TRAINING REGULATIONS

MECHATRONICS SERVICING NC III

ELECTRICAL & ELECTRONICS SECTOR

TECHNICAL EDUCATION AND SKILLS DEVELOPMENT AUTHORITY
East Service Road, South Superhighway, Taguig City, Metro Manila

Technical Education and Skills Development Act of 1994
(Republic Act No. 7796)

Section 22, "Establishment and Administration of the National Trade Skills Standards" of the RA 7796 known as the TESDA Act mandates TESDA to establish national occupational skill standards. The Authority shall develop and implement a certification and accreditation program in which private industry group and trade associations are accredited to conduct approved trade tests, and the local government units to promote such trade testing activities in their respective areas in accordance with the guidelines to be set by the Authority.

The Training Regulations (TR) serve as basis for the:

1 Competency assessment and certification;
2 Registration and delivery of training programs; and
3 Development of curriculum and assessment instruments.

Each TR has four sections:

Section 1 Definition of Qualification - refers to the group of competencies that describes the different functions of the qualification.

Section 2 Competency Standards - gives the specifications of competencies required for effective work performance.

Section 3 Training Arrangements - contains information and requirements in designing training program for certain Qualification. It includes curriculum design, training delivery; trainee entry requirements; tools and requirements; tools and equipment; training facilities and trainer's qualification.

Section 4 Assessment and Certification Arrangements - describes the policies governing assessment and certification procedure

TABLE OF CONTENTS

ELECTRICAL & ELECTRONICS SECTOR

MECHATRONICS SERVICING

NATIONAL CERTIFICATE LEVEL III

TRAINING REGULATIONS FOR MECHATRONICS SERVICING NC III

SECTION 1: MECHATRONICS SERVICING NC III QUALIFICATIONS

The Mechatronics Servicing NC III Qualification consists of competencies that must be possess to enable a person to develop mechatronics and automation control circuits and PLC software programs, develop motion control and system configuration on mechatronics and automation system as well as to maintain and repair PLC-based mechatronics and automation devices.

This Qualification is packaged from the competency map of the Electrical & Electronics Industry Sector as shown in Annex A.

The units of competency comprising this qualification include the following:

Code	BASIC COMPETENCIES
5 00 311 1 09	Lead workplace communication
5 00 311 1 10	Lead small teams
5 00 311 1 11	Develop and practice negotiation skills
5 00 311 1 12	Solve problems related to work activities
5 00 311 1 13	Use mathematical concepts and techniques
5 00 311 1 14	Use relevant technologies

Code	COMMON COMPETENCIES
ELC311205	Use Hand Tools
ELC311201	Perform Mensuration and Calculation
ELC311202	Prepare and Interpret Technical Drawing
ELC311204	Apply Quality Standards
ELC311203	Perform Computer Operations
ELC311206	Terminate and Connect Electrical Wiring and Electronic Circuits
ELC311209	Test Electronic Components

Code	CORE COMPETENCIES
ELC311303	Develop Mechatronics and Automation Control Circuits and PLC Application Programs
ELC311304	Develop Motion Control and System Configuration
ELC311305	Maintain and Repair PLC-based Mechatronics and Automation System

A person who has achieved this Qualification is competent to be an:

- Mechatronics and Automation Programmer-Technician

SECTION 2: COMPETENCY STANDARDS

This section gives the details of the contents of the basic, common, and core units of competency required for Mechatronics Servicing NC III.

BASIC COMPETENCIES

UNIT OF COMPETENCY : LEAD WORKPLACE COMMUNICATION

UNIT CODE : 500311109

UNIT DESCRIPTOR : This unit covers the knowledge, skills and attitudes required to lead in the dissemination and discussion of ideas, information and issues in the workplace.

ELEMENT	PERFORMANCE CRITERIA ***Italicized*** terms are elaborated in the Range of Variables	REQUIRED KNOWLEDGE	REQUIRED SKILLS
1. Communicate information about workplace processes	1.1. Appropriate ***communication method*** is selected 1.2. Multiple operations involving several topics areas are communicated accordingly 1.3. Questions are used to gain extra information 1.4. Correct sources of information are identified 1.5. Information is selected and organized correctly 1.6. Verbal and written reporting is undertaken when required 1.7. Communication skills are maintained in all situations	• Organization requirements for written and electronic communication methods • Effective verbal communication methods • Methods of Communication • Types of Question • Communication Tools • Questioning Techniques	• Organizing information • Understanding and conveying intended meaning • Participating in variety of workplace discussions • Complying with organization requirements for the use of written and electronic communication methods • Reporting occupational hazards during safety meeting
2. Lead workplace discussions	1.1. Response to workplace issues are sought 1.2. Response to workplace issues are provided immediately 1.3. Constructive contributions are made to workplace discussions on such issues as production, quality and safety 1.4. Goals/objectives and action plan are undertaken in the workplace are communicated	• Leading as a management function • Barriers of communication • Effective verbal communication methods • Method/techniques of discussion • How to lead discussion	• Communicating effectively • Consulting the crew on the prepared menu for the month

ELEMENT	PERFORMANCE CRITERIA ***Italicized*** terms are elaborated in the Range of Variables	REQUIRED KNOWLEDGE	REQUIRED SKILLS
		• How to solicit response • Goal setting and action planning	
3. Identify and communicate issues arising in the workplace	3.1 Issues and problems are identified as they arise 3.2 Information regarding problems and issues are organized coherently to ensure clear and effective communication 3.3 Dialogue is initiated with appropriate personnel 3.4 Communication problems and issues are raised as they arise	• Types of issues and problems in the workplace • Written and electronic communication methods • Communication barriers affecting workplace discussions	• Identifying cause of problems • Identifying problems and issues • Organizing information on problems and issues • Relating problems and issues in the workplace

RANGE OF VARIABLES

VARIABLE	RANGE
1. Methods of communication	1.1. Non-verbal gestures 1.2. Verbal 1.3. Face to face 1.4. Two-way radio 1.5. Speaking to groups 1.6. Using telephone 1.7. Written 1.8. Internet

EVIDENCE GUIDE

1. Critical aspects of Competency	Assessment requires evidence that the candidate: 1.1. Dealt with a range of communication/information at one time 1.2. Made constructive contributions in workplace issues 1.3. Sought workplace issues effectively 1.4. Responded to workplace issues promptly 1.5. Presented information clearly and effectively written form 1.6. Used appropriate sources of information 1.7. Asked appropriate questions 1.8. Provided accurate information
2. Resource Implications	The following resources **MUST** be provided: 2.1. Variety of Information 2.2. Communication tools 2.3. Simulated workplace
3. Methods of Assessment	Competency may be assessed through: 3.1. Competency in this unit must be assessed through 3.2. Direct Observation 3.3. Interview
4. Context for Assessment	4.1. Competency may be assessed in the workplace or in simulated workplace environment

UNIT OF COMPETENCY : LEAD SMALL TEAMS

UNIT CODE : 500311110

UNIT DESCRIPTOR : This unit covers the knowledge, skills and attitudes to lead small teams including setting and maintaining team and individual performance standards.

ELEMENT	PERFORMANCE CRITERIA ***Italicized*** terms are elaborated in the Range of Variables	REQUIRED KNOWLEDGE	REQUIRED SKILLS
1. Provide team leadership	1.1. ***Work requirements*** are identified and presented to team members 1.2. Reasons for instructions and requirements are communicated to team members 1.3. ***Team members' queries and concerns*** are recognized, discussed and dealt with	• Company policies and procedures • How performance expectations are set • Methods of Monitoring Performance • Client expectations • Team member's duties and responsibilities • Definition of Team • Skills and techniques in promoting team building • Up-to-date dissemination of instructions and requirements to members • Art of listening and treating individual team members concern	• Communication skills required for leading teams • Team building skills • Negotiating skills • Evaluation skills
2. Assign responsibilities	2.1 Duties and responsibilities are allocated having regard to the skills, knowledge and aptitude required to properly undertake the assigned task and according to company policy 2.2 Duties are allocated having regard to individual preference, domestic and personal considerations, whenever possible	• Concept of delegation • How to delegate • Understanding individual differences • Methods of monitoring performance • Duties and responsibilities of each team member • Knowledge in identifying each team member duties and responsibilities	• Delegating skills • Identifying individual skills, knowledge and attitude as basis for allocating responsibilities • Identifying each team member duties and responsibilities
3. Set performance expectations for team members	3.1 Performance expectations are established based on client needs and according to assignment requirements 3.2 Performance expectations are based on individual team members duties and area of responsibility	• Definition of performance indicators/ criteria • Definition of team goals and expectations • Methods of monitoring performance	• Identifying performance indicators • Evaluating performance • Setting individual performance

ELEMENT	PERFORMANCE CRITERIA ***Italicized*** terms are elaborated in the Range of Variables	REQUIRED KNOWLEDGE	REQUIRED SKILLS
	3.3 Performance expectations are discussed and disseminated to individual team members	• Client expectations • Team members duties and responsibilities • Defining performance expectations criteria	target/ expectation indicators
4. Supervised team performance	4.1 ***Monitoring of performance*** takes place against defined performance criteria and/or assignment instructions and corrective action taken if required 4.2 Team members are provided with ***feedback***, positive support and advice on strategies to overcome any deficiencies 4.3 ***Performance issues*** which cannot be rectified or addressed within the team are referenced to appropriate personnel according to employer policy 4.4 Team members are kept informed of any changes in the priority allocated to assignments or tasks which might impact on client/customer needs and satisfaction 4.5 Team operations are monitored to ensure that employer/client needs and requirements are met 4.6 Follow-up communication is provided on all issues affecting the team 4.7 All relevant documentation is completed in accordance with company procedures	• Understanding Monitoring of work • How to undertake corrective action • Understanding feedback and procedure • Feedback reporting procedure • Methods of monitoring performance • Team member's duties and responsibilities • Monitoring team operation to ensure client needs and satisfaction	• Monitoring skills • Setting priorities • Evaluating performance • Informal/ formal counseling skills

RANGE OF VARIABLES

VARIABLE	RANGE
1. Work requirements	1.1. Client Profile 1.2. Assignment instructions
2. Team member's concerns	2.1. Roster/shift details
3. Monitor performance	3.1. Formal process 3.2. Informal process
4. Feedback	4.1. Formal process 4.2. Informal process
5. Performance issues	5.1. Work output 5.2. Work quality 5.3. Team participation 5.4. Compliance with workplace protocols 5.5. Safety 5.6. Customer service

EVIDENCE GUIDE

1. Critical aspects of Competency	Assessment requires evidence that the candidate: 1.1. Maintained or improved individuals and/or team performance given a variety of possible scenario 1.2. Assessed and monitored team and individual performance against set criteria 1.3. Represented concerns of a team and individual to next level of management or appropriate specialist and to negotiate on their behalf 1.4. Allocated duties and responsibilities, having regard to individual's knowledge, skills and aptitude and the needs of the tasks to be performed 1.5. Set and communicated performance expectations for a range of tasks and duties within the team and provided feedback to team members
2. Resource Implications	The following resources **MUST** be provided: 2.1. Access to relevant workplace or appropriately simulated environment where assessment can take place 2.2. Materials relevant to the proposed activity or task
3. Methods of Assessment	Competency may be assessed through: 3.1. Direct observations of work activities of the individual member in relation to the work activities of the group 3.2. Observation of simulation and/or role play involving the participation of individual member to the attainment of organizational goal 3.3. Case studies and scenarios as a basis for discussion of issues and strategies in teamwork
4. Context for Assessment	4.1. Competency assessment may occur in workplace or any appropriately simulated environment 4.2. Assessment shall be observed while task are being undertaken whether individually or in-group

UNIT OF COMPETENCY: DEVELOP AND PRACTICE NEGOTIATION SKILLS

UNIT CODE : 500311111

UNIT DESCRIPTOR : This unit covers the skills, knowledge and attitudes required to collect information in order to negotiate to a desired outcome and participate in the negotiation.

ELEMENT	PERFORMANCE CRITERIA ***Italicized*** terms are elaborated in the Range of Variables	REQUIRED KNOWLEDGE	REQUIRED SKILLS
1. Plan negotiations	1.1 Information on ***preparing for negotiation*** is identified and included in the plan 1.2 Information on creating ***nonverbal environments*** for positive negotiating is identified and included in the plan 1.3 Information on ***active listening*** is identified and included in the plan 1.4 Information on different ***questioning techniques*** is identified and included in the plan 1.5 Information is checked to ensure it is correct and up-to- date	• Knowledge on Codes of practice and guidelines for the organization • Knowledge of organizations policy and procedures for negotiations • Decision making and conflict resolution strategies procedures • Concept of negotiation	• Communication skills (verbal and listening) • Active listening • Setting conflict • Preparing conflict resolution • Problem solving strategies on how to deal with unexpected questions and attitudes during negotiation • Interpersonal skills to develop rapport with other parties
2. Participate in negotiations	2.1 Criteria for successful outcome are agreed upon by all parties 2.2 Desired outcome of all parties are considered 2.3 Appropriate language is used throughout the negotiation 2.4 A variety of questioning techniques are used 2.5 The issues and processes are documented and agreed upon by all parties 2.6 Possible solutions are discussed and their viability assessed 2.7 Areas for agreement are confirmed and recorded 2.8 Follow-up action is agreed upon by all parties	• Outcome of negotiation • Knowledge on Language • Different Questioning techniques • Problem solving strategies on how to deal with unexpected questions and attitudes during negotiation	• Negotiating skill • Communication skills (verbal and listening) • Observation skills • Interpersonal skills to develop rapport with other parties • Applying effective questioning techniques • Setting conflict

RANGE OF VARIABLES

VARIABLE	RANGE
1. Preparing for negotiation	1.1 Background information on other parties to the negotiation 1.2 Good understanding of topic to be negotiated 1.3 Clear understanding of desired outcome/s 1.4 Personal attributes 1.4.1 self awareness 1.4.2 self esteem 1.4.3 objectivity 1.4.4 empathy 1.4.5 respect for others 1.5 Interpersonal skills 1.5.1 listening/reflecting 1.5.2 non verbal communication 1.5.3 assertiveness 1.5.4 behavior labeling 1.5.5 testing understanding 1.5.6 seeking information 1.5.7 self disclosing 1.6 Analytic skills 1.6.1 observing differences between content and process 1.6.2 identifying bargaining information 1.6.3 applying strategies to manage process 1.6.4 applying steps in negotiating process 1.6.5 strategies to manage conflict 1.6.6 steps in negotiating process 1.6.7 options within organization and externally for resolving conflict
2. Non verbal environments	2.1 Friendly reception 2.2 Warm and welcoming room 2.3 Refreshments offered 2.4 Lead in conversation before negotiation begins
3. Active listening	3.1 Attentive 3.2 Don't interrupt 3.3 Good posture 3.4 Maintain eye contact 3.5 Reflective listening
4. Questioning techniques	4.1 Direct 4.2 Indirect 4.3 Open-ended

EVIDENCE GUIDE

1. Critical aspects of Competency	Assessment requires evidence that the candidate: 1.1 Demonstrated sufficient knowledge of the factors influencing negotiation to achieve agreed outcome 1.2 Participated in negotiation with at least one person to achieve an agreed outcome
4. Resource Implications	The following resources **MUST** be provided: 4.1 Room with facilities necessary for the negotiation process 4.2 Human resources (negotiators)
5. Methods of Assessment	Competency may be assessed through: 5.1 Observation/demonstration and questioning 5.2 Portfolio assessment 5.3 Oral and written questioning 5.4 Third party report
6. Context for Assessment	6.1 Competency to be assessed in real work environment or in a simulated workplace setting.

