Model Curriculum

NOS Name: Clean-Room Operations (for semiconductors)

NOS Code: ELE/N0166

NOS Version: 1.0

NSQF Level: 4

Model Curriculum Version: 1.0

Electronics Sector Skills Council of India || 155, 2nd Floor ESC House, Okhla Industrial Area – Phase 3, New Delhi - 110020

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Training Parameters

Sector	Electronics
Sub-Sector	Semiconductor & Components
Occupation	Production-S&C
Country	India
NSQF Level	4
Aligned to NCO/ISCO/ISIC Code	NCO-2015/2111.1100
Minimum Educational Qualification and Experience	12 or Equivalent (Science Stream) **Or** 10th with 2 years ITI in the relevant area
Pre-Requisite License or Training	NA
Minimum Job Entry Age	18
Last Reviewed On	*30.04.2024*
Next Review Date	*30.04.2027*
NSQC Approval Date	*30.04.2024*
NOS Version	1.0
Model Curriculum Creation Date	*30.04.2024*
Model Curriculum Valid Up to Date	*30.04.2027*
Model Curriculum Version	1.0
Maximum Duration of the Course	60

Program Overview

This section summarizes the end objectives of the program along with its duration.

Training Outcomes:
At the end of the program, the learner should have acquired the listed knowledge and skills:

Compulsory:

- Basic lecture introduces different aspects of Electronics and exposure to the current activities at a particular.

Compulsory Modules:
The table lists the modules and their duration corresponding to the Compulsory NOS of the QF.

NOS and Module Details	Theory / Demonstration Duration (In Hours)	Practical/OJT Duration (In Hours)	On-the-Job Training Duration (in hours) (Mandatory)	On-the-Job Training Duration (in hours) (Recommended)	Total Duration (In Hours)
ELE/N0166	30:00	30:00	00:00	00:00	60:00
Module 1: Clean Room Fundamentals and Design Principles	05:00	05:00	00:00	00:00	10:00
Module 2: Airflow Mechanics and Filtration Technologies	05:00	05:00	00:00	00:00	10:00
Module 3: Construction and Materials for Clean Rooms	05:00	05:00	00:00	00:00	10:00
Module 4: Contamination Control Strategies and Chemical Management	05:00	05:00	00:00	00:00	10:00

Module 5: Access Control, Personnel Practices, and Safety Procedures	05:00	05:00	00:00	00:00	10:00
Module 6: Automation, Maintenance, and Quality Assurance	05:00	05:00	00:00	00:00	10:00
Total Duration	**30:00**	**30:00**	**00:00**	**00:00**	**60:00**

Module Details

Module 1: Clean Room Fundamentals and Design Principles

Terminal Outcomes:
Students will understand clean room fundamentals, significance of controlled environments, cleanroom standards, types of cleanrooms, and HVAC impact in semiconductor manufacturing.

Duration: 05:00 hrs
Theory - Key Learning Outcomes
• Understanding the importance of cleanrooms in semiconductor manufacturing and their impact on the production process • Recognizing the significance of controlled environments for semiconductor fabrication and the role of cleanroom standards and classifications • Identifying different types of cleanrooms, including laminar flow, turbulent flow, and mixed flow cleanrooms • Understanding basic design considerations for effective cleanrooms, including layout, size, and location • Recognizing the impact of HVAC systems on cleanroom environments, including temperature, humidity, and air pressure control
Duration: 05:00 hrs
Practical - Key Learning Outcomes
• Applying knowledge of cleanroom standards and classifications to real-world scenarios • Designing and constructing cleanrooms with appropriate layout, size, and location • Operating and maintaining HVAC systems to control temperature, humidity, and air pressure in cleanrooms • Implementing safety protocols and best practices for cleanroom operation • Troubleshooting common issues in cleanroom design and operation
Classroom Aids: (If Offline mode)
• Whiteboard and Markers • Chart paper and sketch pens • LCD Projector and Laptop for presentations
Tools, Equipment and Other Requirements
Labs equipped with the following: • Cleanroom monitoring equipment (e.g. particle counters, temperature and humidity sensors) • Cleanroom safety equipment (e.g. protective garments, gloves, and masks)

Module 2: Airflow Mechanics and Filtration Technologies

Terminal Outcomes:
Students will master airflow mechanics, HEPA/ULPA filtration, airflow pattern evaluation, filtration system maintenance, and airflow-filtration integration for contamination control.

