QUALIFICATION FILE-Standalone NOS

Fundamentals of Thin Film Technology

☐ 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>1.</td><td>NOS-Qualification Name</td><td colspan="2">Fundamentals of Thin Film Technology</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-03731-2025-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 provides foundational knowledge and practical skills in semiconductor manufacturing. The course provides a comprehensive introduction to thin film deposition techniques, including Physical Vapor Deposition (PVD), Chemical Vapor Deposition (CVD), and Atomic Layer Deposition (ALD), covering thin film growth, characterization methods, and real-world applications. Students will gain proficiency in deposition equipment, characterization tools, and process integration, preparing them for roles in electronics, optics, and semiconductor industries.</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>
</table>

		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))*	**1 Credit**	**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)	**12**	**18**	**30**

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. Ashwin Pawar **Email:** ashwin.pawar@nielit.gov.in **Contact No.:** 9425361315 **Website:** https://www.nielit.gov.in **Name:** Sh. Saket Saurabh **Email:** srv.saket@nielit.gov.in **Contact No.:** 011-25308300 **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 the fundamentals of thin deposition techniques, and their importar electronics, optics, and MEMS. ●	Provides foundational knowledge of thin film deposition mechanisms, processes, and characterization techniques. ●	4.5
Professional and Technical Skills/ Expertise/ Professional Knowledge	Proficiency in Physical Vapor Deposition (PVD), Chemical Vapor Deposition (CVD), Atomic Layer Deposition (ALD), and thin film characterization techniques.	Equips learners with technical skills to operate deposition equipment, measure film properties, and optimize processes.	4.5
Employment Readiness & Entrepreneurship Skills & Mind-set/Professional Skill	Prepared for roles like Thin Film Deposition Technician or Process Engineer; skilled in problem-solving, teamwork, and technical communication.	Aligns job readiness and entrepreneurial mindset with industry expectations, focusing on process optimization and innovation.	4.5
Broad Learning Outcomes/Core Skill and Responsibility	Accountability for performing precise thin film deposition, analyzing properties, and integrating processes in semiconductor manufacturing.	Prepares learners to take ownership of thin film deposition tasks and contribute to process improvements and quality control.	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

Deposition Tools

- Physical Vapor Deposition (PVD) Equipment (Sputtering, Thermal Evaporation)
- Chemical Vapor Deposition (CVD) Reactors (LPCVD, PECVD)
- Atomic Layer Deposition (ALD) Systems

Characterization Tools

- Spectroscopic Ellipsometer
- X-ray Diffraction (XRD) Equipment
- Scanning Electron Microscope (SEM)

General Laboratory Equipment

- Wafer Holders and Sample Preparation Tools
- Desktop Computers with Data Analysis and Simulation Software

Consumables

- Silicon Wafers
- Metal Targets for PVD
- Precursor Gases for CVD and ALD Processes
- Cleaning Solvents (Isopropyl Alcohol, Acetone)

Safety Tools

- Chemical Fume Hoods
- Personal Protective Equipment (Gloves, Safety Goggles, Lab Coats)

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 Fundamentals of Thin Film Technology course provides a comprehensive introduction to thin film deposition techniques, including PVD, CVD, and ALD, along with thin film characterization methods. The program combines theoretical knowledge with hands-on practical sessions, enabling learners to operate deposition equipment, analyze thin film properties, and optimize processes. It prepares participants for entry-level roles in semiconductor manufacturing, focusing on precision, problem-solving, and process integration.

2. Scope:

- Prepares learners for entry-level roles in semiconductor manufacturing, such as Thin Film Deposition Technician or Process Engineer, with hands-on expertise in modern deposition and characterization techniques.
- Equips participants with the skills to analyze, optimize, and integrate thin film processes in electronics, optics, and MEMS applications, aligning with industry demands.

