No. 1186 **20 September 2002**

SOUTH AFRICAN QUALIFICATIONS AUTHORITY (SAQA)

In accordance with regulation 24(c) of the National Standards Bodies Regulations of 28 March 1998, the Standards Generating Body (SGB) for

Manufacturing and Assembly

Registered by NSB 06, Manufacturing, Engineering and Technology, publishes the following qualifications and unit standards for public comment.

This notice contains the titles, fields, sub-fields, NQF levels, credits, and purpose of the qualification and unit standards upon which qualifications are based. The full qualification and unit standards can be accessed via the SAQA web-site at **www.saqa.org.za**. Copies may also be obtained from the Directorate of Standards Setting and Development at the SAQA offices, 659 Pienaar street, Brookiyn, Pretoria.

Comment on the unit standards should reach SAQA at the address ***below and no later than 21 October 2002*** espondence should be marked **Standards Setting – SGB for Manufacturing and Assembly** and addressed to

The Director: Standards Setting and Development
SAQA
Attention: Mr. D Mphuthing
Postnet Suite 248
Private Bag X06
Waterkloof
0145
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SAMUEL B.A. ISAACS
EXECUTIVE OFFICER

SOUTH AFRICAN QUALIFICATIONS AUTHORITY

National Certificate in Mechatronics: NQF Level 2

Field: Manufacturing, Engineering and Technology - NSB 06

Sub-field: Manufacturing & Assembly

Level: 2

Credit: 140

Issue date:

Review date:

Rationale for the qualification:

The manufacturing industry is characterised by technologically sophisticated automation processes using Computerised Integrated Manufacturing systems (CIM) that integrate the fields of mechanical, electrical and electronic engineering and control and information technology. The field of mechatronics deals with the installation, maintenance and commissioning of such CIM systems that must conform to all safety aspects as per regulations and legislation. People working in the mechatronics field require specialised technical skills and knowledge as well as highly developed hand skills to enable them to install, maintain and commission mechatronic systems.

This is the first qualification in a series for learners who want to follow a career in mechatronics. This series reflects the skills, knowledge and understanding required to perform effectively in industry, whether in micro, small, medium or large enterprises.

For those who have been in the workplace for a long time, this qualification represents part of the RPL process that acknowledges workplace skills acquired without the benefit of formal education and training. For the new entrant, this qualification recognises the applied competence needed by a productive person in a structured workplace.

This qualification forms the basis for further learning in the field of mechatronics.

Purpose of the qualification:

The purpose of this qualification is to provide learners, education providers, training providers and employers with the standard and range of learning required to work effectively in the mechatronics environment and meet the challenges of such an environment.

The primary skills that are recognised by this qualification include the ability to:

- Construct simple parts within given tolerances
- Install, test and maintain basic electrical circuits
- Construct and test electronic circuits

These capabilities require an understanding of basic electrical and electronic theory, engineering drawings and electrical circuit diagrams and concepts of measurement, and an ability to join engineering materials, use tools and use a computer. Hand skills play a large role in this qualification.

Qualifying learners will be able to relate what they see and experience to science and technology principles and concepts.

What learners achieve in this qualification will also serve as a basis for further learning where they will engage more directly in the installation, maintenance and commissioning of mechatronic systems.

Learning assumed to be in place:

This qualification assumes learners have a GETC at NQF level 1 or alternatively, ABET qualifications.

The qualifications must include:

- Literacy
- Numeracy
- Basic concepts of science and technology

Access to the qualification:

Open access

This qualification series recognises skills, knowledge and values relevant to the workplace. It is designed for learners who:

- Have attended courses and then apply the knowledge and skill gained to activities in the workplace
- Are already workers and have acquired the skills and knowledge without attending formal courses
- Are part of a learnership programme which integrates structured learning and work experience

Exit level Outcomes:

Exit level outcome 1

Demonstrate an understanding of basic mechanical engineering in the joining and assembly of parts and in mechanical installations meeting quality requirements and working safely and in environmentally aware manner

Associated Assessment Criteria

- Assemblies meet specifications.
- Safe working practices are adhered to.
- Working drawings and instructions are interpreted correctly.
- Appropriate materials and tools are selected.
- Tools, equipment and materials are correctly stored upon completion of assembly activity.

- Can respond to questions and discuss issues related to the assembly of mechanical components.

Exit level outcome 2

Demonstrate an understanding of basic electrical/electronic engineering theory and the ability to install electrical and electronic components in a circuit that meets quality requirements, working in a safe and environmentally aware manner.