Duration: 05:00 hrs
Theory - Key Learning Outcomes
• Understanding the mechanics of airflow in clean rooms and its crucial role in contamination control, focusing on air velocity, direction, and turbulence. • Exploring HEPA and ULPA filtration mechanisms for effective contamination control, including principles, efficiency, and maintenance requirements. • Evaluating airflow patterns to optimize clean room performance, utilizing computational fluid dynamics (CFD) simulations. • Learning about the maintenance and efficiency of filtration systems, including filter replacement and monitoring procedures. • Understanding the integration of airflow and filtration systems for contamination control, incorporating air showers, gowning rooms, and air locks.
Duration: 05:00 hrs
Practical - Key Learning Outcomes
• Applying knowledge of airflow mechanics to ensure proper contamination control and clean room performance. • Hands-on experience with HEPA and ULPA filtration systems to maintain efficient contamination control. • Practicing the evaluation of airflow patterns using computational fluid dynamics (CFD) simulations for optimal clean room operation. • Engaging in maintenance tasks for filtration systems, including filter replacement and monitoring practices. • Implementing the integration of airflow and filtration systems practically to enhance contamination control, utilizing air showers, gowning rooms, and air locks.
Classroom Aids: (If Offline mode)
• Whiteboard and Markers • Chart paper and sketch pens • LCD Projector and Laptop for presentations
Tools, Equipment and Other Requirements
Labs equipped with the following:

• Computational Fluid Dynamics (CFD) software for airflow pattern evaluation. • HEPA and ULPA filters for filtration system maintenance.

Module 3: Construction and Materials for Clean Rooms

Terminal Outcomes:
Students will learn best practices for clean room construction, elements of a cleanroom, materials used in clean room construction, power supply considerations, and techniques for controlling vibration and noise in clean rooms.

Duration: 05:00 hrs
Theory - Key Learning Outcomes
• Understanding the principles of clean room design and construction • Identifying the materials used in clean room construction and their impact on cleanliness • Recognizing the importance of power supply considerations in clean room design • Understanding the impact of construction materials on clean room operations • Learning about design considerations for magnetic and electromagnetic flux control in clean room environments
Duration: 05:00 hrs
Practical - Key Learning Outcomes
• Applying knowledge of clean room design and construction principles • Understanding the selection and use of materials in clean room construction • Implementing power supply considerations in clean room design • Applying techniques for controlling vibration and noise in clean rooms • Understanding the importance of clean room operation and maintenance
Classroom Aids: (If Offline mode)
• Whiteboard and Markers • Chart paper and sketch pens • LCD Projector and Laptop for presentations
Tools, Equipment and Other Requirements
Labs equipped with the following: • Clean room design software • Clean room construction materials • Clean room monitoring equipment

Module 4: Contamination Control Strategies and Chemical Management

Terminal Outcomes:
Student will be able to identify sources of contamination in clean rooms, implement protocols for minimizing contamination, handle and store chemicals safely, monitor and control chemical management systems, and integrate strategies for effective contamination control.

Duration: 05:00 hrs
Theory - Key Learning Outcomes
• Understanding the sources of contamination in clean rooms • Learning protocols for minimizing contamination in semiconductor fabs • Safe handling and storage of chemicals and gases in clean rooms • Monitoring and control systems for chemical management • Implementing strategies for effective contamination control
Duration: 05:00 hrs
Practical - Key Learning Outcomes
• Identifying and mitigating sources of contamination in clean rooms • Implementing protocols for minimizing contamination • Handling and storing chemicals safely in clean rooms • Monitoring and controlling chemical management systems • Integrating strategies for effective contamination control
Classroom Aids: (If Offline mode)
• Whiteboard and Markers • Chart paper and sketch pens • LCD Projector and Laptop for presentations
Tools, Equipment and Other Requirements
Labs equipped with the following: • Clean room apparel, gloves, and hairnets • Cleaning and disinfection supplies

Module 5: Access Control, Personnel Practices, and Safety Procedures

Terminal Outcomes:
Implement effective clean room access control, personnel practices, and safety procedures to ensure a secure, clean, and safe environment for semiconductor manufacturing.

