Model Curriculum

QP Name: Mechatronics Maintenance Specialist

QP Code: ELE/Q7105

QP Version: 1.0

NSQF Level: 5

Model Curriculum Version: 1.0

Electronic Sector Skills Council of India (ESSC!) ESC House, 2nd Floor IS, Okhla Industrial Area- Phase 1lI New Delhi-II0020

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Training Parameters

Sector	Electronics
Sub-Sector	Industrial Automation
Occupation	Engineering – I&A
Country	India
NSQF Level	5
Aligned to NCO/ISCO/ISIC Code	NCO-2015/NA
Minimum Educational Qualification and Experience	3 Years Diploma after 10th (Electrical or Electronics or Mechanical Engineering) with 3 Years of Relevant experience OR 3 Years Diploma after 12th (Electrical or Electronics or Mechanical Engineering) with 1 Year of Relevant experience OR B.E./ B. Tech (Degree in Electrical or Electronics or Mechanical Engineering) OR Certificate of NSQF Level-4 in Site Engineer Control Panel with 2 years of relevant Experience
Pre-Requisite License or Training	NA
Minimum Job Entry Age	21 Years
Last Reviewed On	24/02/2022
Next Review Date	02/06/2025
NSQC Approval Date	24/02/2022
QP Version	1.0
Model Curriculum Creation Date	24/02/2022
Model Curriculum Valid Up to Date	02/06/2025
Model Curriculum Version	1.0
Minimum Duration of the Course	720 Hours

Maximum Duration of the Course	720 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:

- Demonstrate the process of setting up circuits and electrical components in the mechatronics system.
- Demonstrate the process of installing, testing and using the sensors and actuators in the mechatronics system.
- Demonstrate the process of installing, testing and using microcontrollers in the mechatronics system.
- Explain the importance of following inclusive practices for all genders and PwD at work.
- Demonstrate the use of relevant health and safety equipment at work.

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 (Recommended)	On-the-Job Training Duration (Mandatory)	Total Duration
Bridge Module	**04:00**	**00:00**	**00:00**	**00:00**	**04:00**
Module 1: Introduction and orientation to the role of a Mechatronics Maintenance Specialist	04:00	00:00	00:00	00:00	04:00
ELE/N7109 Set up circuits and electrical components in the mechatronics system **NOS Version- 1.0** **NSQF Level- 5**	**60:00**	**84:00**	**00:00**	**66:00**	**210:00**
Module 2: Process of setting up circuits and electrical components in the mechatronics system	60:00	84:00	00:00	66:00	210:00
ELE/N7110 Install, test and use the sensors and actuators in the mechatronics system **NOS Version- 1.0** **NSQF Level- 5**	**60:00**	**84:00**	**00:00**	**66:00**	**210:00**
Module 3: Process of installing, testing and using the sensors and actuators in the mechatronics system	60:00	84:00	00:00	66:00	210:00

ELE/N7111 Install, test and use microcontroller in the mechatronics system **NOS Version- 1.0** **NSQF Level- 5**	**64:00**	**84:00**	**00:00**	**68:00**	**216:00**
Module 4: Process of installing, testing and using microcontroller in the mechatronics system	64:00	84:00	00:00	68:00	216:00
ELE/N9905 Work effectively at the workplace **NOS Version- 2.0** **NSQF Level- 4**	**16:00**	**24:00**	**00:00**	**00:00**	**40:00**
Module 5: Soft Skills and Work Ethics	16:00	24:00	00:00	00:00	40:00
ELE/N1002 Apply health and safety practices at workplace **NOS Version- 3.0** **NSQF Level- 4**	**16:00**	**24:00**	**00:00**	**00:00**	**40:00**
Module 6: Basic Health and Safety Practice	16:00	24:00	00:00	00:00	40:00
Total Duration	**220:00**	**300:00**	**00:00**	**200:00**	**720:00**

Module Details

Module 1: Introduction and orientation to the role of a Mechatronics Maintenance Specialist

Terminal Outcomes:

- Describe the job role of a Mechatronics Maintenance Specialist.

