Model Curriculum

QP Name: Semiconductor Process Technology Engineer - Upskilling

QP Code: ELE/Q1406

QP Version: 1.0

NSQF Level: 6

Model Curriculum Version: 1.0

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

Table of Contents

Training Parameters

Sector	Electronics
Sub-Sector	Semiconductor & Components
Occupation	Product Design – S & C
Country	India
NSQF Level	6
Aligned to NCO/ISCO/ISIC Code	NCO-2015/3119.1100
Minimum Educational Qualification and Experience	Pursuing 4th year UG (in case of 4-year UG with honors/ honors with research) (ECE/EEE/EE/CS/Allied Field) OR Pursuing 1st year of PG- Eng. (M.Sc./VLSI) OR Pursuing PhD (in relevant Field)
Pre-Requisite License or Training	NA
Minimum Job Entry Age	21 years
Last Reviewed On	31.08.2023
Next Review Date	31.08.2026
NSQC Approval Date	31.08.2023
QP Version	1.0
Model Curriculum Creation Date	31.08.2023
Model Curriculum Valid Up to Date	31.08.2026
Model Curriculum Version	1.0
Maximum Duration of the Course	300 Hours

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.

- Basic lecture introduces different aspects of Nanoelectronics and exposure to the current research activities at a particular nano canter.
- Provides exposure to the research infrastructure available at the Nano Centres in the form of series of lectures and application notes. This would provide in-depth information about the equipment and their capabilities.
- The lecture series is organized as modules, such as MEMS/ NEMS sensors and microfluidics, compounded semiconductor devices, spintronics, 2D materials and devices, photovoltaics and nanophotonic, etc.

Compulsory Modules

The table lists the modules and their duration corresponding to the Compulsory NOS of the QP.

NOS and Module Details	Theory Duration	Practical Duration	On-the-Job Training Duration (Mandatory)	On-the-Job Training Duration (Recommended)	Total Duration
ELE/N1412– Advanced Hands- on Training on Semiconductor Process Technologies	**10:00**	**10:00**	**10:00**	**00:00**	**30:00**
Module 1: Basics of Semiconductor	10:00	10:00	10:00	00:00	30:00
ELE/N1412 – Advanced Hands- on Training on Semiconductor Process Technologies	**05:00**	**30:00**	**05:00**	**00:00**	**40:00**
Module 2: Introduction to cleanroom and Lab Safety	05:00	30:00	05:00	00:00	40:00
ELE/N1412 – Advanced Hands- on Training on Semiconductor Process Technologies	**18:00**	**32:00**	**00:00**	**00:00**	**50:00**
Module 3: Advanced Lecture on process steps for semiconductor device	18:00	32:00	00:00	00:00	50:00
ELE/N1413 – Design & Packaging Techniques -Semiconductor Process Technologies	**05:00**	**40:00**	**10:00**	**00:00**	**55:00**
Module 4: Hands-on training on Semiconductor device fabrication	05:00	40:00	10:00	00:00	55:00
ELE/N1413 – Design & Packaging Techniques -Semiconductor Process Technologies	**15:00**	**12:00**	**03:00**	**00:00**	**30:00**
Module 5: Hands-on training on Semiconductor device characterization	15:00	12:00	03:00	00:00	30:00
ELE/N1413 – Design & Packaging Techniques -Semiconductor Process Technologies	**13:00**	**20:00**	**02:00**	**00:00**	**35:00**

Module 6: Hands-on training on Semiconductor device Packaging	13:00	20:00	02:00	00:00	35:00
DGT/VSQ/N0102 - Employability Skills (60 Hours)	**24:00**	**36:00**	**00:00**	**00:00**	**60:00**
Module 7: Employability Skills (60 Hours)	24:00	36:00	00:00	00:00	60:00
Total Duration	**90:00**	**180:00**	**30:00**	**00:00**	**300:00**

Module Details

Module 1: Basics of Semiconductor

Mapped to ELE/N1412

Terminal Outcomes:
- Understanding of the basic concepts of semiconductor physics
- knowledge of   various processes in nanotechnology/nanoelectronics