UNIT OF COMPETENCY : SOLVE PROBLEMS RELATED TO WORK ACTIVITIES
UNIT CODE : 500311112
UNIT DESCRIPTOR : This unit of covers the knowledge, skills and attitudes required to solve problems in the workplace including the application of problem solving techniques and to determine and resolve the root cause of problems.

ELEMENT	PERFORMANCE CRITERIA ***Italicized*** terms are elaborated in the Range of Variables	REQUIRED KNOWLEDGE	REQUIRED SKILLS
1. Identify the problem	1.1. Variances are identified from normal operating parameters; and product quality 1.2. Extent, cause and nature of the problem are defined through observation, investigation and ***analytical techniques*** 1.3. ***Problems*** are clearly stated and specified	• Competence includes a thorough knowledge and understanding of the process, normal operating parameters, and product quality to recognize non-standard situations • Competence to include the ability to apply and explain, sufficient for the identification of fundamental cause, determining the corrective action and provision of recommendations o Relevant equipment and operational processes o Enterprise goals, targets and measures o Enterprise quality, OHS and environmental requirement o Enterprise information systems and data collation o Industry codes and standards • Normal operating parameters and product quality • Identifying and clarifying the nature of problem	• Using range of formal problem solving techniques • Identifying and clarifying the nature of the problem • Evaluating the effectiveness of a present process in the workplace • Applying analytical techniques
2. Determine fundamental causes of the problem	2.1 Possible causes are identified based on experience and the use of problem solving tools / analytical techniques. 2.2 Possible cause statements are developed based on	• Relevant equipment and operational processes • Enterprise goals, targets and measures • Enterprise quality, OHS and environmental requirements	• Analysis of root causes

ELEMENT	PERFORMANCE CRITERIA ***Italicized*** terms are elaborated in the Range of Variables	REQUIRED KNOWLEDGE	REQUIRED SKILLS
	findings 2.3 Fundamental causes are identified per results of investigation conducted	• Enterprise information systems and data collation • Industry codes and standards	
3. Determine corrective action	3.1 All possible options are considered for resolution of the problem 3.2 Strengths and weaknesses of possible options are considered 3.3 Corrective actions are determined to resolve the problem and possible future causes 3.4 **Action *plans*** are developed identifying measurable objectives, resource needs and timelines in accordance with safety and operating procedures	• Understanding the procedure in undertaking corrective action • Principles of decision making strategies and techniques • Enterprise information systems and data collation • Action planning	• Identifying and clarifying the nature of the problem • Devising the best solution • Evaluating the solution • Implementing developed plan to rectify the problem • Implementing corrective and preventive actions based on root cause analysis
4. Provide recommendation/s to manager	4.1 Report on recommendations is prepared according to procedures. 4.2 Recommendations are presented to appropriate personnel. 4.3 Recommendations are followed-up, if required	• How to make a report and recommendation	• Writing report and recommendations

RANGE OF VARIABLES

VARIABLE	RANGE
1. Analytical techniques	1.1. Brainstorming 1.2. Intuitions/Logic 1.3. Cause and effect diagrams 1.4. Pareto analysis 1.5. SWOT analysis 1.6. Gant chart, Pert CPM and graphs 1.7. Scatter grams
2. Problem	2.1. Non – routine process and quality problems 2.2. Equipment selection, availability and failure 2.3. Teamwork and work allocation problem 2.4. Safety and emergency situations and incidents
3. Action plans	3.1. Priority requirements 3.2. Measurable objectives 3.3. Resource requirements 3.4. Timelines 3.5. Co-ordination and feedback requirements 3.6. Safety requirements 3.7. Risk assessment 3.8. Environmental requirements

EVIDENCE GUIDE

1. Critical aspects of Competency	Assessment requires evidence that the candidate: 1.1. Identified the problem 1.2. Determined the fundamental causes of the problem 1.3. Determined the correct / preventive action 1.4. Provided recommendation to manager These aspects may be best assessed using a range of scenarios / case studies / what ifs as a stimulus with a walk through forming part of the response. These assessment activities should include a range of problems, including new, unusual and improbable situations that may have happened.
2. Resource Implications	2.1. Assessment will require access to an operating plant over an extended period of time, or a suitable method of gathering evidence of operating ability over a range of situations. A bank of scenarios / case studies / what ifs will be required as well as bank of questions which will be used to probe the reason behind the observable action.
3. Methods of Assessment	Competency may be assessed through: 3.1. Case studies on solving problems in the workplace 3.2. Observation The unit will be assessed in a holistic manner as is practical and may be integrated with the assessment of other relevant units of competency. Assessment will occur over a range of situations, which will include disruptions to normal, smooth operation. Simulation may be required to allow for timely assessment of parts of this unit of competency. Simulation should be based on the actual workplace and will include walk through of the relevant competency components.
4. Context for Assessment	4.1. In all workplace, it may be appropriate to assess this unit concurrently with relevant teamwork or operation units.

UNIT OF COMPETENCY: USE MATHEMATICAL CONCEPTS AND TECHNIQUES

UNIT CODE : 500311113

UNIT DESCRIPTOR : This unit covers the knowledge, skills and attitudes required in the application of mathematical concepts and techniques.

ELEMENT	PERFORMANCE CRITERIA ***Italicized*** terms are elaborated in the Range of Variables	REQUIRED KNOWLEDGE	REQUIRED SKILLS
1. Identify mathematical tools and techniques to solve problem	1.1 Problem areas are identified based on given condition 1.2 ***Mathematical techniques*** are selected based on the given problem	• Fundamental operation (addition, subtraction, division, multiplication) • Units of measurement and its conversion • Fundamental of units • Standard formulas • Basic measuring tools/devices • Measurement system • Basic measuring tools/devices • Steps in solving problem	• Identifying and selecting different measuring tools • Applying different formulas in solving problems • Describing the units of measurement and fundamental units • Stating arithmetic calculations involving the following; addition, subtraction, division, multiplication • Applying theory into actual application on shipboard catering processes
2. Apply mathematical procedure/ solution	2.1 Mathematical techniques are applied based on the problem identified 2.2 Mathematical computations are performed to the level of accuracy required for the problem 2.3 Results of mathematical computation is determined and verified based on job requirements	• Problem-based questions • Estimation • Use of mathematical tools and standard formulas • Mathematical techniques	• Solving mathematical computations • Converting Metric to English • Selecting and using appropriate and efficient techniques and strategies to solve problems
3. Analyze results	3.1 Result of application is reviewed based on expected and required specifications and outcome 3.2 ***Appropriate action*** is applied in case of error	• Techniques in analyzing the results • Process in reviewing the results • Precision and accuracy • Four fundamental operations • Steps in solving problem • Standard formulas • Conversion measurement	• Analyzing the result based on the specified requirements • Interpreting and communicating the results of the analysis

RANGE OF VARIABLES

VARIABLE	RANGE
1. Mathematical techniques	May include but are not limited to: 1.1 Four fundamental operations 1.2 Measurements 1.3 Use/Conversion of units of measurements 1.4 Use of standard formulas
2. Appropriate action	2.1 Review in the use of mathematical techniques (e.g. recalculation, re-modeling) 2.2 Report error to immediate superior for proper action

EVIDENCE GUIDE

1. Critical Aspects of Competency	Assessment requires evidence that the candidate: 1.1 Identified, applied and reviewed the use of mathematical concepts and techniques to workplace problems
4. Resource Implications	The following resources **MUST** be provided: 4.1 Calculator 4.2 Basic measuring tools 4.3 Case Problems
5. Methods of Assessment	Competency may be assessed through: 5.1 Authenticated portfolio 5.2 Written Test 5.3 Interview/Oral Questioning 5.4 Demonstration
6. Context for Assessment	6.1 Competency may be assessed in the work place or in a simulated work place setting

UNIT OF COMPETENCY: USE RELEVANT TECHNOLOGIES

UNIT CODE : 500311114

UNIT DESCRIPTOR : This unit of competency covers the knowledge, skills, and attitude required in selecting, sourcing and applying appropriate and affordable technologies in the workplace.

ELEMENT	PERFORMANCE CRITERIA ***Italicized*** terms are elaborated in the Range of Variables	REQUIRED KNOWLEDGE	REQUIRED SKILLS
1. Study/select appropriate technology	1.1 Usage of different ***technologies*** is determined based on job requirements 1.2 Appropriate technology is selected as per work specification	• Awareness on technology and its function • Communication techniques • Health and safety procedure • Company policy in relation to relevant technology • Machineries/ equipment and their application • Software programs	• Identifying relevant technology on job
2. Apply relevant technology	2.1 Relevant technology is effectively used in carrying out function 2.2 Applicable software and hardware are used as per task requirement 2.3 ***Management concepts*** are observed and practiced as per established industry practices	• Knowledge on operating instructions • Understanding software and hardware system • Communication techniques • Health and safety procedure • Company policy in relation to relevant technology • Different management concepts • Technology adaptability	• Applying relevant technology • Communicating skills • Using software applications skills • Conducting risk assessment
3. Maintain/ enhance relevant technology	3.1 Maintenance of technology is applied in accordance with the ***industry standard operating procedure***, ***manufacturer's operating guidelines*** and ***occupational health and safety procedure*** to ensure its operative ability 3.2 Updating of technology is maintained through	• Awareness on technology and its function • Repair and maintenance procedure • Health and safety procedure • Company policy in relation to relevant technology	• Performing basic troubleshooting skills • Identifying failures or defects • Communication skills • Applying corrective and preventive maintenance

ELEMENT	PERFORMANCE CRITERIA ***Italicized*** terms are elaborated in the Range of Variables	REQUIRED KNOWLEDGE	REQUIRED SKILLS
	continuing education or training in accordance with job requirement 3.3 Technology failure/ defect is immediately reported to the concern/responsible person or section for ***appropriate action***	• Upgrading of technology • Organizational set-up/work flow	

RANGE OF VARIABLES

VARIABLE	RANGE
1. Technology	May include but are not limited to: 1.1 Office technology 1.2 Industrial technology 1.3 System technology 1.4 Information technology 1.5 Training technology
2. Management concepts	May include but not limited to: 2.1 Real Time Management 2.2 KAIZEN or continuous improvement 2.3 5s 2.4 Total Quality Management 2.5 Other management/productivity tools
3. Industry standard operating procedure	3.1 Written guidelines relative to the usage of office technology/equipment 3.2 Verbal advise/instruction from the co-worker
4. Manufacturer's operating guidelines/ instructions	4.1 Written instruction/manuals of specific technology/ equipment 4.2 General instruction manual 4.3 Verbal advise from manufacturer relative to the operation of equipment
5. Occupational health and safety procedure	5.1 Relevant statutes on OHS 5.2 Company guidelines in using technology/equipment
6. Appropriate action	6.1 Implementing preventive maintenance schedule 6.2 Coordinating with manufacturer's technician

EVIDENCE GUIDE

1. Critical aspects of Competency	Assessment requires evidence that the candidate: 1.1 Studied and selected appropriate technology consistent with work requirements 1.2 Applied relevant technology 1.3 Maintained and enhanced operative ability of relevant technology
2. Resource Implications	The following resources **MUST** be provided: 2.1 Relevant technology 2.2 Interview and demonstration questionnaires 2.3 Assessment packages
3. Methods of Assessment	Competency must be assessed through: 3.1 Interview 3.2 Actual demonstration 3.3 Authenticated portfolio (related certificates of training/seminar)
4. Context for Assessment	4.1 Competency may be assessed in actual workplace or simulated environment

COMMON COMPETENCIES

UNIT TITLE : USE HAND TOOLS
UNIT CODE : ELC311205
UNIT DESCRIPTOR : This unit covers the knowledge, skills and attitudes on the safe use, handling and maintenance of tools.

ELEMENT	PERFORMANCE CRITERIA ***Italicized*** terms are elaborated in the Range of Variables	REQUIRED KNOWLEDGE	REQUIRED SKILLS
1. Plan and prepare for tasks to be undertaken	1.1. Tasks to be undertaken are properly identified 1.2. Appropriate ***hand tools*** are identified and selected according to the task requirements	• Planning and preparing task/activity • Electronics hand tools and their uses • Function, operation and common faults in electronics hand tools	• Preparing required tasks • Communication skills • Using hand tools properly
2. Prepare hand tools	2.1. Appropriate hand tools are checked for proper operation and safety 2.2. Unsafe or faulty tools are identified and marked for repair according to standard company procedure	• Checking and safety requirements in handling tools • Standard procedures in checking, identification and marking of safe or unsafe/ faulty tools	• Identifying and checking hand tools • Marking of safe or unsafe/ faulty hand tools

3. Use appropriate hand tools and test equipment	3.1. Tools are used according to tasks undertaken
	3.2. All safety procedures in using tools are observed at all times and appropriate ***personal protective equipment*** (PPE) are used
	3.3. Malfunctions, unplanned or unusual events are reported to the supervisor
		• Safety requirements in using electronics hand tools and test equipment
		• Electronics hand tools for adjusting, dismantling, assembling, finishing, and cutting.
		• Processes, Operations, Systems
		  ○ Proper usage and care of hand tools
		  ○ Types and uses of test equipment
		• Common faults in the use of hand tools
			• Reading skills required to interpret work instruction and numerical skills
			• Using PPE properly
			• Problem solving in emergency situation

4. Maintain hand tools	4.1. Tools are handled without damage according to procedures.
	4.2. Routine ***maintenance*** of tools is undertaken according to standard operational procedures, principles and techniques
	4.3. Tools are stored safely in appropriate locations in accordance with manufacturer's specifications or standard operating procedures
		• Safety requirements in maintenance of hand tools
		• Processes, Operations, Systems
		  ○ Maintenance of tools
		  ○ Storage of hand tools
			• Checking and cleaning hand tools
			• Storing hand tools properly

RANGE OF VARIABLES

VARIABLE	RANGE
1. Hand tools	1.1. Hand tools for adjusting, dismantling, assembling, finishing, and cutting. Tool set includes the following but not limited to: screw drivers, pliers, punches, wrenches, files
2. Personal Protective Equipment (PPE)	2.1. Gloves 2.2. Protective eyewear 2.3. Apron/overall
3. Maintenance	3.1. Cleaning 3.2. Lubricating 3.3. Tightening 3.4. Simple tool repairs 3.5. Hand sharpening 3.6. Adjustment using correct procedures

EVIDENCE GUIDE

1. Critical aspect of competency	Assessment requires evidence that the candidate: 1.1. Demonstrated safe working practices at all times 1.2. Communicated information about processes, events or tasks being undertaken to ensure a safe and efficient working environment 1.3. Planned tasks in all situations and reviewed task requirements as appropriate 1.4. Performed all tasks to specification 1.5. Maintained and stored tools in appropriate location
2. Method of assessment	Competency in this unit must be assessed through: 2.1. Observation 2.2. Oral questioning
3. Resource Implication	3.1. Tools may include the following but not limited to: 3.1.1. screw drivers 3.1.2. pliers 3.1.3. punches 3.1.4. wrenches, files
4. Context of Assessment	4.1. Assessment may be conducted in the workplace or in a simulated environment

UNIT TITLE : PERFORM MENSURATION AND CALCULATION
UNIT CODE : ELC311201
UNIT DESCRIPTOR : This unit covers the knowledge, skills and attitudes and values needed identify, care, handle and use measuring instruments