Duration: 04:00	Duration: 00:00
Theory – Key Learning Outcomes	**Practical – Key Learning Outcomes**
- Describe the size and scope of the Electronics industry and its sub-sectors - Discuss the role and responsibilities of a Mechatronics Maintenance Specialist. - Discuss various employment opportunities for a Mechatronics Maintenance Specialist in the Electronics industry. - State the organisational policies on incentives, personnel management reporting structure, etc.	NA
Classroom Aids	
Training Kit - Trainer Guide, Presentations, Whiteboard, Marker, Projector, Laptop	
Tools, Equipment and Other Requirements	
NA	

Module 2: Process of setting up circuits and electrical components in the mechatronics system
Mapped to ELE/N7109 v1.0

Terminal Outcomes:

- Demonstrate the process of Setting up microcontrollers.
- Demonstrate the process of Setting up circuits, electrical components and pneumatic systems.

Duration: 24:00	Duration: 48:00
Theory – Key Learning Outcomes	**Practical – Key Learning Outcomes**
- Explain the need and scope of the mechatronics system. - Explain the mechatronics system and its scope in the automation sector. - Explain the traditional vs. mechatronics approach. - Explain how to interpret the block diagram representation of a general mechatronics system showing various components with suitable examples. - Explain relevant control systems such as open and closed-loop systems, basic elements of the closed-loop system. - Explain the basic circuit concepts. - Explain the semiconductor circuit elements. - Explain different types of circuits used in mechatronic devices. - Explain how to interpret the pneumatic symbols in pneumatic systems. - Describe the function and operation of pneumatic valves. - Describe the logic functions used in the pneumatic system. - Describe the function of relays and their working in the pneumatic system. - Explain the need for the proximity sensor and its application in a pneumatic cylinder. - Explain the design of cascade circuits.	- Demonstrate the process of testing the mechatronics components to ensure they are functioning correctly. - Demonstrate the process of installing the mechatronics control system and the hardware interfacing units of microcontrollers. - Demonstrate the process of testing the microcontrollers for the correct functioning and carrying out troubleshooting for the issues identified. **Demonstrate how to test the electrical components and circuits for correct functioning and compatibility with the mechatronics system.** - Demonstrate the process of performing sequence control and using the logic functions for operating the pneumatic system. **Demonstrate how to use relays in the pneumatic system.** - Demonstrate how to monitor the pneumatic fluid by analysing the speed and pressure control sensors. - Demonstrate the process of carrying out troubleshooting for any issues encountered with the pneumatic system. **Demonstrate how to design the cascade circuits.** - Demonstrate the process of installing the pneumatic power system. - Demonstrate the process of carrying

• Describe the process of programming PLCs in the Ladder diagram.	out maintenance of the circuits, electrical components and pneumatic system.
• Explain the principles of operation, characteristics and applications of power semiconductor devices.	
• Explain the characteristics of power semiconductor devices and circuits.	
• Explain the concept of fluid power.	
• Explain the relevant case studies for implementing the pneumatic system in the automatic production line.	

Classroom Aids

Training Kit (Trainer Guide, Presentations). Whiteboard, Marker, Projector, Laptop

Tools, Equipment and Other Requirements

Align, Fit and Assemble Component Parts Using Hand Tools, Power Tools, Fixtures, Templates and Microscopes

Module 3: Process of installing, testing and using the sensors and actuators in the mechatronics system
Mapped to ELE/N7110 v1.0

Terminal Outcomes:

- Demonstrate the process of installing, testing and using the sensors and actuators.