Duration: 05:00 hrs
Theory - Key Learning Outcomes
• Understand the importance of access control systems for clean room security • Learn about personnel hygiene practices and training requirements • Identify potential hazards in clean rooms and their impact on operations • Implement emergency response procedures for clean room safety • Ensure compliance with safety regulations in semiconductor clean rooms
Duration: 05:00 hrs
Practical - Key Learning Outcomes
• Implement access control systems using badges, access cards, and biometric systems • Practice proper personnel hygiene, including the use of gloves, gowns, and face masks • Identify and mitigate potential hazards in clean rooms • Implement emergency response procedures for clean room safety • Ensure compliance with safety regulations in semiconductor clean rooms
Classroom Aids: (If Offline mode)
• Whiteboard and Markers • Chart paper and sketch pens • LCD Projector and Laptop for presentations
Tools, Equipment and Other Requirements
Labs equipped with the following: • Access control systems (badges, access cards, biometric systems) • Clean room apparel (gloves, gowns, face masks) • Hazard identification and mitigation tools • Emergency response equipment (fire extinguishers, spill response kits, emergency showers) • Safety regulation compliance tools (OSHA, EPA, FDA regulations)

Module 6: Automation, Maintenance, and Quality Assurance

Terminal Outcomes:
Students will be able to integrate automated material handling systems (AMHS) in clean rooms, understand the benefits and challenges of automated systems, perform routine clean room inspections, monitor and maintain environmental parameters, and implement quality assurance measures for continuous improvement.

Duration: 05:00 hrs
Theory - Key Learning Outcomes
• Understand the integration of AMHS in clean rooms, including robots, conveyors, and automated guided vehicles • Recognize the benefits and challenges of automated systems in semiconductor fabs • Learn about routine clean room inspections and preventive maintenance programs • Understand the importance of monitoring and maintaining environmental parameters • Recognize the importance of implementing quality assurance measures for continuous improvement
Duration: 05:00 hrs
Practical - Key Learning Outcomes
• Apply the integration of AMHS in clean rooms • Implement preventive maintenance programs and predictive maintenance tools • Monitor and maintain environmental parameters using temperature, humidity, and pressure control systems • Implement quality assurance measures for continuous improvement, including quality management systems and statistical process control • Perform root cause analysis for continuous improvement
Classroom Aids: (If Offline mode)
• Whiteboard and Markers • Chart paper and sketch pens • LCD Projector and Laptop for presentations
Tools, Equipment and Other Requirements
Labs equipped with the following: • Preventive maintenance programs and predictive maintenance tools • Temperature, humidity, and pressure control systems

Annexure

Trainer Requirements

Trainer Prerequisites						
Minimum Educational Qualification	**Specialization**	**Relevant Industry Experience**		**Training Experience**		**Remarks**
		Years	**Specialization**	**Years**	**Specialization**	
Graduate Science & Engineering	Electrical/ Mechanical/ Electronics	1	Semiconductor Technology, Cleanroom Operations	1	Semiconductor Technology, Cleanroom Operations	
Diploma/ITI	Electrical/ Mechanical/ Electronics	2	Semiconductor Technology, Cleanroom Operations	1	Semiconductor Technology, Cleanroom Operations	

Trainer Certification	
Domain Certification	**Platform Certification**
"**Clean-Room Operations (for semiconductors)**, ELE/N0166, version 1.0". Minimum accepted score is 80%.	Recommended that the Trainer is certified for the **Clean-Room Operations (for semiconductors)** "Trainer (VET and Skills)", mapped to the Qualification Pack: "MEP/Q2601, V2.0", with minimum score of 80%

Assessor Requirements

Assessor Prerequisites						
Minimum Educational Qualification	**Specialization**	**Relevant Industry Experience**		**Training Experience**		**Remarks**
		Years	**Specialization**	**Years**	**Specialization**	
Graduate Science & Engineering	Electrical/ Mechanical/ Electronics	2	Semiconductor Technology, Cleanroom Operations	2	Semiconductor Technology, Cleanroom Operations	
Diploma/ITI	Electrical/ Mechanical/ Electronics	3	Semiconductor Technology, Cleanroom Operations	2	Semiconductor Technology, Cleanroom Operations	