Associated Assessment Criteria

- Appropriate components are selected
- Safe working practices are adhered to
- Cable installation meets quality standards
- Electrical safety practices are adhered to
- Testing and measurement procedures are followed correctly
- Electrical and electronic circuits function to specifications
- Can respond to questions and discuss issues related to the construction of electrical and electronic diagrams

Exit level outcome 3

Demonstrate an ability to generate and retrieve files and store information and an understanding of the logic of using different paths for retrieving files using personal computers.

Associated Assessment Criteria

- Can respond to questions and discuss issues related to computer hardware and software
- Can generate, save and retrieve documents within a computer system.

Exit level outcome 4

Recognise and respond to routine problems related to the assembly of components and the construction of circuits.

Associated Assessment Criteria

- Various options are considered before a solution is chosen
- Lessons learnt in previous performances are used
- Responses are appropriate to the nature of the problem

- Problems are accurately reported to relevant personnel in a timely manner
- Can respond to questions and discuss issues related to routine problems encountered while working

Exit level outcome 5

Communicate with peers and members of supervisory/management levels by demonstrating the ability to summarise information and express opinions on given information in spoken and written form

Associated Assessment Criteria

- Communication is regular and ongoing
- Information is clear and accurate and conveyed in a timely manner
- Relationships with peers and supervisory/management levels are established and functioning

Exit level outcome 6

Demonstrate an understanding of options for further learning in this or a related field of learning and preparation requirements for such learning

Associated Assessment Criteria

- Options are explained
- Preparation requirements are explained.
- Learning plan is developed

International comparability:

As a starting point, the series of qualifications in the field of mechatronics of which this qualification forms a part, was compared to other, similar outcomes-based qualifications, certifications or skills standards in New Zealand and Australia. It was found to be difficult to compare the New Zealand and Australian narrow focus qualifications with these broad-based qualifications in the specialised field of mechatronics. Therefore, extensive reference was made to training materials from Germany and the United States when constructing these qualifications to ensure the relevance of the qualifications content and benchmarking with best practice world wide.

Integrated Assessment:

The integrated assessment must be based on a summative assessment guide. The guide must spell out how the assessor will assess different aspects of the performance and will include:

- Observing the learner at work (both in primary activities as well as other interactions) or by relevant simulations
- Asking questions and initiating short discussions to test understanding
- Looking at records and reports

The learner may choose in which language s/he wants to be assessed. This should be established as part of a process or preparing the learner for assessment and familiarising the learner on the approach being taken.

While this is primarily a workplace-based qualification, evidence from other areas of endeavour may be introduced if pertinent to any of the exit level outcomes.

The assessment process should cover both the explicit tasks required for the qualification as well as the understanding of the concepts and principles that underpin the activities required of mechatronics. The assessment process should also establish how the critical outcomes have been advanced by the learning process

Recognition of prior learning:

This qualification may be obtained through the process of RPL. The learner should be thoroughly briefed prior to the assessment and support provided to assist in the process of developing a portfolio. While this is primarily a work-based qualification, evidence from other areas of endeavour may be introduced if pertinent to any of the exit level outcomes.

Articulation possibilities:

The qualification has been designed and structured so that qualifying learners can move from one context to another. Employers or institutions should be able to evaluate the outcomes of this qualification against the needs of their context and structure top-up learning appropriately. Equally, holders of other qualifications may be evaluated against this qualification for the purpose of RPL.

Moderation options:

Moderators for the qualification should be qualified and accredited with an appropriate ETQA and have a qualification in engineering.

To assure the quality of the assessment process the moderation should cover one of the following:

- Assessor credentials
- The assessment instrument
- The assessment process

Where assessment and moderation are taking place in sectors other than the MERSETA, assessment and moderation should be in terms of a memorandum of understanding negotiated with the MERS ETQA

Criteria for registration of assessors:

The following criteria should be applied by the relevant ETQA:

1. Appropriate qualification in the field of engineering- with a minimum of four years experience in the field of mechatronics. The subject matter experience of the assessor can be established by recognition of prior learning
2. Appropriate experience and understanding of assessment theory, processes and practices
3. Good interpersonal skills and ability to balance the conflicting requirements of:
    - Maintaining national standards
    - The interests of the learner
    - The need for transformation and redressing the legacies of the past
    - The cultural background and language of the learner
4. Registration as an assessor with the MERS ETQA or any other relevant ETQA
5. Any other criteria required by the MERS ETQA or any other ETQA