Duration: 48:00	Duration: 124:00
Theory – Key Learning Outcomes	**Practical – Key Learning Outcomes**
- Explain the use of contact and non-contact type sensors. - Explain the functions and application of Potentiometer Sensors, Strain Gauge Elements, Capacitive Elements, Eddy Current, Pressure Sensors, Pneumatic, Pyro Electrical, Piezoelectric Sensors etc. - Explain the criteria for selecting sensors for use. - Explain the classification, need and scope of different types of actuators. - Describe the process of pneumatic actuation, hydraulic actuation and double-acting. - Explain the use of different types of motors such as vane motors. - Explain the components of electrical actuation systems such as switching devices, keypads, electromechanical and solid-state relays, stepper motors etc. - Explain the criteria for the selection of different types of actuators. - Explain how to carry out repair and maintenance of sensors and actuators in a mechatronics system.	- Demonstrate the process of installing the selected sensors such as the potentiometer sensor following the standard procedure. - Demonstrate how to test the sensors for correct functioning after installation. - Demonstrate how to check the working of the strain gauge sensor and measure the torque applied by the motor. - Demonstrate the use of an eddy current sensor. - Demonstrate how to use the capacitive element by replacing the mechanical buttons. - Demonstrate how to use the inductive sensor to measure high precision measurements of displacement, distance, oscillation in harsh industrial environments. - Demonstrate the use of the pneumatic and pyro-electric and piezoelectric sensors. - Demonstrate the process of carrying out repair and maintenance of sensors. - Demonstrate the process of installing an actuator with the appropriate properties according to the need - Demonstrate how to use the appropriate interface circuitry to match the actuator to the system driving it. - Demonstrate how to test the actuator for correct functioning after

	installation.
	• Demonstrate the process of carrying out troubleshooting for any issues identified with the installed hydraulic and pneumatic actuator as per the sketches and block diagrams.
	• Demonstrate the process of install and using the vane motor as per the standard procedure.
	• Demonstrate how to control a high-powered circuit using a lower power signal through electro-mechanical and solid-state relays.
	• Demonstrate how to use the stepper motor to convert electrical power into mechanical power.
	• Demonstrate how to create analytical design and development solutions for actuators for different applications.
	• Demonstrate the process of carrying out repair and maintenance of actuators.

Classroom Aids

Training Kit (Trainer Guide, Presentations). Whiteboard, Marker, Projector, Laptop

Tools, Equipment and Other Requirements

Electromechanical Assemblies, Test Instruments Such as Oscilloscopes, Electronic Voltmeters and Bridges.

Module 4: Process of installing, testing and using microcontroller in the mechatronics system
Mapped to ELE/N7111 v1.0

Terminal Outcomes:

- Demonstrate the process of installing, testing and using the microcontroller.

Duration: 48:00	Duration: 124:00
Theory – Key Learning Outcomes	**Practical – Key Learning Outcomes**
- Explain different applications of mechatronic systems. - Explain the structure of different types of microcontrollers and their PIN configuration. - Explain the difference between a microprocessor and a microcontroller. - Explain the advantages, disadvantages and applications of microcontrollers. - Explain the interfacing of D/A converters and A/D converters with microcontrollers. - Explain the application of temperature control stepper motor control. - Describe the function of microcontroller structure in hardware interfacing units of the mechatronics system. - State the instruction sets and programming concepts of microprocessor and microcontroller. - State the programming concepts to interface the hardware units with microprocessor and microcontroller. - Explain the architecture of PIN configuration, ARM Processor. - Explain the criteria for selecting an appropriate microcontroller. - Describe the process of digital to analogue and vice versa conversion in a microcontroller. - Describe the process of controlling	- Demonstrate the process of installing the microcontroller as per the standard procedure and linking the function of the microcontroller structure in hardware interfacing units of the mechatronics system. - Demonstrate how to test the microcontroller after installation to ensure it functions as expected. - Demonstrate how to program the microcontroller to execute a specific set of instructions - Demonstrate the process of testing the functioning of the machine using the mechatronics system. - Demonstrate the process of carrying out interfacing of Analog-To-Digital (A/D) and Digital-To-Analog (D/A) converters using the appropriate type of microcontroller. **Demonstrate how to compose and program stepper motor using the appropriate type of microcontroller.** **Demonstrate how to compose and program Advanced RISC Machine (ARM) and microprocessor with the stepper motor.** - Demonstrate the process of carrying out repair and maintenance of microcontrollers.

the temperature with a temperature sensor using a microcontroller circuit.

- Describe the process of interfacing experiments of A/D and D/A using the appropriate type of microprocessor.

- Describe the process of interfacing and programming of Stepper motor using the appropriate type of microcontroller.

- Describe the process of interfacing and programming of the ARM processor with a Stepper Motor.

- Demonstrate how to carry out repair and maintenance of microcontrollers in the mechatronics system.