Duration: *10:00*	**Duration**: *10:00*
Theory – Key Learning Outcomes	**Practical – Key Learning Outcomes**
• Basic concepts of semiconductor technology. • Basics of semiconductor device physics • Basic of MEMS/NEMS technology • Basic knowledge of Material science • Sensor's technology • Semiconductor Physics • Electrical/ Material characterization • Device Physics	• Working Knowledge of Sensor • Understanding of Semiconductor sensor & Systems
Classroom Aids:	
Training Kit - Trainer Guide, Presentations, Whiteboard, Marker, Projector, Laptop, Hands – out, Notepad	
Tools, Equipment and Other Requirements	
Internet with Wi-Fi (Min 2 Mbps dedicated)	

Module 2: Introduction to the Cleanroom and Lab Safety

Mapped to ELE/N1412

Terminal Outcomes:

- Awareness about various facilities available in the semiconductor clean room.
- Tool capabilities and specifications

Duration: *05:00*	Duration: *30:00*
Theory – Key Learning Outcomes	**Practical – Key Learning Outcomes**
• Awareness about various facilities available in the semiconductor clean room. • Knowledge of Lab-Safety	• Working knowledge in a semiconductor clean room • Practical drill on Lab Safety • Knowledge of wafer handling • Knowledge of wafer cleaning
Classroom Aids (if Offline mode):	
• PCs/ Laptops • Whiteboard and Markers • Chart paper and sketch pens • LCD Projector and Laptop for presentations • Notepad and pens • Internet with Wi-Fi	
Tools, Equipment and Other Requirements	
Labs equipped with the following: • Clean room set-up • Fume-hood • Chemicals used for wafer cleaning • Safety gadgets (like PPE, Masks, Gloves etc.) • Wafers for fabrications	

Module 3: Advanced Lecture on process steps for Semiconductor device

Mapped to ELE/N1412

Terminal Outcomes:

- Concepts of semiconductor device fabrication

Duration: *18:00*	Duration: *32:00*
Theory – Key Learning Outcomes	**Practical – Key Learning Outcomes**
- Knowledge of working with various types of equipment used for semiconductor device fabrication - Knowledge of process flow for the fabrication of semiconductor device - Knowledge of essential software used during device design and simulations	- Practical Knowledge of related software - Knowledge of filling records/job cards for using the facility for semiconductor device fabrication - Knowledge of process optimization
Classroom Aids (if Offline mode):	
- PCs/ Laptops - Whiteboard and Markers - Chart paper and sketch pens - LCD Projector and Laptop for presentations - Notepad and pens - Internet with Wi-Fi	
Tools, Equipment and Other Requirements	
Labs equipped with the following: - Clean room set-up - Equipment used in routine for semiconductor device fabrication. - Safety gadgets (like PPE, Masks, Gloves etc.)	

Module 4: Hands-on training on Semiconductor device fabrication

Mapped to ELE/N1413

Terminal Outcomes:

- Hands-on experience in semiconductor device fabrication
- Understanding of Semiconductor Process Technology

Duration: 05:00	Duration: 40:00
Theory – Key Learning Outcomes	**Practical – Key Learning Outcomes**
• Basic knowledge of operation and process parameters • Basic Knowledge of Lithography • Basic Knowledge of Metallization • Basic knowledge of the metal lift-off process	• Hands-on training on various process steps for semiconductor device fabrication • Capacity building of error diagnosis and essential troubleshooting • Hands-on training on various aspects of mask design • Hands-on training in photolithography • Hands-on training in spin coater • Hands-on training in sputtering tools
Classroom Aids (if Offline mode):	
• Whiteboard and Markers • Chart paper and sketch pens • LCD Projector and Laptop for presentations	
Tools, Equipment and Other Requirements	
• Chemical Bench with exhaust • Ultrasonic cleaner • DI water generator • Nitrogen Drier • Oxidation Furnace/ Diffusion Furnace • Photolithography/Mask Aligner • PR coater/ Spin coater • Heating oven • Optical Microscope • Plasma Cleaner • Metallization equipment • Dicing equipment • Refrigerator	

Module 5: Hands-on training on Semiconductor device characterization

Mapped to ELE/N1413

Terminal Outcomes:

- Gaining knowledge of semiconductor device characterization
- The outcome of an efficient device is highly dependent on device characterization at various steps.