NATIONAL CERTIFICATE IN MECHATRONICS: NQF LEVEL 2

Fundamental			
NLRD	**Title**	**Level**	**Credits**
	Communication		
8962	Maintain and adapt oral communication	2	5
8963	Access and use information from texts	2	5
8964	Write for a defined context	2	5
	Communicate at work	2	5
	Mathematics		
8982	Demonstrate an understanding of rational and irrational numbers and number systems within the context of relevant calculations	2	3
8983	Use mathematics to investigate and monitor the financial aspects of personal and community life	2	2
9009	Apply basic knowledge of statistics and probability in order to investigate life and work related problems	2	3
9008	Measure, estimate and calculate physical quantities and explore, describe and represent geometrical relationships in two dimensions in different life or workplace contexts	2	3
9007	Work with a range of patterns and basic functions to solve related problems	2	5
	Total fundamental		**36**
Core			
NLRD	**Title**	**Level**	**Credits**
	General		
	Select, use and care for engineering hand tools	2	8
	Select, use and care for engineering power tools	2	6
	Select, use and care for engineering measuring equipment	2	4
	Mark off basic engineering shapes	2	2
	Perform basic welding / joining of metals	2	8
	Read, interpret and produce basic engineering drawings	2	6
	Mechanical assembly		
	Assemble mechanical components	2	12
	Industrial Electronics:		

	Construct and test basic electronic circuits	2	16
	Electrical installations		
	Install, test, maintain and commission basic electrical circuits	2	16
	Safety, health & environmental quality assurance		
	Keep the work area safe and productive	2	8
	Information Technology:		
7547	Operate a personal computer system	2	6
	Total Core		**92**
	Elective		
NLRD	**Safety, Health & Environment**		
	Perform basic first aid	2	4
	Perform basic fire fighting	2	2
	Business Relations		
	Explain the individual's role within business	2	4
	People: interacting, leading and developing		
9322	Work in a team	2	3
	Life Skills		
9268	Manage basic personal finance	2	6
	Understand and deal with HIV/Aids	2	3
	Develop a learning plan and a portfolio for assessment	2	6
	Information Technology:		
7568	Demonstrate knowledge of and produce word processing documents using basic functions	2	3
	Working with Information:		
	Collect and use information	2	5
	Minimum elective credits required for qualification		**10**
	Total for qualification		**140**

SOUTH AFRICAN QUALIFICATIONS AUTHORITY

National Certificate in Mechatronics: NQF Level 3

Field: Manufacturing, Engineering and Technology - NSB 06

Sub-field: Manufacturing & Assembly

Level: 3

Credit: 146

Issue date:

Review date:

Rationale for the qualification:

The manufacturing industry is characterised by technologically sophisticated automation processes using Computerised Integrated Manufacturing systems (CIM) that integrate the fields of mechanical, electrical and electronic engineering and control and information technology. The field of mechatronics deals with the installation, maintenance and commissioning of such CIM systems that must conform to all safety aspects as per regulations and legislation. People working in the mechatronics field require specialised technical skills and knowledge as well as highly developed hand skills to enable them to install, maintain and commission mechatronic systems.

This is the second qualification in a series for learners who want to follow a career in mechatronics. This series reflects the skills, knowledge and understanding required to perform effectively in industry, whether in micro, small, medium or large operations.

For those who have been in the workplace for a long time, this qualification represents part of the RPL process that acknowledges workplace skills acquired without the benefit of formal education and training.

This qualification forms the basis for further learning in the field of mechatronics.

Purpose of the qualification:
The purpose of this qualification is to provide learners, education providers, training providers and employers with the standard and range of learning required to work effectively in the mechatronics environment and meet the challenges of such an environment.

The primary skills that are recognised by this qualification include the ability to:

- Installation, test and commission single phase AC/DC machines, control and switch gear
- Install, test and maintain basic pneumatic systems
- Install, test and maintain basic hydraulic systems
- Program, install and test basic PLC control systems

These capabilities require an understanding of mechanical, electrical and electronic theory, and circuit diagrams, and an ability to machine simple parts using milling machines or lathes. Hand skills play a large role in this qualification.

Qualifying learners will also be able to relate what they are doing to scientific and technological principles and concepts. They will also be able to maintain and support the various policies and procedures related to the safety, health, environment and quality systems that govern their workplace.

What learners achieve in this qualification will also serve as a basis for further learning where they will engage further in the installation, maintenance and commissioning of mechatronic systems.

Learning assumed to be in place:

It is assumed that learners entering a programme towards this qualification have achieved a mechatronics NQF level 2 qualification or have the relevant experience.

Access to the qualification:

Open access.

This qualification series recognises skills, knowledge and values relevant to the workplace. It is designed for learners who:

- Have attended courses and then apply the knowledge and skill gained to activities in the workplace
- Are already workers and have acquired the skills and knowledge without attending formal courses
- Are part of a learnership programme which integrates structured learning and work experience

Exit level Outcomes:

Exit level outcome 1

Demonstrate an understanding of a variety of machining methods and an ability to produce simple components that meet quality and output requirements, working safely and in an environmentally aware manner.