Assessor Certification	
Domain Certification	**Platform Certification**
"**Clean-Room Operations (for semiconductors)**, ELE/N0166, version 1.0". Minimum accepted score is 80%.	Recommended that the Assessor is certified forthe **Clean-Room Operations (for semiconductors)** "Assessor (VET and Skills)", mapped to the Qualification Pack: "MEP/Q2701, V2.0", with minimum score of 80%

Assessment Strategy

1. Assessment System Overview:
   - Batches assigned to the assessment agencies for conducting the assessment on SDMS/SIP or email
   - Assessment agencies send the assessment confirmation to VTP/TC looping SSC
   - Assessment agency deploys the ToA certified Assessor for executing the assessment
   - SSC monitors the assessment process & records

2. Testing Environment:
   - Confirm that the centre is available at the same address as mentioned on SDMS or SIP
   - Check the duration of the training.
   - Check the Assessment Start and End time to be as 10 a.m. and 5 p.m.
   - If the batch size is more than 30, then there should be 2 Assessors.
   - Check that the allotted time to the candidates to complete Theory & Practical Assessment is correct.
   - Check the mode of assessment—Online (TAB/Computer) or Offline (OMR/PP).
   - Confirm the number of TABs on the ground are correct to execute the Assessment smoothly.
   - Check the availability of the Lab Equipment for the particular Job Role.

3. Assessment Quality Assurance levels / Framework:
   - Question papers created by the Subject Matter Experts (SME)
   - Question papers created by the SME verified by the other subject Matter Experts
   - Questions are mapped with NOS and PC
   - Question papers are prepared considering that level 1 to 3 are for the unskilled & semi-skilled individuals, and level 4 and above are for the skilled, supervisor & higher management
   - Assessor must be ToA certified & trainer must be ToT Certified
   - Assessment agency must follow the assessment guidelines to conduct the assessment

4. Types of evidence or evidence-gathering protocol:

   - Time-stamped & geotagged reporting of the assessor from assessment location
   - Centre photographs with signboards and scheme specific branding
   - Biometric or manual attendance sheet (stamped by TP) of the trainees during the training period
   - Time-stamped & geotagged assessment (Theory + Viva + Practical) photographs & videos

5. Method of verification or validation:

   - Surprise visit to the assessment location
   - Random audit of the batch

- Random audit of any candidate

6. Method for assessment documentation, archiving, and access

- Hard copies of the documents are stored
- Soft copies of the documents & photographs of the assessment are uploaded / accessed from Cloud Storage
- Soft copies of the documents & photographs of the assessment are stored in the Hard Drives

References

Glossary

Term	Description
Key Learning Outcome	Key learning outcome is the statement of what a learner needs to know, understand and be able to do to achieve the terminal outcomes. A set of key learning outcomes will make up the training outcomes. Training outcome is specified in terms of knowledge, understanding (theory) and skills (practical/OJT application).
Training Outcome	Training outcome is a statement of what a learner will know, understand and be able to do **upon the completion of the training**
Terminal Outcome	Terminal outcome is a statement of what a learner will know, understand and be able to do **upon the completion of a module**. A set of terminal outcomes help to achieve the training outcome.
National Occupational Standard	National Occupational Standard specify the standard of performance an individual must achieve when carrying out a function in the workplace
Persons with Disability	Persons with Disability are those who have long-term physical, mental, intellectual, or sensory impairments which in interaction with various barriers may hinder their full and effective participation in society on an equal basis with others

Acronyms and Abbreviations

Term	Description
QF	Qualification File
NSQF	National Skills Qualification Framework
NSQC	National Skills Qualification Committee
NOS	National Occupational Standards
SSC	Skill Sectors Councils
NASSCOM	National Association of Software & Service Companies
NCO	National Classification of Occupations
ISO	International Organization for Standardization
SLA	Service Level Agreement
IT	Information Technology
CRM	Customer Relationship Management
PC	Performance Criteria
PwD	Persons with Disability
SOP	Standard Operating Procedure