Duration: *15:00*	**Duration**: *12:00*
Theory – Key Learning Outcomes	**Practical – Key Learning Outcomes**
- Basics of various characterization tools, techniques and their importance. - Basics of electrical, mechanical, optical and compositional/elemental characterization. - Knowledge of errors that occurred in characterization equipment and their diagnosis and essential troubleshooting	- Knowledge of the operation of various characterization tools - Basic analysis of the characterized data - Device feasibility study - Practical Knowledge of errors that occurred in characterization equipment and their diagnosis and essential troubleshooting
Classroom Aids (if Offline mode):	
- Whiteboard and Markers - Chart paper and sketch pens - LCD Projector and Laptop for presentations	
Tools, Equipment and Other Requirements	
- IV-CV Measurement equipment - Layer thickness measurement equipment - Sheet resistance measurement equipment - Hall Effect measurement - Optical Microscopy - Profilometry	

Module 6: Hands-on training on Semiconductor Device Packaging

Mapped to ELE/N1413

Terminal Outcomes:

- Gaining knowledge of semiconductor device packaging
- The outcome of an efficient device is highly dependent on device packaging.

Duration: 13:00	Duration: 20:00
Theory – Key Learning Outcomes	**Practical – Key Learning Outcomes**
• Knowledge of selecting device packages based on the device and their application. • Knowledge of the essential software used for packaging-related simulation study	• Hands-on training on device packaging • Practical Knowledge of errors that occurred in Packaging related equipment and their diagnosis and essential troubleshooting
Classroom Aids (if Offline mode):	
• Whiteboard and Markers • Chart paper and sketch pens • LCD Projector and Laptop for presentations	
Tools, Equipment and Other Requirements	
• Die-bonder • Wire-bonder • Screen printing • 3D printer • Laminator • Stacker	

Module 7: Employability Skills (60 Hours)

Mapped to DGT/VSQ/N0102

Terminal Outcomes:

- Discuss about Employability Skills in meeting the job requirements
- Describe opportunities as an entrepreneur.
- Describe ways of preparing for apprenticeship & Jobs appropriately.

Duration: *24:00*	Duration: *36:00*
Theory – Key Learning Outcomes	**Practical – Key Learning Outcomes**
- Explain constitutional values, civic rights, responsibility towards society to become a responsible citizen - Discuss 21st century skills - Explain use of basic English phrases and sentences. - Demonstrate how to communicate in a well-behaved manner - Demonstrate how to work with others - Demonstrate how to operate digital devices - Discuss the significance of Internet and Computer/ Laptops - Discuss the need for identifying business opportunities - Discuss about types of customers. - Discuss on creation of biodata - Discuss about apprenticeship and opportunities related to it.	- List different learning and employability related GOI and private portals and their usage - Show how to practice different environmentally sustainable practices. - Exhibit 21st century skills like Self-Awareness, Behavior Skills, time management, etc. - Show how to use basic English sentences for everyday conversation in different contexts, in person and over the telephone - Demonstrate how to communicate in a well -mannered way with others. - Demonstrate how to communicate effectively using verbal and nonverbal communication etiquette - Utilize virtual collaboration tools to work effectively - Demonstrate how to maintain hygiene and dressing appropriately. - Perform a mock interview
Classroom Aids	
Training Kit (Trainer Guide, Presentations). Whiteboard, Marker, Projector, Laptop	
Tools, Equipment and Other Requirements	
Computer, UPS, Scanner, Computer Tables, LCD Projector, Computer Chairs, White Board OR Computer Lab	

Module 8: On-the-Job Training

Mapped to Semiconductor Process Technology Engineer - Upskilling

Mandatory Duration: 30:00	Recommended Duration: 00:00
Location: On Site	

Terminal Outcomes
1. Understanding of Semiconductor sensor & Systems
2. Working knowledge in a semiconductor clean room
3. Hands-on training in photolithography
4. Device feasibility study
5. Practical Knowledge of selecting Packages based on device and their application

Annexure

Trainer Requirements

<table>
<tr><th colspan="7">Trainer Prerequisites</th></tr>
<tr><th rowspan="2">Minimum Educational Qualification</th><th rowspan="2">Specialization</th><th colspan="2">Relevant Industry Experience</th><th colspan="2">Training Experience</th><th rowspan="2">Remarks</th></tr>
<tr><th>Years</th><th>Specialization</th><th>Years</th><th>Specialization</th></tr>
<tr><td>Doctorate in Science & Engineering</td><td>Electrical/ Electronics /Physics</td><td>1</td><td>Semiconductor Technology</td><td>1</td><td>Semiconductor Technology</td><td></td></tr>
</table>

