategies for quality management in future production environments.	16	10	-	-
Project	Include all Elements	-	-	20	-
Viva	Include all Elements	-	-	-	20
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.