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 Thin Film Technology	**PC1.** Demonstrate understanding of the principles of thin film deposition and their applications in electronics, optics, and MEMS. **PC2.** Explain the mechanisms of thin film growth, including nucleation and growth processes.
Introduction to Vacuum technology	**PC3:** Describe the importance of vacuum in various industrial and scientific applications **PC4**: Describe the different types of vacuum systems, pumps, and gauges
Physical Vapor Deposition (PVD) Techniques	**PC5:** Describe the fundamentals of PVD, including sputtering and thermal evaporation, and explain their applications and limitations. **PC6:** Operate PVD equipment, deposit metal thin films, and evaluate film quality and uniformity.
Chemical Vapor Deposition (CVD) Techniques	**PC7:** Explain the principles of CVD processes, including LPCVD and PECVD, and their significance in semiconductor manufacturing. **PC8**: Perform CVD processes to deposit dielectric thin films, analyzing process challenges and solutions.
Thin Film Characterization Techniques	**PC9:** Explain the methods for characterizing thin films, including thickness, composition, and structural analysis using tools like XRD, SEM, and spectroscopic ellipsometry. **PC10:** Perform thin film characterization techniques, measuring film thickness and evaluating optical and electrical properties.
Process Integration and Final Project	**PC11:** Demonstrate the integration of thin film processes in semiconductor devices, addressing challenges and optimizing outcomes. **PC12:** Design, implement, and evaluate a complete thin film deposition process as part of a final project, demonstrating technical and practical expertise.

4. Knowledge and Understanding (KU):

The individual on the job needs to know and understand:

KU1: The principles and applications of thin film deposition techniques (PVD, CVD, and ALD) and characterization methods, including their importance in electronics, optics, and MEMS industries.

KU2: The impact of material selection, thin film growth mechanisms, and deposition process compatibility on product performance, reliability, and production efficiency.

KU3: The tools and techniques used for characterizing thin films, including measuring thickness, composition, and structural properties, and analyzing deposition process outcomes in laboratory settings.

5. Generic Skills (GS):

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

GS1: Identify and troubleshoot challenges in thin film technology processes, applying critical thinking to optimize fabrication techniques for improved yield, uniformity, and reliability.

GS2: Communicate technical findings effectively, collaborate with cross-functional teams (e.g., process engineers, designers, and quality analysts), and present process optimizations clearly and concisely.

GS3: Leverage analytical and decision-making skills to evaluate process outcomes, refine parameters, and achieve desired fabrication goals.

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 Thin Film Technology	**PC1.** Demonstrate understanding of the principles of thin film deposition and their applications in electronics, optics, and MEMS. **PC2.** Explain the mechanisms of thin film growth, including nucleation and growth processes.	**16**	**12**	**-**	**-**
Introduction to Vacuum technology	**PC3:** Describe the importance of vacuum in various industrial and scientific applications. **PC4**: Describe the different types of vacuum systems, pumps, and gauges	**16**	**12**	**-**	**-**
Physical Vapor Deposition (PVD) Techniques	**PC5:** Describe the fundamentals of PVD, including sputtering and thermal evaporation, and explain their applications and limitations. **PC6:** Operate PVD equipment, deposit metal thin films, and evaluate film quality and uniformity.	**17**	**12**	**-**	**-**
Chemical Vapor Deposition (CVD) Techniques	**PC7:** Explain the principles of CVD processes, including LPCVD and PECVD, and their significance in semiconductor manufacturing. **PC8**: Perform CVD processes to deposit dielectric thin films, analyzing process challenges and solutions.	**17**	**12**	**-**	**-**
Thin Film Characterization Techniques	**PC9:** Explain the methods for characterizing thin films, including thickness, composition, and structural analysis using tools like XRD, SEM, and spectroscopic ellipsometry. **PC10:** Perform thin film characterization techniques, measuring film thickness and evaluating optical and electrical properties.	**17**	**12**	**-**	**-**
Process Integration and Final Project	**PC11:** Demonstrate the integration of thin film processes in semiconductor devices, addressing challenges and optimizing outcomes. **PC12:** Design, implement, and evaluate a complete thin film deposition process as part of a final project, demonstrating technical and practical expertise.	**17**	**-**	**20**	**-**
Viva	Including 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 Qualification 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.