ELEMENT	PERFORMANCE CRITERIA ***Italicized Bold*** terms are elaborated in the Range of Variables	REQUIRED KNOWLEDGE	REQUIRED SKILLS
1. Select measuring instruments	1.1. Object or component to be measured is identified 1.2. Correct specifications are obtained from relevant source 1.3. Measuring tools are selected in line with job requirements	• Category of measuring instruments • Types and uses of measuring instruments • Shapes and Dimensions • Formulas for volume, areas, perimeters of plane and geometric figures	• Identifying and selecting measuring instruments • Visualizing objects and shapes
2. Carry out measurements and calculation	2.1. Appropriate ***measuring instrument*** is selected to achieve required outcome 2.2. Accurate measurements are obtained for job 2.3. ***Calculation*** needed to complete work tasks are performed using the four basic process of addition (+), subtraction (-), multiplication (x), and division (/) 2.4. Calculation involving fractions, percentages and mixed numbers are used to complete workplace tasks. 2.5. Numerical computation is self-checked and corrected for accuracy 2.6. Instruments are read to the limit of accuracy of the tool	• Calculation & measurement • Four fundamental operation • Linear measurement • Dimensions • Unit conversion • Ratio and proportion	• Performing calculation by addition, subtraction, multiplication and division; • Interpreting formulas for volume, areas, perimeters of plane and geometric figures • Handling of measuring instruments
3. Maintain measuring instruments	3.1. Measuring instruments are not dropped to avoid damage 3.2. Measuring instruments are cleaned before and after using. 3.3. Proper storage of instruments undertaken according to manufacturer's specifications and standard operating procedures.	• Types of measuring instruments and their uses • Safe handling procedures in using measuring instruments • Four fundamental operation of mathematics • Formula for volume, area, perimeter and other geometric figures	• Handling and maintaining measuring instruments

RANGE OF VARIABLES

VARIABLE	RANGE
1. Measuring instruments	1.1. Straight edge 1.2. Torque gauge 1.3. Try square 1.4. Protractor 1.5. Combination gauge 1.6. Steel rule
2. Calculation	Kinds of part mensuration includes the following but not limited to: 2.1. Volume 2.2. Area 2.3. Displacement 2.4. Inside diameter 2.5. Circumference 2.6. Length 2.7. Thickness 2.8. Outside diameter 2.9. Taper 2.10. Out of roundness

EVIDENCE GUIDE

1. Critical aspect of competency	Assessment requires evidence that the candidate: 1.1. Selected proper measuring instruments according to tasks 1.2. Carried out measurement and calculations 1.3. Maintained and stores instruments
2. Method of assessment	Competency in this unit must be assessed through: 2.1. Observation 2.2. Oral questioning
3. Resource implication	3.1. Place of assessment 3.2. Measuring instruments 3.3. Straight edge 3.4. Torque gauge 3.5. Try square 3.6. Protractor 3.7. Combination gauge 3.8. Steel rule
4. Context of Assessment	4.1. Assessment may be conducted in the workplace or in a simulated environment

UNIT TITLE : PREPARE AND INTERPRET TECHNICAL DRAWING

UNIT CODE : ELC311202

UNIT DESCRIPTOR : This unit covers the knowledge, skills and attitudes and values needed to prepare/interpret diagrams, engineering abbreviation and drawings, symbols, dimension.

ELEMENT	PERFORMANCE CRITERIA ***Italicized*** terms are elaborated in the Range of Variables	REQUIRED KNOWLEDGE	REQUIRED SKILLS
1. Identify different kinds of technical drawings	1.1. Correct ***technical drawing*** is selected according to job requirements. 1.2. Technical drawings are segregated in accordance with the types and kinds of drawings	• Types of technical drawings • Applications for technical drawing • Methods of technical drawings • Symbols • Mark up/ Notation of Drawings	• Reading skills required to interpret work instruction • Interpreting electrical/ electronic signs and symbols
2. Interpret technical drawing	2.1. Components, assemblies or objects are recognized as required. 2.2. ***Dimensions*** of the key features of the objects depicted in the drawing are correctly identified. 2.3. ***Symbols*** used in the drawing are identified and interpreted correctly. 2.4. Drawing is checked and validated against job requirements or equipment in accordance with standard operating procedures.	• Trade Mathematics o Linear measurement o Dimension o Unit conversion • Blueprint Reading and Plan Specification o Architectural, electrical, electronics, mechanical plan, symbols and abbreviations o Drawing standard symbols • Trade Theory o Basic technical drawing o Types technical plans o Various types of drawings o Notes and specifications	• Interpreting drawing/ orthographic drawing • Interpreting technical plans • Matching specification details with existing resources • Safety handling of drawing instruments
3. Prepare/ make changes to electrical/ electronic schematics and drawings	3.1. Electrical/electronic schematic is drawn and correctly identified. 3.2. Correct drawing is identified, equipment are selected and used in accordance with job requirements.	• Drawing conventions • Dimensioning Conventions • Mathematics o Four fundamental operations o Percentage o Fraction o Algebra o Geometry	• Reading skills required to interpret work instruction • Communication skills • Preparing/ Making electrical/ electronic signs and symbols • Computing formulas

ELEMENT	PERFORMANCE CRITERIA ***Italicized*** terms are elaborated in the Range of Variables	REQUIRED KNOWLEDGE	REQUIRED SKILLS
4. Store technical drawings and equipment / instruments	4.1. Care and maintenance of drawings are undertaken according to company procedures. 4.2. Technical drawings are recorded and inventory is prepared in accordance with company procedures. 4.3. Proper storage of instruments is undertaken according to company procedures.	• Effective ways to catalogue and store technical drawings • Manual methods of handling, storing and maintaining paper drawings • Storing drawing in digital forms ○ Scanner ○ CAD	• Handling and storing of drawings • Scanning and storing drawings in digital form • Matching specification details with existing resources • Handling of drawing instruments

RANGE OF VARIABLES

VARIABLE	RANGE
1. Technical drawings	Technical drawings include the following but not limited to: 1.1. Schematic diagrams 1.2. Charts 1.3. Block diagrams 1.4. Lay-out plans 1.5. Location plans 1.6. Process and instrumentation diagrams 1.7. Loop diagrams 1.8. System Control Diagrams
2. Dimensions	Dimensions may include but not limited to: 2.1. Length 2.2. Width 2.3. Height 2.4. Diameter 2.5. Angles
3. Symbols	May include but not limited to: 3.1. NEC- National Electric Code 3.2. IEC -International Electrotechnical Commission 3.3. ASME - American Society of Mechanical Engineers 3.4. IEEE - Institute of Electrical and Electronics Engineers 3.5. ISA - Instrumentation System and Automation Society
4. Instruments/Equipment	4.1. Components/dividers 4.2. Drawing boards 4.3. Rulers 4.4. T-square 4.5. Calculator

EVIDENCE GUIDE

1. Critical aspect of competencies	Assessment requires evidence that the candidate: 1.1. selected correct technical drawing in line with job requirements 1.2. correctly identified the objects represented in the drawing 1.3. identified and interpreted symbols used in the drawing correctly 1.4. prepared/produced electrical/electronic drawings including all relevant specifications 1.5. stored diagrams/equipment
2. Method of assessment	Competency in this unit must be assessed through: 2.1. Practical tasks involving interpretation of a range of technical drawings 2.2. Oral questioning
3. Resource implication	3.1. Drawings 3.2. Diagrams 3.3. Charts 3.4. Plans
4. Context of Assessment	Assessment may be conducted in the workplace or in a simulated work environment

UNIT TITLE : APPLY QUALITY STANDARDS

UNIT CODE : ELC311204

UNIT DESCRIPTOR : This unit covers the knowledge, skills, (and) attitudes and values needed to apply quality standards in the workplace. The unit also includes the application of relevant safety procedures and regulations, organization procedures and customer requirements

ELEMENT	PERFORMANCE CRITERIA ***Italicized Bold*** terms are elaborated in the Range of Variables	REQUIRED KNOWLEDGE	REQUIRED SKILLS
1. Assess quality of received materials or components	1.1. Work instructions are obtained and work is carried out in accordance with standard operating procedures 1.2. Received ***materials or component parts*** are checked against workplace standards and specifications 1.3. Faulty material or components related to work are identified and isolated 1.4. ***Faults*** and any identified causes are recorded and/or reported to the supervisor concerned in accordance with workplace procedures 1.5. Faulty materials or components are replaced in accordance with workplace procedures	• Relevant production processes, materials and products • Characteristics of materials, software and hardware used in production processes • Quality checking procedures • Quality Workplace procedures • Identification of faulty materials related to work	• Reading skills required to interpret work instruction • Critical thinking • Interpreting work instructions
2. Assess own work	2.1. ***Documentation*** relative to quality within the company is identified and used 2.2. Completed work is checked against workplace standards relevant to the task undertaken 2.3. Faulty pieces are identified and isolated 2.4. Information on the quality and other indicators of production performance is recorded in accordance with workplace procedures 2.5. Deviations from specified ***quality standards***, causes are documented and reported in accordance with the workplace' standards operating procedures	• Safety and environmental aspects of production processes • Fault identification and reporting • Workplace procedure in documenting completed work • Workplace Quality Indicators	• Carry out work in accordance with OHS policies and procedures

ELEMENT	PERFORMANCE CRITERIA ***Italicized Bold*** terms are elaborated in the Range of Variables	REQUIRED KNOWLEDGE	REQUIRED SKILLS
3. Engage in quality improvement	3.1. Process improvement procedures are participated in relation to workplace assignment 3.2. Work is carried out in accordance with process improvement procedures 3.3. Performance of operation or quality of product or service to ensure ***customer*** satisfaction is monitored	• Quality improvement processes • Company customers defined	• Solution providing and decision-making • Practice company process improvement procedure

RANGE OF VARIABLES

VARIABLE	RANGE
1. Materials/components	1.1. Materials may include but not limited to: 1.1.1. wires 1.1.2. cables, soldering lead 1.1.3. electrical tape 1.2. Components may include but not limited to: 1.2.1. ICs 1.2.2. Diodes
2. Faults	Faults may include but not limited to: 2.1. Components/materials not according to specification 2.2. Components/materials contain manufacturing defects 2.3. Components/materials do not conform with government regulation i.e., PEC, environmental code 2.4. Components/materials have safety defect
3. Documentation	3.1. Organization work procedures 3.2. Manufacturer's instruction manual 3.3. Customer requirements 3.4. Forms
4. Quality standards	4.1. Quality standards may relate but not limited to the following: 4.1.1. materials 4.1.2. component parts 4.1.3. final product 4.1.4. production processes
5. Customer	5.1. Co-worker 5.2. Supplier 5.3. Client 5.4. Organization receiving the product or service

EVIDENCE GUIDE

1. Critical aspect of competency	Assessment requires evidence that the candidate: 1.1. Carried out work in accordance with the company's standard operating procedures 1.2. Performed task according to specifications 1.3. Reported defects detected in accordance with standard operating procedures 1.4. Carried out work in accordance with the process improvement procedures
2. Method of assessment	2.1. The assessor may select two (2) of the following assessment methods to objectively assess the candidate: 2.1.1. Observation 2.1.2. Questioning 2.1.3. Practical demonstration
3. Resource implication	3.1. Materials and component parts and equipment to be used in a real or simulated electronic production situation
4. Context of Assessment	4.1. Assessment may be conducted in the workplace or in a simulated work environment.

UNIT TITLE : PERFORM COMPUTER OPERATIONS

UNIT CODE : ELC311203

UNIT DESCRIPTOR : This unit covers the knowledge, skills, (and) attitudes and values needed to perform computer operations which include inputting, accessing, producing and transferring data using the appropriate hardware and software

ELEMENT	PERFORMANCE CRITERIA ***Italicized*** terms are elaborated in the Range of Variables	REQUIRED KNOWLEDGE	REQUIRED SKILLS
1. Plan and prepare for task to be undertaken	1.1. Requirements of task are determined according to job specifications 1.2. Appropriate ***hardware*** and ***software*** are selected according to task assigned and required outcome 1.3. Task is planned to ensure ***OH & S guidelines*** and procedures are followed	• Main types of computers and basic features of different operating systems • Main parts of a computer • Information on hardware and software • Data security guidelines	• Reading and comprehension skills required to interpret work instruction and to interpret basic user manuals. • Communication skills to identify lines of communication, request advice, follow instructions and receive feedback. • Interpreting user manuals and security guidelines
2. Input data into computer	2.1. Data are entered into the computer using appropriate program/application in accordance with company procedures 2.2. Accuracy of information is checked and information is saved in accordance with standard operating procedures 2.3. Inputted data are stored in ***storage media*** according to requirements 2.4. Work is performed within ***ergonomic guidelines***	• Basic ergonomics of keyboard and computer user • Storage devices and basic categories of memory • Relevant types of software	• Technology skills to use equipment safely including keyboard skills. • Entering data
3. Access information using computer	3.1. Correct program/ application is selected based on job requirements 3.2. Program/application containing the information required is accessed according to company procedures	• General security, privacy legislation and copyright • Productivity Application • Business Application	• Accessing information • Searching and browsing files and data

ELEMENT	PERFORMANCE CRITERIA ***Italicized*** terms are elaborated in the Range of Variables	REQUIRED KNOWLEDGE	REQUIRED SKILLS
	3.3. ***Desktop icons*** are correctly selected, opened and closed for navigation purposes 3.4. Keyboard techniques are carried out in line with OH & S requirements for safe use of keyboards		
4. Produce/ output data using computer system	4.1. Entered data are processed using appropriate software commands 4.2. Data printed out as required using computer hardware/peripheral devices in accordance with standard operating procedures 4.3. Files, data are transferred between compatible systems using computer software, hardware/ peripheral devices in accordance with standard operating procedures	• Computer application in printing, scanning and sending facsimile • Types and function of computer peripheral devices	• Computer data processing • Printing of data • Transferring files and data
5. Maintain computer equipment and systems	5.1. Systems for cleaning, minor ***maintenance*** and replacement of consumables are implemented 5.2. Procedures for ensuring security of data, including regular back-ups and virus checks are implemented in accordance with standard operating procedures 5.3. Basic file maintenance procedures are implemented in line with the standard operating procedures	• Computer equipment/system basic maintenance procedures • Viruses • OH & S principles and responsibilities • Calculating computer capacity • System Software • Basic file maintenance procedures	• Removing computer viruses from infected machines • Making backup files

RANGE OF VARIABLES

VARIABLE	RANGE
1. Hardware and peripheral devices	1.1. Personal computers 1.2. Networked systems 1.3. Communication equipment 1.4. Printers 1.5. Scanners 1.6. Keyboard 1.7. Mouse
2. Software	Software includes the following but not limited to: 2.1. Word processing packages 2.2. Data base packages 2.3. Internet 2.4. Spreadsheets
3. OH & S guidelines	3.1. OHS guidelines 3.2. Enterprise procedures
4. Storage media	Storage media include the following but not limited to: 4.1. diskettes 4.2. CDs 4.3. zip disks 4.4. hard disk drives, local and remote
5. Ergonomic guidelines	5.1. Types of equipment used 5.2. Appropriate furniture 5.3. Seating posture 5.4. Lifting posture 5.5. Visual display unit screen brightness
6. Desktop icons	Icons include the following but not limited to: 6.1. directories/folders 6.2. files 6.3. network devices 6.4. recycle bin
7. Maintenance	7.1. Creating more space in the hard disk 7.2. Reviewing programs 7.3. Deleting unwanted files 7.4. Backing up files 7.5. Checking hard drive for errors 7.6. Using up to date anti-virus programs 7.7. Cleaning dust from internal and external surfaces