<table>
<tr><th colspan="2">Trainer Certification</th></tr>
<tr><th>Domain Certification</th><th>Platform Certification</th></tr>
<tr><td>"Semiconductor Process Technology Engineer - Upskilling, ELE/Q1406, version 1.0". Minimum accepted score is 80%.</td><td>Recommended that the Trainer is certified for the **Semiconductor Process Technology Engineer - Upskilling** "Trainer (VET and Skills)", mapped to the Qualification Pack: "MEP/Q2601, V2.0", with minimum score of 80%</td></tr>
</table>

Assessor Requirements

<table>
<tr><th colspan="7">Assessor Prerequisites</th></tr>
<tr><th rowspan="2">Minimum Educational Qualification</th><th rowspan="2">Specialization</th><th colspan="2">Relevant Industry Experience</th><th colspan="2">Training/Assessment Experience</th><th rowspan="2">Remarks</th></tr>
<tr><th>Years</th><th>Specialization</th><th>Years</th><th>Specialization</th></tr>
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<tr><td>"Semiconductor Process Technology Engineer - Upskilling, ELE/Q1406, version 1.0". Minimum accepted score is 80%.</td><td>Recommended that the Assessor is certified for the **Semiconductor Process Technology Engineer** "Assessor (VET and Skills)", mapped to the Qualification Pack: "MEP/Q2701, V2.0", with minimum score of 80%</td></tr>
</table>

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

Glossary

Sector	Sector is a conglomeration of different business operations having similar business and interests. It may also be defined as a distinct subset of the economy whose components share similar characteristics and interests.
Sub-sector	Sub-sector is derived from a further breakdown based on the characteristics and interests of its components.
Occupation	Occupation is a set of job roles, which perform similar/ related set of functions in an industry.
Job role	Job role defines a unique set of functions that together form a unique employment opportunity in an organisation.
Occupational Standards (OS)	OS specify the standards of performance an individual must achieve when carrying out a function in the workplace, together with the Knowledge and Understanding (KU) they need to meet that standard consistently. Occupational Standards are applicable both in the Indian and global contexts.
Performance Criteria (PC)	Performance Criteria (PC) are statements that together specify the standard of performance required when carrying out a task.
National Occupational Standards (NOS)	NOS are occupational standards which apply uniquely in the Indian context.
Qualifications Pack (QP)	QP comprises the set of OS, together with the educational, training and other criteria required to perform a job role. A QP is assigned a unique qualifications pack code.
Unit Code	Unit code is a unique identifier for an Occupational Standard, which is denoted by an 'N'
Unit Title	Unit title gives a clear overall statement about what the incumbent should be able to do.
Description	Description gives a short summary of the unit content. This would be helpful to anyone searching on a database to verify that this is the appropriate OS they are looking for.
Scope	Scope is a set of statements specifying the range of variables that an individual may have to deal with in carrying out the function which have a critical impact on quality of performance required.

Knowledge and Understanding (KU)	Knowledge and Understanding (KU) are statements which together specify the technical, generic, professional and organisational specific knowledge that an individual needs in order to perform to the required standard.
Organisational Context	Organisational context includes the way the organisation is structured and how it operates, including the extent of operative knowledge managers have of their relevant areas of responsibility.
Technical Knowledge	Technical knowledge is the specific knowledge needed to accomplish specific designated responsibilities.
Core Skills/ Generic Skills (GS)	Core skills or Generic Skills (GS) are a group of skills that are the key to learning and working in today's world. These skills are typically needed in any work environment in today's world. These skills are typically needed in any work environment. In the context of the OS, these include communication related skills that are applicable to most job roles.
Electives	Electives are NOS/set of NOS that are identified by the sector as contributive to specialization in a job role. There may be multiple electives within a QP for each specialized job role. Trainees must select at least one elective for the successful completion of a QP with Electives.
Options	Options are NOS/set of NOS that are identified by the sector as additional skills. There may be multiple options within a QP. It is not mandatory to select any of the options to complete a QP with Options.

Acronyms and Abbreviations

NOS	National Occupational Standard(s)
NSQF	National Skills Qualifications Framework
QP	Qualifications Pack
TVET	Technical and Vocational Education and Training
IPR	Intellectual Property Rights