Classroom Aids

Training Kit (Trainer Guide, Presentations). Whiteboard, Marker, Projector, Laptop

Tools, Equipment and Other Requirements

Common Hand and Power Tools, Such as Hammers, Hoists, Saws, Drills and Wrenches, to Precision Measuring Instruments and Electrical and Electronic Testing Device

Module 5: Soft Skills and Work Ethics
Mapped to ELE/N9905

Terminal Outcomes:

- Work effectively at the workplace.
- Implement the practices related to gender and PwD sensitization.

Duration: 16:00	Duration: 24:00
Theory – Key Learning Outcomes	**Practical – Key Learning Outcomes**
- State the importance of work ethics and workplace etiquette - State the importance of effective communication and interpersonal skills. - Explain ways to maintain discipline at the workplace. - Discuss the common reasons for interpersonal conflict and ways of managing them effectively. - Discuss the importance of following organisational guidelines for dress code, time schedules, language usage and other behavioural aspects. - Explain the importance of working as per the workflow of the organisation to receive instructions and report problems. - Explain the importance of conveying information/instructions as per defined protocols to the authorised persons/team members. - Explain the common workplace guidelines and legal requirements on non-disclosure and confidentiality of business-sensitive information. - Describe the process of reporting grievances and unethical conduct such as data breaches, sexual harassment at the workplace, etc. - Explain the concept and importance of gender sensitivity and equality. - Discuss ways to create sensitivity for different genders and Persons with Disabilities (PwD).	- Develop a sample plan to achieve organisational goals and targets. - Create a sample feedback form to obtain feedback from customers, colleagues etc. - Roleplay to demonstrate the use of professional language and behaviour that is respectful of PwD and all genders. - Apply organisational protocol on data confidentiality and sharing only with the authorised personnel.

• Discuss ways of dealing with heightened emotions of self and others.	

Classroom Aids

Training Kit (Trainer Guide, Presentations). Whiteboard, Marker, Projector, Laptop

Tools, Equipment and Other Requirements

Sample Of Escalation Matrix, Organization Structure.

Module 6: Basic Health and Safety Practice
Mapped to ELE/N1002

Terminal Outcomes:

- Apply health and safety practices at the workplace.

Duration: 16:00	Duration: 24:00
Theory – Key Learning Outcomes	**Practical – Key Learning Outcomes**
- Discuss job-site hazards, risks and accidents. - Explain the organizational safety procedures for maintaining electrical safety, handling tools and hazardous materials. - Elaborate on electronic waste disposal procedures. - Describe the process of disposal of hazardous waste - List the name and location of concerned people, documents and equipment for maintaining health and safety in the workplace. - Describe how to interpret warning signs while accessing sensitive work areas. - Explain the importance of good housekeeping. - Describe the importance of maintaining appropriate postures while lifting heavy objects. - List the types of fire and fire extinguishers. - Explain the importance of efficient utilisation of water, electricity and other resources. - List the common sources of pollution and ways to minimize it. - Describe the concept of waste management and methods of disposing hazardous waste. - Explain various warning and safety signs. - Describe different ways of preventing accidents at the workplace.	- Demonstrate the use of protective equipment suitable as per tasks and work conditions. - Prepare a report to inform the relevant authorities about any abnormal situation/behaviour of any equipment/system. - Administer first aid in case of a minor accident. - Demonstrate the steps to free a person from electrocution safely. - Administer Cardiopulmonary Resuscitation (CPR). - Demonstrate the application of defined emergency procedures such as raising alarm, safe/efficient, evacuation, moving injured people, etc. - Prepare a sample incident report. - Use a fire extinguisher in case of a fire incident. - Demonstrate the correct method of lifting and handling heavy objects.

Classroom Aids

Training Kit (Trainer Guide, Presentations). Whiteboard, Marker, Projector, Laptop

Tools, Equipment and Other Requirements

Personal Protection Equipment: Safety Glasses, Head Protection, Rubber Gloves, Safety Footwear, Warning Signs and Tapes, Fire Extinguisher, First Aid Kit, Fire Extinguishers and Warning Signs.