EVIDENCE GUIDE

1. Critical aspect of competency	Assessment requires evidence that the candidate: 1.1. Selected and used hardware components correctly and according to the task requirement 1.2. Identified and explained the functions of both hardware and software used, their general features and capabilities 1.3. Produced accurate and complete data in accordance with the requirements 1.4. Used appropriate devices and procedures to transfer files/data accurately 1.5. Maintained computer system
2. Method of assessment	2.1. The assessor may select two of the following assessment methods to objectively assess the candidate: 2.1.1. Observation 2.1.2. Questioning 2.1.3. Practical demonstration
3. Resource implication	3.1. Computer hardware with peripherals 3.2. Appropriate software
4. Context of Assessment	4.1. Assessment may be conducted in the workplace or in a simulated environment

UNIT TITLE : **TERMINATE AND CONNECT ELECTRICAL WIRING AND ELECTRONICS CIRCUIT**

UNIT CODE : **ELC311206**

UNIT DESCRIPTOR : This unit covers the knowledge, skills, attitudes and values needed to terminate and connect electrical wiring and electronic circuits

ELEMENT	PERFORMANCE CRITERIA ***Italicized*** terms are elaborated in the Range of Variables	REQUIRED KNOWLEDGE	REQUIRED SKILLS
1. Plan and prepare for termination/ connection of electrical wiring/ electronics circuits	1.1. ***Materials*** are checked according to specifications and tasks 1.2. Appropriate ***tools and equipment*** are selected according to tasks requirements 1.3. Task is planned to ensure OH & S guidelines and procedures are followed 1.4. Electrical wiring/electronic circuits are correctly prepared for connecting/termination in accordance with instructions and work site procedures	• Use of tools • Use of test instruments / equipment • Electrical theory • Principals of AC and DC • OH & S guidelines and procedures • Basic electrical and electronic devices	• Reading skills required to interpret work instruction • Checking materials for conformance to specifications • Checking existing and new installation site for correct location and specification
2. Terminate/ connect electrical wiring/ electronic circuits	2.1. Safety procedures in using tools are observed at all times and appropriate ***personal protective equipment*** are used 2.2. Work is undertaken safely in accordance with the workplace and standard procedures 2.3. Appropriate range of ***methods*** in termination/connection are used according to specifications, manufacturer's requirements and safety 2.4. Correct sequence of operation is followed according to job specifications 2.5. ***Accessories*** used are adjusted, if necessary 2.6. Confirm termination/ connection undertaken successfully in accordance with job specification	• Wiring techniques • OH & S principles • Use of lead-free soldering technology • Specifications and methods for terminating different materials	• Communication skills • Marking, tagging and labeling requirements for cables, wires, conductors and connections

ELEMENT	PERFORMANCE CRITERIA ***Italicized*** terms are elaborated in the Range of Variables	REQUIRED KNOWLEDGE	REQUIRED SKILLS
3. Test termination/ connections of electrical wiring/ electronics circuits	3.1. Testing of all completed termination/ connections of electric wiring/electronic circuits is conducted for compliance with specifications and regulations using appropriate procedures and equipment 3.2. Wiring and circuits are checked using specified testing procedures 3.3. Unplanned events or conditions are responded to in accordance with established procedures	• AC and DC power supplies • Use of diagnostic equipments • Surface mount soldering techniques • Tests for wiring and connections • Wiring support techniques and alternatives	• Soldering techniques • Printed circuit board repair and techniques • Electronic assembly functional and quality testing • Undertaking testing of wiring and connections for conformance to specification • Using language and literacy skills to complete short reports and required • Adjusting and fixing wiring supports

RANGE OF VARIABLES

VARIABLE	RANGE
1. Materials	1.1 Materials included the following but not limited to: 1.1.1 Soldering lead 1.1.2 Cables 1.1.3 Wires
2. Tools and equipment	2.1 Tools for measuring, cutting, drilling, assembling/disassembling. Tool set includes the following but not limited to: 2.1.1 Pliers 2.1.2 Cutters 2.1.3 Screw drivers 2.2 Equipment 2.2.1 Soldering gun 2.2.2 Multi-tester
3. Personal protective equipment	3.1 goggles 3.2 gloves 3.3 apron/overall
4. Methods	4.1 Clamping 4.2 Pin connection 4.3 Soldered joints 4.4 Plugs
5. Accessories	5.1 Accessories may include the following but not limited to: 5.1.1 brackets 5.1.2 clamps

EVIDENCE GUIDE

1. Critical aspect of competency	Assessment requires evidence that the candidate: 1.1. Undertook work safely and according to workplace and standard procedures 1.2. Used appropriate termination/ connection methods 1.3. Followed correct sequence in termination / connection process 1.4. Conducted testing of terminated connected electrical wiring/electronic circuits using appropriate procedures and standards
2. Method of assessment	2.1. The assessor may select two (2) of the following assessment methods to objectively assess the candidate: 2.1.1. Observation 2.1.2. Oral Questioning 2.1.3. Practical demonstration
3. Resource implication	3.1. Tools for measuring, cutting, drilling, assembling/disassembling, connecting. Tool set includes the following but not limited to: 3.1.1. screw drivers 3.1.2. pliers 3.1.3. cutters
4. Context of Assessment	4.1. Assessment may be conducted in the workplace or in a simulated environment

UNIT OF COMPETENCY: **TEST ELECTRONIC COMPONENTS**

UNIT CODE : **ELC311209**

DESCRIPTON : This unit covers the knowledge, skills and attitudes required to test electronic components. It includes competencies in determining the criteria for testing electronics components, planning an approach for component testing, testing the components and evaluating the testing process.

ELEMENT	PERFORMANCE CRITERIA ***Italicized*** terms are elaborated in the Range of Variables	REQUIRED KNOWLEDGE	REQUIRED SKILLS
1. Determine criteria for testing electronics components	1.1 Work instructions are obtained and clarified based on job order or client requirements 1.2 ***Responsible person*** is consulted for effective and proper work coordination 1.3 Data sheets/Application notes are obtained and interpreted based on manufacturer's specifications 1.4 ***Testing criteria*** are defined to ensure that components meet technical and quality requirements 1.5 Document and communicate testing criteria to relevant personnel	• Mensuration/ Mathematics o Conversion of Units o Applied Mathematics • Safety o Work Safety requirements and economy of materials with durability • Systems and Processes o Principles of electrical/ electronic circuits o Identifying sources of electricity o Identifying conductors and insulators o Supplying different voltage using variable power supply o Measuring resistance using VOM o Testing resistors o Measuring current and voltage using VOM • Testing Criteria o Controls o Effectiveness o Efficiency o Bug detection o Functionality, including flow o Interoperability o Performance o Reliability o Operating parameters	• Work efficiently & systematically • Communication skills • Skills in testing electronic components • Work safety practices and time management • Reading skills

ELEMENT	PERFORMANCE CRITERIA ***Italicized*** terms are elaborated in the Range of Variables	REQUIRED KNOWLEDGE	REQUIRED SKILLS
2. Plan an approach for component testing	2.1 Various ***testing methods*** are Identified based on ***types of electronic components*** 2.2 Characteristics and appropriateness of testing methods to be used during development and on completion is determined 2.3 Testing methods are considered/selected in relation to appropriate ***testing strategy*** 2.4 Plan for testing components is developed at specified points during development and on completion 2.5 Required ***test & measuring instruments*** and ***tools*** are prepared and checked in accordance with established procedures 2.6 ***Records system*** is established to document testing results, including problems and faults	• Safety ○ Work Safety requirements and economy of materials with durability ○ Knowledge in 5S application & observation of required timeframe • Materials, tools and equipment uses and specifications ○ Proper care and use of tools • *Types of electronic components* ○ Passive components ○ Active components ○ Dynamic components ○ Hybrid components • *Testing methods* ○ Automated ○ Debugging ○ Inspection ○ Platform testing ○ Prototyping • *Systems and Processes* ○ Describing resistance & identify resistors ○ Describing alternating current circuits ○ Describing capacitance & identifying capacitors ○ Describing inductance & identifying inductors ○ Describing the characteristic of transformers ○ Describing & identifying semiconductor diode ○ Describing & identifying bipolar transistor ○ Describing & analyzing digital gate	• Skills in testing electronic components • Work safety practices and time management • Planning skills • Problem solving skills • Reading skills • Checking test & measuring instruments and tools • Documentation skills
3. Test components	3.1 Testing methods are applied to ensure that products meet creative, production and technical requirements 3.2 Problems and faults detected by testing are	• Safety ○ Work Safety requirements and economy of materials with durability • Materials, tools and equipment uses and	• Skills in testing electronic components • Troubleshooting skills • Problem solving

ELEMENT	PERFORMANCE CRITERIA *Italicized* terms are elaborated in the Range of Variables	REQUIRED KNOWLEDGE	REQUIRED SKILLS
	recorded and remedial steps taken in records system is documented 3.3 Problems and faults detected during testing are resolved in accordance with agreed project or industry practice 3.4 Evaluate final products against the previously determined criteria 3.5 Testing process is documented and summarized evaluation report is submitted to relevant personnel	specifications ○ Proper care and use of tools • Systems and Processes ○ Principles of electrical/ electronic circuits ○ Supplying different voltage using variable power supply ○ Measuring resistance using VOM ○ Testing resistors ○ Measuring current and voltage using VOM ○ Observing waveform using oscilloscope ○ Generating waveform in various frequency using function generator ○ Measuring frequency using oscilloscope ○ Measuring capacitance using VOM ○ Testing capacitors ○ Testing inductors ○ Testing semiconductor diode ○ Testing bipolar transistor ○ Testing logic gates	skills • Documentation skills • Work efficiently & systematically • Product analysis and evaluation skills • Communication skills • Reading skills
4. Evaluate the testing process	4.1 Testing methods that were successful and those that led to difficulties are identified based on industry standards 4.2 Testing process and records system are evaluated based on standard procedures 4.3 Test results/findings are documented for subsequent components testing.	• Evaluation of testing process and records system • Systems and Processes ○ Analyzing simple circuit using ohms & power law ○ Analyzing series/parallel circuits using ohms and power law ○ Analyzing series/parallel capacitances ○ analyzing series parallel inductors ○ Analyzing rectifier circuits ○ Analyzing amplifier circuit ○ Analyzing multi-vibrator circuit ○ Analyzing logic networks ○ Analyzing sequence circuits	• Work efficiently & systematically • Skills in testing electronic components • Product analysis and evaluation skills • Documentation skills • Communication skills • Reading skills

RANGE OF VARIABLES

VARIABLE	RANGE
1. Responsible person	Relevant personnel may include: 1.1. Immediate supervisor 1.2. Manager
2. Testing criteria	Testing criteria may include: 2.1. controls 2.2. effectiveness 2.3. efficiency 2.4. bug detection 2.5. functionality, including flow 2.6. interoperability 2.7. performance 2.8. reliability 2.9. operating parameters
3. Testing methods	Testing methods may include: 3.1. automated 3.2. debugging 3.3. inspection 3.4. platform testing 3.5. prototyping
4. Types of electronic components	4.1. Passive components 4.2. Active components 4.3. Dynamic components 4.4. Hybrid components
5. Testing strategy	Testing strategy may be determined by: 5.1. Passive testing 5.2. Dynamic testing 5.3. In-circuit testing
6. Test and measuring instruments	Test and measuring instruments may include: 6.1. Variable DC power supply 6.2. Digital VOM 6.3. analog VOM 6.4. dual trace triggered oscilloscope 6.5. function generator
7. Tools	Tools may include: 7.1. set of pliers 7.2. set of screw drivers 7.3. set of wrenches 7.4. Hand drills, 7.5. Hack saw 7.6. set of files 7.7. tin snip 7.8. hammer

VARIABLE	RANGE
8. Records system	Records system may include: 8.1. metadata that includes: 8.1.1. description of fault 8.1.2. identification of code 8.1.3. user responses 8.1.4. written or verbal comments 8.1.5. quantitative data 8.1.6. remedial action taken 8.1.7. retest result 8.1.8. date 8.1.9. tester's details 8.2. questionnaire 8.3. survey

EVIDENCE GUIDE

1 Critical aspects of competency	Assessment requires evidence that the candidate: 1.1 Determined criteria for testing electronics components 1.2 Planned an approach for component testing 1.3 Tested components 1.4 Evaluated the testing process
2 Method of assessment	Competency may be assessed through two or more of the following methods: 2.1 Direct observation of application to tasks and questions related to required knowledge 2.2 Demonstration with oral questioning 2.3 Third party report 2.4 Written test 2.5 Portfolio
3 Resource implications	The following resources must be provided: 3.1 Tools and equipment (see range of variables) 3.2 Working area/bench 3.3 Electronic components 3.4 Testing instruments and equipment 3.5 Assessment rating sheet 3.6 Reporting forms
4 Context of assessment	4.1 Assessment maybe conducted in the workplace or in a simulated workplace setting

CORE COMPETENCIES

UNIT TITLE : **DEVELOP MECHATRONICS AND AUTOMATION CONTROL CIRCUITS AND PLC APPLICATION PROGRAMS**

UNIT CODE : **ELC311303**

UNIT DESCRIPTOR : This unit covers the knowledge, skills and attitudes needed to develop, analyze, implement and review mechatronics and automation control circuits and basic/intermediate PLC application programs in line with requirements, software specifications and applications. This includes competencies in determining control circuits requirements, developing PLC application program, testing the developed control circuits and PLC application program and documenting control circuits and PLC application program being developed.

ELEMENT	PERFORMANCE CRITERIA ***Italicized*** items are elaborated in the range of Variables	REQUIRED KNOWLEDGE	REQUIRED SKILLS

1. Determine control circuits requirements	1.1. Control circuits requirements and design data are obtained and clarified as needed for the application.
	1.2. PLC software application program flow is documented according to the validated requirements of the application.
	1.3. The coding, modules and links required are determined according to the application.
	1.4. Appropriate ***language*** is used according to the application
		• Logic circuit analysis and development
		  o Sequential circuit
		  o Ladder circuit
		• Operation process flowcharting
		• PLC data types
		• PLC modules
		• PLC hardware configuration
		• Standard programming languages
		  o Ladder
		  o Function block diagram (FBD)
		  o Instructions list (IL)
		  o Sequential function flowchart (SFC)
		  o Structured Text Language (STL)
			• Reading skills required to understand work instructions
			• Communication skills needed to collect and interchange information
			• Documentation skills
			• Analytical skills
			• Programming skills
			• Skills in computer operation

2. Develop PLC application program	2.1. PLC application program is developed using appropriate code.
	2.2. PLC application program is ***debugged*** and reworked for correction of errors
	2.3. Appropriate ***ergonomic standards*** are observed to reduce fatigue while working on a computer
		• PLC programming
		  o Program organization
		  o Data types
		  o Variables
		  o Configuration
		• PLC program instructions
		  o Relay / Logic/ Bit
		  o Timer
		  o Counter
		  o Arithmetic instructions
		  o Data manipulation
		  o Program control
			• Skills in computer operation
			• PLC programming skills
			• Debugging skills
			• Documentation skills
			• Analytical skills

ELEMENT	PERFORMANCE CRITERIA ***Italicized*** items are elaborated in the range of Variables	REQUIRED KNOWLEDGE	REQUIRED SKILLS

		• Ergonomic guidelines/ standards
		  o Movement space
		  o Furniture dimensions
		  o Working postures
		  o Illumination and glare
		• PLC program debugging techniques
		  o Online
		  o Off-line	

3. Test developed control circuits and PLC application program	3.1 Developed control circuits and PLC software application program is run to ensure all syntax errors are corrected. 3.2 Program is downloaded using manufacturer's procedures. 3.3 Any limits, exceptions and other aspects built into the control circuits and PLC software application program are tested against user's control requirements. 3.4 Control circuits and PLC software application program is tested for user's acceptance	• Computer interfacing • Concepts of I/O driver software • Downloading and uploading procedures of PLC software program • Control concepts and applications • Standard operating procedures for PLC software application program • Testing and commissioning procedures for control circuits and PLC software application program	• Skills in computer operation • PLC programming skills • Debugging skills • Analytical skills • Testing and commissioning skills

4. Document control circuits and PLC application program developed	4.1 Final control circuits and PLC application program flow or flowchart is prepared according to company standards.
	4.2 ***Labels and comments*** are indicated into the program for user–friendliness.
	4.3 Final revision of the PLC application program and external devices assignment are prepared in softcopy and printed formats
		• Computer software applications
		  o Computer Aided Design (CAD)
		  o Microsoft office application
		• Tagging and labeling of program components
		• Exporting PLC software program
		• Compilation of softcopy and printed formats
			• Skills in computer operation
			• Documentation skills

RANGE OF VARIABLES

VARIABLE	RANGE
1. Language	Include but not limited to: 1.1. Standard Programming languages • Ladder • Function block diagram (FBD) • Instructions list (IL) • Sequential function flowchart (SFC) • Structured Text Language (STL) 1.2. Procedural language
2. Ergonomic guidelines/ standards	Include but not limited to: 2.1. Movement space 2.2. Furniture dimensions 2.3. Working postures 2.4. Illumination and glare
3. Debugging	PLC program debugging techniques: 3.1. Online 3.2. Off-line
4. Labels and comments	Include but not limited to: 4.1 Elements tagging 4.2 Labeling 4.3 Remarks and description

EVIDENCE GUIDE

1. Critical aspects of competency	Assessment requires evidence that the candidate: 1.1. Obtained and clarified control circuits requirements and design data as needed for the application 1.2. Developed PLC software application program using appropriate code 1.3. Downloaded program using manufacturer's procedure 1.4. Run developed control circuits and PLC software application program 1.5. Tested developed control circuits and PLC software application 1.6. Debugged and reworked PLC software application program 1.7. Prepared a user-friendly documentation of the developed control circuits and PLC software application programs
2. Method of assessment	2.1. The assessor may select two of the following assessment methods to objectively assess the candidate: 2.1.1. Practical Demonstration with Oral questioning 2.1.2. Written Examination 2.1.3. Direct Observation with Oral questioning
3. Resource Implication	3.1. Computer hardware with peripherals 3.2. Software application programs 3.3. Appropriate control equipment 3.4. Materials
4. Context of Assessment	4.1. Assessment may be conducted in the workplace or in a simulated work process and procedures

UNIT TITLE : **DEVELOP MOTION CONTROL AND SYSTEM CONFIGURATION**

UNIT CODE : **ELC311304**

UNIT DESCRIPTOR: This unit covers the knowledge, skills and attitudes needed to develop motion control and system configuration in line with application requirements and specifications. This includes competencies in determining motion control system requirements, developing and configuring motion control system, testing the developed motion control system and documenting motion control system being developed.

ELEMENT	PERFORMANCE CRITERIA ***Italicized i***tems are elaborated in the range of Variables	REQUIRED KNOWLEDGE	REQUIRED SKILLS

1. Determine motion control system requirements	1.1. Motion control system requirements and design data are obtained and clarified as needed for the application.
	1.2. ***Input and output signals*** are identified according to system requirements
	1.3. Motion control system specifications are identified according to system requirements.
	1.4. Motion control system requirements are documented according to the validated application.
		• Logic circuit analysis and development
		  o Sequential circuit
		  o Ladder circuit
		• Motion control elements
		  o Variable Frequency Drive (VFD)
		  o Servo motor
		  o Stepper motor
		• Operation process flowcharting and application
		• Motion control system input and output signals
			• Reading skills required to understand work instructions
			• Communication skills needed to collect and interchange information
			• Documentation skills
			• Analytical skills
			• Skills in computer operation

2. Develop and configure motion control system	2.1. Motion control system diagram is developed according to application requirements 2.2. ***Motion control devices*** are integrated according to system diagram 2.3. Motion control devices are configured according to system requirements	• Computer Aided Design • Software operation for system diagram • Motion control system operation • Functions and applications of motion control devices • Motion control devices technical specifications	• Reading skills required to understand work instructions • Communication skills needed to collect and interchange information • Analytical skills • Skills in computer operation
3. Test developed motion control system	3.1. Developed motion control system is run to ensure all configuration errors are corrected. 3.2. Any limits, exceptions and other aspects built into the motion control system are tested against user's control requirements. 3.3. Motion Control system is tested for user's acceptance	• Concepts of I/O types • Motion control concepts and applications • Standard operating procedures for testing motion control system • Commissioning procedures for motion control system	• Reading skills required to understand work instructions • Communication skills needed to collect and interchange information • Analytical skills • Skills in computer operation

ELEMENT	PERFORMANCE CRITERIA ***Italicized i***tems are elaborated in the range of Variables	REQUIRED KNOWLEDGE	REQUIRED SKILLS
4. Document motion control system	4.1. Final motion control system flowchart is prepared according to company standards. 4.2. ***Labels and comments*** are indicated into the motion control system for user–friendliness. 4.3. Final revision of motion control system external devices assignment are prepared in softcopy and printed formats	• Tagging and labeling of motion control system devices • Compilation of softcopy and printed formats	• Skills in computer operation • Documentation skills

RANGE OF VARIABLES

VARIABLE	RANGE
1. Motion Control Devices	Include but not limited to: 1.1. Variable Frequency Drive (VFD) 1.2. Stepper Motor 1.3. Servo Motor
2. Input and Output signals	2.1. Analog 2.2. Digital
3. Labels and comments	Include but not limited to: 5.1 Elements tagging 5.2 Labeling 5.3 Remarks and description

EVIDENCE GUIDE

1. Critical aspects of competency	Assessment requires evidence that the candidate: 1.1. Obtained and clarified motion control system requirements and design data 1.2. Identified input and output signals according to system requirements. 1.3. Identified motion control system specification according to system requirements 1.4. Integrated motion control devices according to system diagram 1.5. Developed and configured motion control system based on application requirements. 1.6. Run developed motion control system to ensure all configuration errors are corrected. 1.7. Tested any limits, exceptions and other aspects built into the motion control system against user's control requirements. 1.8. Prepared final motion control system flowchart according to company standards.
2. Method of assessment	2.1. The assessor may select two of the following assessment methods to objectively assess the candidate: 2.1.1. Practical Demonstration with Oral questioning 2.1.2. Written Examination 2.1.3. Direct Observation with Oral questioning
3. Resource Implication	3.1. Computer hardware with peripherals 3.2. Software application programs 3.3. Appropriate control equipment 3.4. Materials
4. Context of Assessment	4.1. Assessment may be conducted in the workplace or in a simulated work process and procedures

UNIT TITLE : **MAINTAIN AND REPAIR PLC-BASED MECHATRONICS AND AUTOMATION SYSTEM**

UNIT CODE : **ELC311305**

UNIT DESCRIPTOR: This unit covers the knowledge, skills and attitudes needed to maintain & repair PLC-based mechatronics and automation system. This includes competencies in planning and preparing for maintenance and repair of PLC-based mechatronics and automation system, maintaining mechatronics and automation system, repairing mechatronics and automation system, and inspecting and testing mechatronics system.

ELEMENT	PERFORMANCE CRITERIA ***Italicized i***tems are elaborated in the Range of Variables	REQUIRED KNOWLEDGE	REQUIRED SKILLS
1. Plan and prepare for maintenance and repair of PLC-based mechatronics and automation system	1.1. Maintenance and repair is planned and prepared in line with job requirements. 1.2. ***OHS policies and procedures*** are followed in line with job requirements. 1.3. ***Mechatronics and automation devices*** for maintenance or repair are checked against specifications and requirements. 1.4. ***Materials*** necessary to complete the work are obtained in accordance with established procedures and checked against job requirements. 1.5. ***Tools, equipment and testing devices*** needed for the maintenance/repair are obtained and checked for correct operation and safety 1.6. Mechatronics and automation system to be maintained or repaired are identified from the job instructions	1.1. PLC-based mechatronics and automation system maintenance procedures 1.2. Occupational health and safety standards 1.3. Mechatronics devices specifications 1.4. Materials planning and workflow 1.5. Testing procedures of equipment and devices 1.6. Proper use of tools 1.7. Maintenance and repair instruction manuals	1.1. Reading skills required to understand work instructions 1.2. Communication skills needed to collect and interchange information 1.3. Analytical skills 1.4. Skills in computer operation 1.5. Planning skills
2. Maintain mechatronics and automation system	2.1. Appropriate ***personal protective equipment*** is used and OHS policies & procedures are followed 2.2. Normal functions of the mechatronics and automation devices are checked in accordance with manufacturer's instructions.	2.1 Uses of personal protective equipment (PPE) 2.2 Principles of 5S 2.3 Functions and applications of mechatronics and automation devices 2.4 Understanding of preventive	2.1 Reading skills required to understand work instructions 2.2 Communication skills needed to collect and interchange information

ELEMENT	PERFORMANCE CRITERIA *Italicized i*tems are elaborated in the Range of Variables	REQUIRED KNOWLEDGE	REQUIRED SKILLS
	2.3. Scheduled/periodic maintenance is performed in accordance with manufacturer's & company requirements. 2.4. Unplanned events or conditions are responded to in accordance with established procedures	maintenance checklist 2.5 Use of tools 2.6 Use of test equipment/ instruments 2.7 Knowledge & interpretation of manufacturer's/ company preventive maintenance requirements 2.8 Out-of-control action plan (OCAP)	2.3 Analytical skills 2.4 Problem solving skills
3. Repair mechatronics and automation system	3.1. Appropriate personal protective equipment is used and OHS policies & procedures are followed 3.2. Normal function of mechatronics and automation system are checked in accordance with manufacturer's instructions. 3.3. Fault or problem in component is diagnosed and corrected in line with the standard operating procedures. 3.4. Unplanned events or conditions are responded to in accordance with established procedures	3.1 Principles of 3R's 3.2 Environmental Safety • Waste Segregation 3.3 Fault finding on control circuits • Electro-mechanical • Pneumatic & electro-pneumatic • Hydraulic and electro-hydraulic • Electronic logic 3.4 Mechatronics and automation devices specifications	3.1 Reading skills required to understand manufacturers specification 3.2 Analytical skills 3.3 Problem solving skills 3.4 Troubleshooting skills
4. Inspect and test mechatronics and automation system	4.1 Mechatronics and automation system are checked to ensure safe operation. 4.2 Final inspection and testing are undertaken according to manufacturer's instructions. 4.3 Work site is cleaned and cleared of all debris and left in safe condition in accordance with company procedures. 4.4 Report is prepared in accordance with company requirements.	4.1 Mechatronics and automation devices configuration 4.2 Final inspection and testing procedures • Visual Inspection • Functional inspection 4.3 Applicable technical reports • Commissioning • Inspection • Testing • Operation 4.4 Office software application • Word • Excel	4.1 Reading skills required to understand manufacturers specification 4.2 Problem solving skills 4.3 Documentation Skills 4.4 Skills in computer operation

RANGE OF VARIABLES

VARIABLE	RANGE	
1. OH & S policies and procedures	1.1. OH & S guidelines 1.2. Philippine environmental standards 1.3. OSHE standards	
2. Mechatronics and automation devices	Include the following but not limited to: • Servo & Stepper Motors • Frequency drives • Actuators • Buzzers • Indicating Lamps • Limit switches • Magnetic contactors • Photo-sensors • Proximity sensors • Directional solenoid valves	
3. Materials	Include the following but not limited to: 3.1. Connectors 3.2. Adaptors 3.3. Fittings and tube 3.4. Rags	
4. Tools	Include the following but not limited to: 4.1. Pliers; assorted 4.2. Screwdrivers; assorted 4.3. Soldering iron	
5. Test equipment/instruments	5.1. Multi-tester • Digital • Analog 5.2. Programming device (PC/ Laptop)	
6. Personal protective equipment	6.1. Safety hat 6.2. Safety shoes 6.3. Ear muffs 6.4. Goggles	6.5. Safety belt/Harness 6.6. Gloves 6.7. Mask

EVIDENCE GUIDE

1. Critical aspects of competency	Assessment requires evidence that the candidate: 1.1. Checked mechatronics devices for maintenance and repair against specification and requirements 1.2. Identified mechatronics devices to be maintained or repaired from the job instructions 1.3. Conducted test accurately on the mechatronics and automation devices using standard procedures 1.4. Diagnosed faults on the mechatronics and automation devices/system 1.5. Repaired or replaced defective mechatronics and automation devices 1.6. Inspected/checked and tested repaired mechatronics and automation system to ensure safety 1.7. Prepared report in accordance with the company requirements
2. Method of assessment	2.1. The assessor may select two of the following assessment methods to objectively assess the candidate: 2.1.1. Demonstration with oral questioning 2.1.2. Direct observation with oral questioning 2.1.3. Written Examination
3. Resource Implication	3.1. Tools 3.2. Test equipment/instruments 3.3. Mechatronic devices 3.4. Materials 3.5. PPE 3.6. Technical manuals
4. Context of Assessment	4.1. Assessment may be conducted in the workplace or in a simulated environment

SECTION 3 TRAINING ARRANGEMENTS

This set of standards provides Technical and Vocational Education and Training (TVET) providers with information and other important requirements to consider when designing training programs for Mechatronics Servicing NC III.

This includes information on curriculum design; training delivery; trainee entry requirements; tools and equipment; training facilities; and trainer's qualification and institutional assessment.

3.1 CURRICULUM DESIGN

TESDA shall provide the training on the development of competency-based curricula to enable training providers develop their own curricula with the components mentioned below.

Delivery of knowledge requirements for the basic, common and core units of competency specifically in the areas of mathematics, science/technology, communication/language and other academic subjects shall be contextualized. To this end, TVET providers shall develop a Contextual Learning Matrix (CLM) to accompany their curricula.

Course Title: Mechatronics Servicing **NC Level:** NC III

Nominal Training Duration:

32 hrs – Basic Competencies
60 hrs – Common Competencies
104 hrs – Core Competencies
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196 hrs

Course Description:

This course is designed to develop & enhance the knowledge, skills, & attitudes of a mechatronics and automation technician, in accordance with industry standards. It covers the basic & common competencies in addition to the core competencies such as developing mechatronics and automation control circuits and PLC application programs, developing motion control and system configuration on mechatronics and automation system as well as maintaining and repairing PLC-based mechatronics and automation sytems.