Module 7: On-the-Job Training
Mapped to Mechatronics Maintenance Specialist

Mandatory Duration: 00:00	Recommended Duration: 200:00
Location: On-Site	

Terminal Outcomes

1. Explain the basics of the mechatronics system and its scope in the automation sector.
2. Explain the traditional vs. mechatronics approach.
3. Explain different types of circuits used in mechatronic devices.
4. Explain the logic functions used in the pneumatic system.
5. Set up circuits, electrical components and pneumatic system.
6. Carry out maintenance of the circuits, electrical components and pneumatic system.
7. Install, test and use the sensors and actuators.
8. Carry out repair and maintenance of sensors and actuators.
9. Install, test and use the microcontroller.
10. Carry out repair and maintenance of microcontrollers.
11. Maintain a healthy, safe and secure working environment.

Annexure

Trainer Requirements

Trainer Prerequisites						
Minimum Educational Qualification	**Specialization**	**Relevant Industry Experience**		**Training Experience**		**Remarks**
		Years	*Specialization*	*Years*	*Specialization*	
Diploma/ Degree in Electrical or Electronics	I.T.I/ Industrial Automation/ Engineering	3	Mechatronics Maintenance Specialist	2	Electronics	

Trainer Certification	
Domain Certification	**Platform Certification**
"Mechatronics Maintenance Specialist", "ELE/Q7105, v1.0", Minimum accepted score is 80%	"Trainer", "MEP/Q2601" with the scoring of a minimum of 80%

Assessor Requirements

Assessor Prerequisites						
Minimum Educational Qualification	**Specialization**	**Relevant Industry Experience**		**Training/Assessment Experience**		**Remarks**
		Years	*Specialization*	*Years*	*Specialization*	
Diploma/ Degree in Electrical or Electronics	I.T.I/ Industrial Automation/ Engineering	5	Mechatronics Maintenance Specialist	2	Electronics	

Assessor Certification	
Domain Certification	**Platform Certification**
"Mechatronics Maintenance Specialist", "ELE/Q7105, v1.0", Minimum accepted score is 80%	"Assessor", "MEP/Q2701" with the scoring of a minimum 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

   - The assessment agency deploys the ToA certified Assessor for executing the assessment

   - SSC monitors the assessment process & records

2. Testing Environment

   To ensure a conducive environment for conducting a test, the trainer will:

   - 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 10 a.m. and 5 p.m.

   - Ensure there are 2 assessors if the batch size is more than 30.

   - 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 levels 1 to 3 are for the unskilled & semi-skilled individuals, and levels 4 and above are for the skilled, supervisor & higher management

   - The assessor must be ToA certified & the trainer must be ToT Certified

   - The 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:

   To verify the details submitted by the training centre, the assessor will undertake:

   - A surprise visit to the assessment location

   - A random audit of the batch

   - A random audit of any candidate

6. Method for assessment documentation, archiving, and access

   To protect the assessment papers and information, the assessor will ensure:

   - Hard copies of the documents are stored

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Skilling India in Electronics

Skill India

NSDC
National Skill Development Corporation
Transforming the skill landscape

- 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 drive

References

Glossary

Term	Description
Declarative knowledge	Declarative knowledge refers to facts, concepts and principles that need to be known and/or understood to accomplish a task or to solve a problem.
Key Learning	The 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 application).
OJT (M)	On-the-job training (Mandatory); trainees are mandated to complete specified hours of training on the site
OJT (R)	On-the-job training (Recommended); trainees are recommended the specified hours of training on the site
Procedural Knowledge	Procedural knowledge addresses how to do something, or how to perform a
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	The 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.

Acronyms and Abbreviations

Term	Description
A/D	Analog-To-Digital
ARM	Advanced RISC Machine
CPR	Cardiopulmonary Resuscitation
D/A	Digital-To-Analog
NCO	National Occupational Standards
NOS	National Skills Qualification Committee
NSQF	National Skills Qualification Framework
OJT	On-the-Job Training
PC	Performance Criteria
PwD	Persons with Disabilities
QP	Qualification Pack
SaaS	Software-as-a-Service
SDMS	Skill Development & Management System
SIP	Skill India Portal
SME	Small and Medium Enterprises
SOP	Standard Operating Procedure
SSC	Sector Skill Council
TC	Trainer Certificate
ToA	Training of Assessors
ToT	Training of Trainers
TP	Training Provider