(*The nominal duration of 196 hours covers only the basic, common and core units at Mechatronics Servicing NC III level. TVET providers can however, offer a longer, ladderized course covering both Mechatronics Servicing NC II and NC III basic, common and core units.*)

BASIC COMPETENCIES

32 hrs

Unit of Competency	Learning Outcomes	Learning Content (Required Knowledge)	Practical Activities (Required Skills)	Methodology	Assessment Approach	Nominal Duration
1. Lead workplace communication	1.1 Communicate information about workplace processes. .	• Method of communication • Communication skills • Communication tools • Questioning techniques	• Expressing One self • Practice on Public speaking • Written activities on workplace process	• Group discussion • Role Play • Brainstorming • Demonstration	• Written Test • Interview • Observation	2 hours
	1.2 Lead workplace discussions	• Method/technique of discussion • How to lead discussion • How to solicit response	• Written and Electronic communication activities • Debate Exercises	• Self-paced handout/ module • Discussion • Role Play	• Written Test • Demonstration	2 hours
	1.3 Identify and communicate issues arising in the workplace	• Identify problems and issues • Organizing information on problem and issues • Relating problems and issues • Communication barriers affecting workplace discussions	• Resolving conflict in the workplace • Making a report about problem and issues • Practice communication model	• Brainstorming • Self-paced handout/ module • Role Play • Self-paced handout/ module	• Interviews • Written exam • Demonstration	2 hours
2. Lead small teams	2.1 Provide team leadership.	• Communication skills required for leading small team • Skills and techniques in promoting team building • Negotiating skills • Up to date dissemination of instruction and requirements to members • Art of listening and treating individual team members concern	• Evaluate the success factors in the contribution of the personnel in the implementation of the safety, quality and environmental objectives of the company • Practice leadership activities • Teambuilding activities • Write simple negotiation strategy on workplace issues • Role play on communication model and the art of listening	• Self-paced handout/ module • Role Play • Case Study	• Written • Oral Questioning • Demonstration	2 hours

Unit of Competency	Learning Outcomes	Learning Content (Required Knowledge)	Practical Activities (Required Skills)	Methodology	Assessment Approach	Nominal Duration
	2.2 Assign responsibilities among members	• Duties and responsibilities of each team member • Skills in identifying individual skills, knowledge and attitude as basis for allocating responsibilities • Knowledge in identifying each team member duties and responsibilities	• Planning session regarding duties and responsibilities of each team member • Writeshop of interpersonal abilities, attitude and knowledge • Identification of team members responsibilities thru simulation	• Role Play • Workshop • Demonstration	• Case studies • Interview • Demonstration	2 hours
	2.3 Set performance expectation for team members.	• Knowledge and skills in setting individual performance target/expectation • Team members duties and responsibilities • Employee policies and procedures • Defining performance expectations criteria	• Develop /implement an appraisal document for the technician • Workshop on setting individual performance target • Writeshop on team members duties and responsibilities • Video presentation regarding employees performance role and expectation towards work	• Group discussion • Writeshop • Multimedia presentation	• Written exam • Demonstration • Written Exam	1 hour
	2.4 Supervise team performance	• Knowledge and skills in monitoring team member performance • Monitoring team operation to ensure client needs and satisfaction • Methods of monitoring performance • Informal/formal counseling skills	• Practice monitoring skills • Design monitoring scheme for team operation as well as client satisfaction and needs • Evaluate performance of technicians	• Role Play • Writeshop • Discussions • Self-paced handout/ module • Group Dynamics	• Written Test • Demonstration • Written Test • Demonstration	1 hour
3. Develop and practice negotiation skills	3.1 Identify relevant information in planning negotiations	• Background information on other parties to the negotiation • Observing differences between content and process • Identifying bargaining information • Applying strategies to manage process	• Perform Data gathering regarding relevant information related to negotiation • Designing a negotiation process • Practice negotiation strategies and manage the process	• Direct observation • Self-paced handout/ module • Discussion • Workshop	• Interview • Written exam • Demonstration	2 hours

Unit of Competency	Learning Outcomes	Learning Content (Required Knowledge)	Practical Activities (Required Skills)	Methodology	Assessment Approach	Nominal Duration
	3.2 Participate in negotiations	• Applying steps in negotiating process • Strategies to manage conflict • Steps in negotiating process	• Writeshop on identifying negotiation process • Perform background information gathering	• Simulation/ role playing • Writeshop • Discussion	• Written exam • Practical/ performance test	2 hour
	3.3 Document areas for agreement	• Procedure in documenting negotiations • Managing information • Filing documents	• Practice documentation techniques/minutes of meeting • Practice recording of agreement • Keeping of records	• Case studies • Role play	• Written exam • Practical/ performance test	2 unit
4. Solve workplace problem related to work activities	4.1 Explain the analytical techniques	• Observation, investigation & analytical techniques • Brainstorming • Cause and effect diagrams	• Conduct investigation and root cause analyses and implement corrective actions • Perform analytical skills in solving problem related to work	• Direct observation • Simulation	• Written test • Demonstration	2 hours
	4.2 Identify the problem	• Normal operating parameters & product quality • Identifying & clarifying the nature of problem • Application of analytical techniques	• Evaluate the present status of the performance against the established safety, quality and environmental policies in the workplace • Discussion in identifying and clarifying the nature of problem	• Simulation/ role playing • Discussion • Simulation	• Written exam • Practical/ performance test • Demonstration	1 hour
	4.3 Determine the possible cause/s of the problem	• Non-routine process and quality problems • Teamwork and work allocation problem • Safety and emergency situations and incidents	• Implement corrective or preventive actions based on root cause analyses • View video presentation on possible cause of problem in the workplace • Writeshop on the determining problems in the workplace	• Case studies • Multimedia presentation • Writeshop	• Written exam • Interviews • Written Test	1 hour
5. Use mathematical concepts and techniques	5.1 Identify mathematical tools and techniques to solve problem	• Measurement system • Basic measuring tools/devices	• Practice mathematical concepts to solve problem in the workplace	• Direct observation • Demonstration	• Written exam • Practical/ performance test	1 hour
	5.2 Apply mathematical procedures/ solution	• Fundamental operation (addition, subtraction, division, multiplication)	• Practice linear measurements and conversion • Practice mathematical calculation on workplace situation	• Simulation/ role playing • Demonstration	• Written exam • Practical/ performance test	2 hours

Unit of Competency	Learning Outcomes	Learning Content (Required Knowledge)	Practical Activities (Required Skills)	Methodology	Assessment Approach	Nominal Duration
	5.3 Analyze results	• Precision and accuracy	• Compare the results against the new requirements and identify gaps • Analysis of result	• Case studies • Demonstration	• Written exam • Interviews	2 hours
6. Use relevant technologies	6.1 Identify appropriate technology	• Awareness on technology and its function • Communication techniques	• Film Viewing regarding technology and its benefits • Identify different technology applicable to workplace	• Direct observation • Multimedia presentation	• Written exam • Demonstration	1 hour
	6.2 Apply relevant technology	• Study different relevant technology in the workplace • Relate 5s to technology	• Conduct risk assessment for a routine or non-routine task in the workplace using the established systems • Application of relevant technology to the workplace	• Direct observation • Simulation/ role playing	• Written exam • Demonstration	2 hour
	6.3 Maintain/ enhance relevant technology	• Corrective and preventive maintenance • Upgrading of technology • Communication Skills • Organizational set–up / work flow	• Identify monthly maintenance tasks based on the Planned Maintenance System • Application of corrective and preventive maintenance to workplace	• Case studies • Simulation/ role playing	• Interviews • Demonstration	2 hour

Note: Basic competencies may be embedded in the core competencies.

COMMON COMPETENCIES

60 hrs

Note: *Those who have completed the course on Mechatronics and Automation Servicing NC II or have acquired the Mechatronics and Automation Servicing NC II qualification can skip this portion on common competencies.*

Unit of Competency	Learning Outcomes	Learning Contents	Practical Activities	Methodologies	Assessment Methods	Nominal Duration
1. Use Hand Tools	1.1. Plan and prepare for tasks to be undertaken	• Identification of different types of hand tools • Electronics hand tools and their uses • Function, operation and common faults in electronics hand tools	• Planning and preparing task/activity	▪ Lecture / Demonstration ▪ Distance education ▪ Film Showing	▪ Written/Oral examination ▪ Practical demonstration	2 hours
	1.2. Prepare hand tools	• Proper use of hand tools • Checking and safety requirements in handling tools • Standard procedures in checking, identification and marking of safe or unsafe/ faulty tools	• Identifying and checking hand tools • Marking of safe or unsafe/ faulty hand tools	▪ Lecture / Demonstration ▪ Distance education ▪ Film Showing	▪ Written/Oral examination ▪ Practical demonstration	2 hours
	1.3. Use appropriate hand tools and test equipment.	• Safety requirements in using electronics hand tools and test equipment • Electronics hand tools for adjusting, dismantling, assembling, finishing, and cutting • Processes, Operations, Systems • Proper usage and care of hand tools • Types and uses of test equipment • Common faults in the use of hand tools	• Applying safety handling of hand tools and test equipment • Using appropriate hand tools and test equipment for the job requirement	▪ Lecture / Demonstration ▪ Distance education ▪ Film Showing	▪ Written/Oral examination ▪ Practical demonstration	2 hours

Unit of Competency	Learning Outcomes	Learning Contents	Practical Activities	Methodologies	Assessment Methods	Nominal Duration
	1.4. Maintain hand tools	○ Safety requirements in maintenance of hand tools ○ Processes, Operations, Systems ▪ Maintenance of tools ▪ Storage of hand tools ○ Procedures in maintaining hand tools	○ Applying 5S principles in maintenance of hand tools	▪ Lecture / Demonstration ▪ Distance education ▪ Film Showing	▪ Written/Oral examination ▪ Practical demonstration	2 hours
2. Perform Mensurations and Calculation	2.1 Select measuring instruments;	• Types of measuring tools and its uses	• Selecting measuring instruments	▪ Self- paced/ modular ▪ Demonstration ▪ Small group discussion	▪ Written/Oral examination ▪ Practical demonstration	2 hours
	2.2 Carry-out measurements and calculations	• Measurements ▪ Linear measurement ▪ Geometrical measurement • Trade Mathematics ▪ Unit conversion ▪ Ratio and proportion ▪ Area	• Interpreting formulas for volume, areas, perimeters of plane and geometric figures • Performing measurement • Computing measurement formulas	▪ Self- paced/ modular ▪ Demonstration ▪ Small group discussion	▪ Written/Oral examination ▪ Practical demonstration	4 hours
	2.3 Maintain measuring instruments	○ Safe handling procedures in using measuring instruments ○ Procedures on maintenance of measuring instruments	○ Handling and maintaining measuring instruments	▪ Lecture ▪ Self- paced/ modular ▪ Demonstration	▪ Written/Oral examination ▪ Practical demonstration	2 hours
3. Prepare and Interpret Technical Drawing	3.1 Identify different kinds of technical drawings	• Types of technical drawings • Technical drawing applications • Mark up/Notation of Drawings	• Identifying type of drawing • Evaluating mark-up/ notation of drawings • Interpreting signs and symbols	▪ Lecture ▪ demonstration ▪ Film Viewing ▪ Individualized Learning	▪ Written /oral ▪ examinations ▪ Direct observation ▪ Project method ▪ interview	2 hours

Unit of Competency	Learning Outcomes	Learning Contents	Practical Activities	Methodologies	Assessment Methods	Nominal Duration
	3.2 Interpret technical drawing	• Blueprint Reading and Plan Specification ▪ Electronics symbols and abbreviations • Trade Theory ▪ Types of electronics/ semiconductors product plans ▪ Notes and specification	• Interpreting technical drawing and plans for electronics • Matching specification details with existing resources	▪ Lecture ▪ demonstration ▪ Film Viewing ▪ Individualized Learning ▪ Direct Student Laboratory Experience	▪ Written /oral ▪ examinations ▪ Direct observation ▪ Project method ▪ Interview	2 hours
	3.3 Prepare/ make changes to electrical/ electronic schematics and drawings	○ Freehand sketching techniques ○ Pictorial drawing ○ Drawing conventions ○ Dimensioning conventions ○ Mathematics ▪ Four fundamental operations ▪ Percentage ▪ Fraction ▪ Algebra ▪ Geometry	○ Sketching drawings and plans ○ Sketching pictures ○ Computing formulas ○ Using drawing instruments	▪ Lecture ▪ demonstration ▪ Film Viewing ▪ Individualized Learning ▪ Direct Student Laboratory Experience	▪ Written /oral ▪ examinations ▪ Direct observation ▪ Project method ▪ Interview	2 hours
	3.4 Store technical drawings and equipment/ instruments	○ Effective ways to catalogue and store technical drawings ○ Manual methods of handling, storing and maintaining paper drawings ○ Storing drawing in digital forms ▪ Scanner ▪ CAD	○ Handling and storing of drawings ○ scanning and storing drawings in digital form ○ Handling and storing drawing instruments	▪ Lecture ▪ demonstration ▪ Film Viewing ▪ Direct Student Laboratory Experience	▪ Written /oral ▪ examinations ▪ Direct observation ▪ Project method ▪ Interview	2 hours
4. Apply Quality Standards	4.1 Assess quality of received materials	○ Relevant production processes, materials and products ○ Characteristics of materials, software and hardware used in production processes ○ Quality checking procedures ○ Quality Workplace procedures ○ Identification of faulty materials	○ Checking quality of materials or component parts as per manufacturer's standards ○ Interpreting specifications or symbols	▪ Field trip ▪ Symposium ▪ Video clips ▪ Simulation/ Role playing ▪ On the job training	▪ Written test ▪ Demonstration & questioning ▪ Observation & questioning	3 hours

Unit of Competency	Learning Outcomes	Learning Contents	Practical Activities	Methodologies	Assessment Methods	Nominal Duration
	4.2 Assess own work	• Safety and environmental aspects of production processes • Fault identification and reporting • Workplace procedure in documenting completed work • Workplace Quality Indicators	• Observing safety and environmental aspects of production processes • Preparing technical reports • Performing procedures in the workplace	▪ Field trip ▪ Symposium ▪ Film showing ▪ Simulation ▪ On the job training	▪ Demonstration & questioning ▪ Observation & questioning ▪ Third party report	3 hours
	4.3 Engage in quality improvement	○ Quality improvement processes ▪ IEC/ISO standards ▪ Environmental and safety standards	○ Implementing continuous improvement	▪ Field trip ▪ Symposium ▪ Film showing ▪ Simulation ▪ On the job training	▪ Demonstration & questioning ▪ Observation & questioning ▪ Third party report	2 hours
5. Perform Computer Operations	5.1 Plan and prepare for task to be undertaken	○ Main types of computers and basic features of different operating systems ○ Main parts of a computer ○ Information on hardware and software ○ Data security guidelines ○ Different Computer specifications	○ Planning and preparing computer operation activity	▪ Modular ▪ Film showing ▪ Computer based training (e-learning) ▪ Project method ▪ On the job training	▪ Demonstration & questioning ▪ Observation & questioning ▪ Assessment of output product ▪ Portfolio ▪ Computer-based assessment	2 hours
	5.2 Input data into computer	○ keyboard and computer user ○ Storage devices and basic categories of memory ○ Relevant types of software	○ Encoding of data ○ Saving encoded data	▪ Modular ▪ Film showing ▪ Computer based training (e-learning) ▪ Project method ▪ On the job training	▪ Demonstration & questioning ▪ Observation & questioning ▪ Assessment of output product ▪ Computer-based assessment	1 hour

Unit of Competency	Learning Outcomes	Learning Contents	Practical Activities	Methodologies	Assessment Methods	Nominal Duration
	5.3 Access information using computer	○ General security, privacy legislation and copyright ○ Productivity Application ▪ Microsoft office applications ○ Business Application ▪ Introduction to Basic Programming software	○ Accessing computer data/files ○ Performing data encoding ○ Creating presentation materials ○ Drafting office communication and documents	▪ Modular ▪ Film showing ▪ Computer based training (e-learning) ▪ Project method ▪ On the job training	▪ Demonstration & questioning ▪ Observation & questioning ▪ Third party report ▪ Assessment of output product ▪ Portfolio ▪ Computer-based assessment	2 hours
	5.4 Produce/ output data using computer system	○ Computer application in printing, scanning and sending facsimile ○ Types and function of computer peripheral devices	○ Printing and scanning of office documents ○ and materials ○ Sending of office/business documents ○ Saving of documents in storage devices ○ CD/DVD ○ USB drives ○ Hard disk drives	▪ Modular ▪ Film showing ▪ Computer based training (e-learning) ▪ Project method ▪ On the job training	▪ Demonstration & questioning ▪ Observation & questioning ▪ Third party report ▪ Assessment of output product ▪ Portfolio ▪ Computer-based assessment	1 hour
	5.5 Maintain computer equipment and systems	○ Computer equipment/system basic maintenance procedures ○ Different types of computer viruses ○ Basic file maintenance procedures	○ Performing cleaning of PC parts/hardware components ○ Scanning/Debugging of computer software and applications ○ Performing cleaning and defragmentation of computer files ○ Performing backup of computer files	▪ Modular ▪ Film showing ▪ Computer based training (e-learning) ▪ Project method ▪ On the job training	▪ Demonstration & questioning ▪ Observation & questioning ▪ Third party report ▪ Portfolio ▪ Computer-based assessment	2 hours

Unit of Competency	Learning Outcomes	Learning Contents	Practical Activities	Methodologies	Assessment Methods	Nominal Duration
6. Terminate and Connect Electrical wiring and Electronic Circuit	6.1 Plan and prepare for termination/ connection of electrical wiring/ electronics circuits	○ Use of handtools and test instruments / equipment ○ Basic Electrical theory and application ○ OH & S guidelines and procedures ○ Basic electrical and electronic devices	○ Preparing hand tools and test equipment for termination ○ Preparing electrical/electronic materials for termination	▪ Film Viewing ▪ Individualized Learning ▪ Direct Student Laboratory Experience ▪ On the Job Training ▪ Project Method	▪ Demonstration and Questioning ▪ Assessment of Output Product	1 hour
	6.2 Terminate/ connect electrical wirings/ electronic circuits	○ Electrical wirings ▪ Wiring techniques ▪ OH & S principles ▪ Specifications and methods for terminating different materials ○ Electronics circuits ▪ Soldering techniques and procedures ▪ OH & S principles ▪ Surface mount soldering techniques ▪ Use of lead-free soldering technology	○ Performing different types of splices ○ Perform soldering techniques and procedures	▪ Film Viewing ▪ Individualized Learning ▪ Direct Student Laboratory Experience ▪ On the Job Training ▪ Project Method	▪ Demonstration and Questioning ▪ Assessment of Output Product	4 hours
	6.3 Test termination/ connections of electrical wiring/ electronics circuits	○ Use of diagnostic equipment ○ Continuity testing and grounding ▪ Electrical ▪ Electronics ○ Functionality test ▪ Electrical ▪ Electronics	○ Performing continuity test ○ Performing functionality test	▪ Film Viewing ▪ Individualized Learning ▪ Direct Student Laboratory Experience ▪ On the Job Training ▪ Project Method	▪ Demonstration and Questioning ▪ Assessment of Output Product	3 hours

Unit of Competency	Learning Outcomes	Learning Contents	Practical Activities	Methodologies	Assessment Methods	Nominal Duration
7. Test electronic components	7.1 Determine criteria for testing electronics components	○ Work Safety requirements and economy of materials with durability ○ Testing Criteria ▪ controls ▪ effectiveness ▪ efficiency ▪ bug detection ▪ functionality, including flow ▪ interoperability ▪ performance ▪ reliability ▪ operating parameters	○ Determining testing criteria for electronics components	▪ Film Viewing ▪ Individualized Learning ▪ Direct Student Laboratory Experience ▪ On the Job Training ▪ Project Method	▪ Demonstration and Questioning ▪ Assessment of Output Product	2 hours
	7.2 Plan an approach for component testing	○ Knowledge in 5S application and observation of required timeframe ○ Work Safety requirements and economy of materials with durability ○ Various testing methods ○ Types of electronic components	○ Proper use of VOM/DMM ○ Observing OH&S principles ○ Identifying electronics components ○ Identifying testing methods	▪ Film Viewing ▪ Individualized Learning ▪ Direct Student Laboratory Experience ▪ On the Job Training ▪ Project Method	▪ Demonstration and Questioning ▪ Assessment of Output Product	2 hours
	7.3 Test components	○ Materials, tools and equipment uses and specifications ▪ Proper care and use of tools ○ Types of electronic components ▪ Passive components ▪ Active components ▪ Dynamic components ▪ Hybrid components ○ Testing methods ▪ automated ▪ debugging ▪ inspection ▪ platform testing	○ Determining testing procedures for electronics components ○ Identifying electronics component parts ○ Applying proper use of testing instruments	▪ Film Viewing ▪ Individualized Learning ▪ Direct Student Laboratory Experience ▪ On the Job Training ▪ Project Method	▪ Demonstration and Questioning ▪ Assessment of Output Product	6 hours

Unit of Competency	Learning Outcomes	Learning Contents	Practical Activities	Methodologies	Assessment Methods	Nominal Duration
		▪ prototyping ○ Measuring capacitance and resistance using VOM/ DMM				
	7.4 Evaluate the testing process	○ Evaluation of testing process and records system ○ Systems and Processes ▪ Analyzing simple circuit using ohms and power law ▪ Analyzing series/parallel circuits using ohms and power law ▪ Analyzing series/parallel capacitances ▪ analyzing series parallel inductors ▪ analyzing rectifier circuits ▪ analyzing amplifier circuit ▪ analyzing multi-vibrator circuit ▪ analyzing logic networks ▪ analyzing sequence circuits	○ Performing data evaluation and records ○ Evaluating functionality and operation of electronic system	▪ Film Viewing ▪ Individualized Learning ▪ Direct Student Laboratory Experience ▪ On the Job Training ▪ Project Method	▪ Demonstration and Questioning ▪ Assessment of Output Product	2 hours

CORE COMPETENCIES

104 hrs

Note: *This course design covers only Mechatronics Servicing NC III level core units. The trainee attending this course must have completed first the units for Mechatronics Servicing NC II level.*

Unit of Competency	Learning Outcomes	Learning Contents	Practical Activities	Methodology	Assessment Approach	Nominal Duration

1. Develop Mechatronics and Automation Control Circuits and PLC Application Programs	1.1 Determine & document mechatronics and automation control circuits requirements	• Logic circuit analysis and development
		  • Sequential circuit
		  • Ladder circuit
		• Operation process flowcharting
		• I/O identification and assignment
		• PLC architecture
		  • PLC data types
		  • PLC modules
		  • PLC hardware configuration
		• Identification of system requirement
			• Identifying the different application of Programmable logic controller (PLC) in a certain sector or industry
			• Enumerating the different considerations in choosing and acquiring a PLC
			• Developing schematic diagrams and power circuits
			• Developing control circuits
			• Following work instructions and manuals
			• Documenting PLC software application program flow
				• Lecture
				• Discussion
				• Demonstration
				• Viewing multimedia
				• Structured learning exercises
					• Written exam
					• Practical exam
						8 hours

	1.2 Develop PLC application program using appropriate code and language	• Standard programming languages
		  • Ladder
		  • Function block diagram (FBD)
		  • Instructions list (IL)
		  • Sequential function flowchart (SFC)
		  • Structured Text Language (STL)
		• PLC programming
		  • Program organization
		  • Data types
			• Applying the different PLC programming language available
			• Configuring the PLC to your programming device
			• Analyzing and Creating PLC programs using basic instructions like relay or bit instructions, timer and counter
			• Creating PLC programs using basic and intermediate instructions
				• Lecture
				• Discussion
				• Demonstration
				• Program simulation
					• Written exam
					• Practical exam
						32 hours

Unit of Competency	Learning Outcomes	Learning Contents	Practical Activities	Methodology	Assessment Approach	Nominal Duration
		• Variables • Configuration • PLC program instructions • Relay / Logic/ Bit • Timer • Counter • Arithmetic instructions • Data manipulation • Program control • PLC programming procedures • Create program • Save and Compile • Downloading / Uploading • Online monitoring • PLC program debugging techniques	• Applying PLC program debugging techniques • Document PLC program developed			
	1.3 Test developed mechatronics and automation control circuits & PLC application program for user acceptance	• PLC to Computer interfacing using different communication protocol • Concepts of I/O driver software • Downloading and uploading procedures of PLC software program • Standard operating procedures for PLC application program • Testing and commissioning techniques for control circuits and PLC application program	• Interfacing PLC to computer using different communication protocol • Downloading/uploading PLC program • Identifying warnings and errors on your programs and its priority. • Distinguishing the different modes of operation of PLC • Applying testing and commissioning techniques for control circuits and PLC application program • Performing online/ offline simulation	• Lecture • Discussion • Demonstration • Program simulation	• Written exam • Practical exam	**8 hours**

Unit of Competency	Learning Outcomes	Learning Contents	Practical Activities	Methodology	Assessment Approach	Nominal Duration

	1.4 Document mechatronics and automation control circuits and PLC application program developed	• Computer software applications
		  • Computer Aided Design (CAD)
		  • Microsoft office application
		• Tagging and labeling of program components
		• Compilation of softcopy and printed formats
			• Applying comments and tags on software programs
			• Saving and converting developed software programs
			• Creating a security or password on your program
			• Printing the whole program or part of the program on applicable sizes
			• Compiling documents
			• CAD drawings of wiring and circuit diagrams
			• Technical reports
				• Lecture
				• Discussion
				• Demonstration
				• Program simulation
					• Written exam
					• Practical exam
						8 hours

2. Develop Motion Control and system configuration	2.1 Determine motion control system requirements	• Motion control elements
		  • Variable Frequency Drive (VFD)
		  • Servo motor
		  • Stepper motor
		• Operation process flowcharting and application
		• Motion control system input and output signals
			• Identifying the different application of AC and DC servo motor in a certain sector or industry
			• Enumerating the different considerations in choosing and acquiring a servo motor
				• Lecture
				• Discussion
				• Hands-on/ Demonstration
				• Viewing multimedia
					• Written exam
					• Practical exam
						4 hours

	2.2 Develop and configure motion control system	• Computer Aided Design Software operation for system diagram • Motion control system operation • Functions and applications of motion control devices • Motion control devices technical specifications	• Connecting and interfacing the motion control system to your system or PLC • Configuring the motion control system on different modes of application • Following work instruction and manuals	• Lecture • Discussion • Hands-on/ Demonstration • Viewing multimedia	• Written exam • Practical exam	**8 hours**

Unit of Competency	Learning Outcomes	Learning Contents	Practical Activities	Methodology	Assessment Approach	Nominal Duration
	2.3 Test developed motion control system for user acceptance.	• Standard operating procedures for testing motion control system • Commissioning procedures for motion control system	• Initializing the operation of the motion control system using simple circuit or instructions. • Evaluating the functionality of the integrated motion control system	• Lecture • Discussion • Hands-on/ Demonstration • Viewing multimedia	• Written exam • Practical exam	**4 hours**
	2.4 Document motion control system developed	• Tagging and labeling of motion control system devices • Compilation of softcopy and printed formats	• Compiling motion control system schematic diagram and parameter settings • Tagging and labeling	• Lecture • Discussion • Hands-on/ Demonstration	• Written exam • Practical exam	**4 hours**
3. Maintain and Repair PLC-based Mechatronics and Automation System	3.1 Plan and prepare for maintenance and repair of PLC-based mechatronics and automation system	• Occupational health and safety standards • PLC-based mechatronics and automation system maintenance procedures • Mechatronics devices specifications • Materials planning and workflow • Proper use of tools	• Enumerating the difference between types of maintenance activity • Demonstrating failure analysis on mechatronics devices and system	• Lecture • Discussion • Hands-on/ Demonstration • Viewing multimedia	• Written exam • Practical exam	4 hours
	3.2 Maintain mechatronics and automation system.	• Maintenance and repair instruction manuals • Use of PPE and OHS procedures • Testing procedures of equipment and devices • Functions and applications of mechatronics and automation devices • Preventive maintenance checklist	• Explaining preventive maintenance and its importance • Using PPE • Practicing 5S • Enumerating and following preventive maintenance procedures and techniques applicable to mechatronics and automation system. • Using and maintaining tools and equipment	• Lecture • Discussion • Hands-on/ Demonstration • Viewing multimedia	• Written exam • Practical exam	**8 hours**

Unit of Competency	Learning Outcomes	Learning Contents	Practical Activities	Methodology	Assessment Approach	Nominal Duration
		• Procedures in responding to unplanned events or condition				

	3.3 Repair mechatronics and automation system	• Fault finding on control circuits
		  • Electro-mechanical
		  • Pneumatic & electro-pneumatic
		  • Hydraulic and electro-hydraulic
		  • Electronic logic
		• Principles of 3R's
		• Environmental Safety on waste segregation
		• Out-of-control action plan (OCAP)
			• Explaining corrective maintenance and its importance
			• Interpreting manufacturer's specification
			• Enumerating corrective maintenance procedures and techniques applicable to mechatronics and automation system.
			• Analyzing causes of fault and perform problem solving techniques in mechatronics and automation system
				• Lecture
				• Discussion
				• Demonstration
				• Viewing multimedia
					• Written exam
					• Practical exam
						8 hours

	3.4 Inspect and test mechatronics and automation system	• Mechatronics and automation devices configuration
		• Final inspection and testing procedures
		• Applicable technical reports
		  • Commissioning
		  • Inspection
		  • Testing
		  • Operation
		• Office software application
		  • Word
		  • Excel
			• Defining the desired outcome on each station in a mechatronics system
			• Distinguishing the final output or outcome of the final stage or station of the system
			• Interpreting manufacturer's specifications
			• Comparing initial test or configuration to final outcome or output.
			• Preparing work report
				• Lecture
				• Discussion
				• Demonstration
					• Written exam
					• Practical exam
						8 hours

3.2 TRAINING DELIVERY

1. The delivery of training shall adhere to the design of the curriculum. Delivery shall be guided by the principles of competency-based TVET.

    a. Course design is based on competency standards set by the industry or recognized industry sector; **(Learning system is driven by competencies written to industry standards)**

    b. Training delivery is learner-centered and should accommodate individualized and self-paced learning strategies;

    c. Training can be done on an actual workplace setting, simulation of a workplace and/or through adoption of modern technology.

    d. Assessment is based in the collection of evidence of the performance of work to the industry required standards;

    e. Assessment of competency takes the trainee's knowledge and attitude into account but requires evidence of actual performance of the competency as the primary source of evidence.

    f. Training program allows for recognition of prior learning (RPL) or current competencies;

    g. Training completion is based on satisfactory performance of all specified competencies.

2. The competency-based TVET system recognizes various types of delivery modes, both on-and off-the-job as long as the learning is driven by the competency standards specified by the industry. The following training modalities and their variations/components may be adopted singly or in combination with other modalities when designing and delivering training programs:

    ### 2.1. Institution- Based:

    - Dual Training System (DTS)/Dualized Training Program (DTP) which contain both in-school and in-industry training or fieldwork components. Details can be referred to the Implementing Rules and Regulations of the DTS Law and the TESDA Guidelines on the DTP;

    - Distance learning is a formal education process in which majority of the instruction occurs when the students and instructor are not in the same place. Distance learning may employ correspondence study, audio, video, computer technologies or other modern technology that can be used to facilitate learning and formal and non-formal training. Specific guidelines on this mode shall be issued by the TESDA Secretariat.

- The traditional classroom-based or in-center instruction may be enhanced through use of learner-centered methods as well as laboratory or field-work components.

2.2 Enterprise-Based:

- **Formal Apprenticeship** – Training within employment involving a contract between an apprentice and an enterprise on an approved apprenticeable occupation.

- **Enterprise-based Training-** where training is implemented within the company in accordance with the requirements of the specific company. Specific guidelines on this mode shall be issued by the TESDA Secretariat.

3.3 TRAINEE ENTRY REQUIREMENTS

The trainees who wish to enter the course should possess the following requirements:

- Must have completed training in Mechatronics Servicing NCII
- Can communicate orally & in writing
- Can perform basic mathematical computations

This list does not include specific institutional requirements such as written entrance exam, and other that may be required of the trainees by the school or training center delivering TVET program.

3.4 LIST OF TOOLS, EQUIPMENT AND MATERIALS

Recommended list of tools, equipment and materials for the training of 25 trainees for Mechatronics Servicing NC III:

TOOLS		EQUIPMENT		MATERIAL	
Qty.	Description	Qty.	Description	Qty.	Description
10 pcs	Long-nosed pliers	5 sets	PLC system	1 spool	Solder lead
10 pcs	Diagonal cutters	5 sets	PLC software	1 spool	Shielded cable
10 pcs	Standard screwdrivers	10 pcs	Multimeters	1 lot	Terminal lugs
10 pcs	Phillips screwdrivers	3 pcs	Transmitters or Transducers	1 lot	Terminal strips/blocks
10 pcs	Electrical pliers	1 pc.	Air compressor	25 pcs	Cotton gloves
10 pcs	Soldering iron	5 pcs	Regulated power supplies	1 lot	Plastic tubing
10 pcs	Adjustable wrench	20 pcs	Cylinder Actuator	1 lot	Quick-connect fittings
5 pcs	Wire stripper	1 pc.	Stepper motor	10 rolls	Electrical tape
5 pcs	Crimping tool	1 pc.	Servomotor	1 lot	Wire markers
5 sets	Allen wrench	2 pc.	Variable frequency drive	1 lot	Cable ties
5 sets	Precision screwdrivers	10 pcs	Buzzers		
		25 pcs	Industrial panel switches		
		10 pcs	Indicating lamps		
		10 pcs	Directional solenoid valves		
		5 pcs	Filter-Regulator-Lubricator set		
		10 pcs	Limit switches		
		10 pcs	Photoelectric switches		
		10 pcs	Proximity switches		
		25 pcs	Relays		
		10 pcs	Magnetic contactors		
		10 pcs	Desktop/Laptop PC		
		5 pcs.	Safety helmet		
		5 pcs.	Safety shoes		
		5 pcs.	Safety harness		
		5 pcs.	Safety glasses/goggles		
		5 pcs.	Ear plugs/ear muffs		
		5 pcs.	Gas mask		

3.5 TRAINING FACILITIES

Based on class size of 25 students/trainees the space requirements for the teaching/learning and circulation areas are as follows:

TEACHING/LEARNING AREAS	SIZE IN METERS	AREA IN SQ. METERS	QTY	TOTAL AREA IN SQ. METERS
Lecture Area	5 x 8	40	1	40
Laboratory Area	5 x 8	40	1	40
Learning Resource Area	4 x 5	20	1	20
Tool Room / Storage Area	4 x 5	20	1	20
Wash ,Toilet & Locker Room	1 x 2	2	1	2
Total				122
Facilities / Equipment / Circulation**				36
Total Area				**158**

***** *Area requirement is equivalent to 30% of the total teaching/learning areas***

3.6 TRAINERS QUALIFICATIONS

- Holder of National TVET Trainer's Certificate (NTTC) Level 1 in Mechatronics Servicing NC III
- Must have at least 2 years mechatronics and automation industry experience.

3.7 INSTITUTIONAL ASSESSMENT

Institutional assessment is undertaken by trainees to determine their achievement of units of competency. A certificate of achievement is issued for each unit of competency.

The result of the institutional assessment may be considered as evidence for the assessment for national certification.

SECTION 4 ASSESSMENT AND CERTIFICATION ARRANGEMENTS

Competency Assessment is the process of collecting evidence and making judgments whether competency has been achieved. The purpose of assessment is to confirm that an individual can perform to the standards expected at the workplace as expressed in relevant competency standards.

The assessment process is based on evidence or information gathered to prove achievement of competencies. The process may be applied to an employable unit(s) of competency in partial fulfillment of the requirements of the national qualification.

4.1 NATIONAL ASSESSMENT AND CERTIFICATION ARRANGEMENTS

4.1.1. To attain the National Qualification of the qualification, the candidate must demonstrate in all the units listed in Section 1. Successful candidates shall be awarded a **National Certificate III** signed by the TESDA Director General.

4.1.2. The qualification of **Mechatronics Servicing NC III** may be attained through:

4.1.2.1. Accumulation of Certificates of Competency (COCs) in all the following units of competencies:

COC #1. Develop Mechatronics and Automation Control Circuits and PLC Application Programs

COC #2. Develop Motion Control and System Configuration

COC #3. Maintain and Repair PLC-based Mechatronics and Automation System

Successful candidates shall be awarded a **Certificate of Competency (COC)** in each of the core units.

4.1.2.2. Demonstration of competence through project-type assessment covering all the units required in the qualification.

4.1.3. Accumulation and submission of all COCs acquired for the relevant units of competency comprising a qualification, an individual shall be issued the corresponding National Certificate (NC).

4.1.4. Assessment shall focus on the core units of competency. The basic and common units shall be integrated or assessed concurrently with the core units.

4.1.5. The following are qualified to apply for assessment and certification:

4.1.5.1. Graduate of formal and non-formal including enterprise-based training programs.

4.1.5.2. Experienced workers (wage employed or self employed)

4.1.6. The existing NCs or COCs in Mechatronics Servicing NC III shall be in effect until the said NCs or COCs have expired. The NCs or COCs in this qualification maybe renewed provided that the:

4.1.6.1. Holders present the evidence that they are currently or have been employed in mechatronics and/or industrial automation job for the past three (3) years;

4.1.6.2. Holders pass the performance assessment of the new COC#2 (Develop Motion Control and System Configuration) under Mechatronics and Automation Servicing NC III.

4.1.7. The conduct of assessment and issuance of certificates shall follow the procedures manual and implementing guidelines developed for the purpose.

4.2 COMPETENCY ASSESSMENT REQUISITE

4.2.1 Self-Assessment Guide. The self-assessment guide (SAG) is accomplished by the candidate prior to actual competency assessment. SAG is a pre-assessment tool to help the candidate and the assessor determine what evidence is available, where gaps exist, including readiness for assessment.

This document can:

a. Identify the candidate's skills and knowledge
b. Highlight gaps in candidate's skills and knowledge
c. Provide critical guidance to the assessor and candidate on the evidence that need to be presented
d. Assist the candidate to identify key areas in which practice is needed or additional information or skills that should be gained prior `

4.2.2 Accredited Assessment Center. Only Assessment Center accredited by TESDA is authorized to conduct competency assessment. Assessment centers undergo a quality assured procedure for accreditation before they are authorized by TESDA to manage the assessment for National Certification.

4.2.3 Accredited Competency Assessor. Only accredited competency assessor is authorized to conduct assessment of competence. Competency assessors undergo a quality assured system of accreditation procedure before they are authorized by TESDA to assess the competencies of candidates for National Certification.

DEFINITION OF TERMS

GENERAL

1) **Certification -** is the process of verifying and validating the competencies of a person through assessment

2) **Certificate of Competency (COC)** – is a certification issued to individuals who pass the assessment for a single unit or cluster of units of competency

3) **Common Competencies** - are the skills and knowledge needed by all people working in a particular industry

4) **Competency** - is the possession and application of knowledge, skills and attitudes to perform work activities to the standard expected in the workplace

5) **Competency Assessment -** is the process of collecting evidence and making judgments on whether competency has been achieved

6) **Competency Standard (CS)** - is the industry-determined specification of competencies required for effective work performance

7) **Context of Assessment** - refers to the place where assessment is to be conducted or carried out

8) **Core Competencies -** are the specific skills and knowledge needed in a particular area of work - industry sector/occupation/job role

9) **Critical aspects of competency -** refers to the evidence that is essential for successful performance of the unit of competency

10) **Elective Competencies -** are the additional skills and knowledge required by the individual or enterprise for work

11) **Elements** - are the building blocks of a unit of competency. They describe in outcome terms the functions that a person performs in the workplace.

12) **Evidence Guide** - is a component of the unit of competency that defines or identifies the evidences required to determine the competence of the individual. It provides information on critical aspects of competency, underpinning knowledge, underpinning skills, resource implications, assessment method and context of assessment

13) **Level -** refers to the category of skills and knowledge required to do a job

14) **Method of Assessment** - refers to the ways of collecting evidence and when, evidence should be collected

15) **National Certificate (NC)** – is a certification issued to individuals who achieve all the required units of competency for a national qualification defined under the Training Regulations. NCs are aligned to specific levels within the PTQF

16) **Performance Criteria** - are evaluative statements that specify what is to be assessed and the required level of performance

17) **Qualification** - is a cluster of units of competencies that meets job roles and is significant in the workplace. It is also a certification awarded to a person on successful completion of a course in recognition of having demonstrated competencies in an industry sector

18) **Range of Variables** - describes the circumstances or context in which the work is to be performed

19) **Recognition of Prior Learning (RPL)** – is the acknowledgement of an individual's skills, knowledge and attitudes gained from life and work experiences outside registered training programs

19) **Resource Implication -** refer to the resources needed for the successful performance of the work activity described in the unit of competency. It includes work environment and conditions, materials, tools and equipment

20) **Basic Competencies -** are the skills and knowledge that everyone needs for work

21) **Training Regulations (TR)** – refers to the document promulgated and issued by TESDA consisting of competency standards, national qualifications and training guidelines for specific sectors/occupations. The TR serves as basis for establishment of qualification and certification under the PTQF. It also serves as guide for development of competency-based curricula and instructional materials including registration of TVET programs offered by TVET providers

22) **Underpinning Knowledge -** refers to the competency that involves in applying knowledge to perform work activities. It includes specific knowledge that is essential to the performance of the competency

23) **Underpinning Skills** - refers to the list of the skills needed to achieve the elements and performance criteria in the unit of competency. It includes generic and industry specific skills

24) **Unit of Competency** – is a component of the competency standards stating a specific key function or role in a particular job or occupation; it is the smallest component of achievement that can be assessed and certified under the PTQF

SECTOR SPECIFIC

25) **Actuator:** In a closed-loop control system, that part of the final control element that translates the control signal into action by the control device.

26) **Automation**: (1) The conversion to and implementation of procedures, processes, or equipment by automated means. (2) Industrial open- or closed-loop control systems in which the manual operation of controls is replaced by servo operation.

27) **CAD**: Computer-Aided Design is the use of high-resolution graphics in a wide range of design activities, allowing quick evaluation and modification of intent. It is commonly used to design architectural, mechanical and electrical engineering drawings.

28) **Conveyor:** A horizontal, inclined or vertical device for moving or transporting bulk materials, packages, or objects in a path predetermined by the design of the device and having points of loading and discharge fixed, or selective.

29) **Ergonomics** --"The systematic application of knowledge about the psychological, physical, and social attributes of human beings in the design and use of all things which affect a person's working conditions: equipment and machinery, the work environment and layout, the job itself, training and the organization of work." (Humansystems Inc).

30) **PLC (Programmable Logic Controller)** : A class of industrially hardened devices that provides hardware interface for input sensors and output actuators. PLCs can be programmed using relay ladder logic to control the outputs based on input conditions and / or algorithms contained in the memory of the PLC.

31) **Robotics**: The study of the design and use of robots, particularly for their use in manufacturing and related processes.

32) **Sensor:** A transducer whose input is a physical phenomenon and whose output is a quantitative measure of the phenomenon.

33) **Sequence control:** The control of a series of machine movements, with the completion of one movement initiating the next. The extent of movements is typically not specified by numerical input data.

34) **Servomechanism**: An automatic device for controlling large amounts of power by means of small amounts of power.

35) **Servomotor**: A power-driven mechanism that supplements a primary control operated by a comparatively feeble force (as in a servomechanism).

36) **Simulation**: (1) A device, system, or computer program that represents certain features of the behavior of a physical or abstract system. Vendors of planning and scheduling, forecasting and demand management, and other types of decision-support systems make growing use of simulation to compare the consequences of alternative courses of action.

37) **Software**: The entire set of programs, procedures, and related documentation associated with a computer.

38) **Static Calibration:** A calibration recording pressure versus output at fixed points at room temperature.

39) **Systems integration**: The ability of computers, instrumentation, and equipment to share data or applications with other components in the same or other functional areas.

ANNEX A - COMPETENCY MAP (*Electrical & Electronics sector*)

BASIC COMPETENCIES

Receive and Respond to Workplace Communication	Work with Others	Demonstrate work values	Practice basic housekeeping procedures	Participate in Workplace Communication
Work in a Team Environment	Practice career professionalism	Practice occupational health and safety procedures	**Lead Workplace Communication**	**Lead Small Team**
Develop and practice negotiation skills	**Solve Problems Related to Work Activities**	**Use mathematical concepts and techniques**	**Use relevant technologies**	Utilize Specialist Communication Skills
Develop Team and Individuals	Apply Problem Solving Techniques in the Workplace	Collect, analyze and organize information	Plan and Organize Work	Promote environmental protection

COMMON COMPETENCIES

Use Hand Tools	**Perform Mensuration and Calculation**	**Prepare and Interpret Technical Drawing**	**Apply Quality Standards**	**Perform Computer Operations**
Terminate and Connect Electrical Wiring and Electronic Circuits	**Test Electronic Components**			

CORE COMPETENCIES

Install Instrumentation and Control Devices	Calibrate Instrumentation and Control Devices	Configure Instrumentation and Control Devices	Loop Check Instrumentation and Control Devices	Maintain and Repair Instrumentation & Control Devices
Start-up Instrumentation and Control Systems	Diagnose and Troubleshoot Instrumentation and Control Systems	Install Mechatronics and Automation Devices	Configure & Test Mechatronics and Automation System	**Maintain and Repair PLC-based Mechatronics and Automation System**
Develop PLC and HMI software application program	Diagnose and Troubleshoot Mechatronics and Automation System	Commission PLC- and HMI-based Mechatronics and Automation System	**Develop Mechatronics and Automation Control Circuits & PLC Software Application Programs**	**Develop Motion Control and System Configuration**
Service and Repair Audio Systems and Products	Service and Repair Video Systems and Products	Service and Repair Business Machines	Assemble and Disassemble Consumer Electronic Products	Maintain and Repair Electronically Controlled Domestic Appliances
Maintain and Repair Audio-Video Products and Systems	Maintain and Repair Cellular Phones	Commission Consumer Electronic Products and Systems	Develop Servicing Systems for Consumer Electronic Products	Train service technician
Manage Servicing Systems for Consumer Electronics Products and Systems	Train service technician supervisors			

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  - Qualifications and Standards Office (QSO)

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2. JULFORD C. ABASOLO	- CSDD-QSO-TESDA
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