Associated Assessment Criteria

- Output and quality requirements are met
- Safe working practices are adhered to
- Can respond to questions and discuss issues related to the theoretical principles of machining, the various machining methods and the functioning of machinery.

Exit level outcome 2

Demonstrate the understanding of and an ability to install, test and commission basic hydraulic and pneumatic systems, working safely and in an environmentally aware manner.

Associated Assessment Criteria

- Hydraulic and pneumatic system installation, testing and commissioning meets specifications
- Safe working practices are adhered to.
- Can respond to questions and discuss issues related to pneumatic systems

Exit level outcome 3

Demonstrate an understanding of and an ability to install, test, maintain and programme programmable logic controllers (PLCs)

Associated Assessment Criteria

- PLC installation, testing and maintenance meets specifications
- PLC programming meets specifications
- Safe working practices are observed
- Can respond to questions and discuss issues related to PLCs

Exit level outcome 4

Demonstrate the ability to install and configure PC hardware and software

Associated Assessment Criteria

- Hardware and software interfaces and compatibility of hard ware components and system requirements for software are checked
- System components are installed to specifications and hardware is configured.
- Software is installed and configured to software manufacturer's specifications
- Safe working practices are adhered to
- Can respond to questions and discuss issues related to PC hardware and software installation and configuration.

Exit level outcome 5

Select appropriate procedures to solve familiar problems within a mechatronics environment and operate within clearly defined contexts, with some scope for personal decision-making and responsibility

Associated Assessment Criteria

- Appropriate procedures are selected to solve problems in an efficient and effective manner
- Unfamiliar problems are accurately reported to appropriate personnel
- Can respond to questions and discuss issues related to familiar problems in the mechatronics environment

Exit level outcome 6

Communicate with peers, customers and members of supervisory/management levels by demonstrating the ability to gather and summarise information from a range of sources and produce coherent presentations in a prescribed format

Associated Assessment Criteria

- Information is gathered from a range of sources and accurately summarised into a prescribed format.
- Information is clear and accurate and presented in a timely manner in the required format to appropriate parties.
- Relationships with peers and supervisory./management levels are established and functioning

Exit level outcome 7

Demonstrate an understanding of options for further learning in this or a related field of learning and preparation requirements for such learning

Associated Assessment Criteria

- Options are explained
- Preparation requirements are explained.
- Learning plan is developed

International comparability:

As a starting point, the series of qualifications in the field of mechatronics of which this qualification forms a part, was compared to other, similar outcomes-based qualifications, certifications or skills standards in New Zealand and Australia. It was found to be difficult to compare the New Zealand and Australian narrow focus qualifications with these broad-based qualifications in the specialised field of mechatronics. Therefore, extensive reference was made to training materials from Germany and the United States

when constructing these qualifications to ensure the relevance of the qualifications content and benchmarking with best practice world wide.

Integrated Assessment:

The integrated assessment must be based on a summative assessment guide. The guide must spell out how the assessor will assess different aspects of the performance and will include:

- Observing the learner at work (both in primary activities as well as other interactions) or by relevant simulations
- Asking questions and initiating short discussions to test understanding
- Looking at records and reports

The learner may choose in which language s/he wants to be assessed. This should be established as part of a process or preparing the learner for assessment and familiarising the learner on the approach being taken.

While this is primarily a workplace-based qualification, evidence from other areas of endeavour may be introduced if pertinent to any of the exit level outcomes.

The assessment process should cover both the explicit tasks required for the qualification as well as the understanding of the concepts and principles which underpin the activities required of mechatronics. The assessment process should also establish how the critical outcomes have been advanced by the learning process

Recognition of prior learning:

This qualification may be obtained through the process of RPL. The learner should be thoroughly briefed prior to the assessment and support provided to assist in the process of developing a portfolio. While this is primarily a work-based qualification, evidence from other areas of endeavour may be introduced if pertinent to any of the exit level outcomes.

Articulation possibilities:

The qualification has been designed and structured so that qualifying learners can move from one context to another. Employers or institutions should be able to evaluate the outcomes of this qualification against the needs of their context and structure top-up

learning appropriately. Equally, holders of other qualifications may be evaluated against this qualification for the purpose of RPL.

Moderation options

Moderators for the qualification should be qualified and accredited with an appropriate ETQA and have a qualification in engineering.

To assure the quality of the assessment process the moderation should cover one of the following:

- Assessor credentials
- The assessment instrument
- The assessment process

Where assessment and moderation are taking place in sectors other than the MERSETA, assessment and moderation should be in terms of a memorandum of understanding negotiated with the MERS ETQA

Criteria for registration of assessors:

The following criteria should be applied by the relevant ETQA:

1. Appropriate qualification in the field of engineering- with a minimum of four years in a mechatronics environment. The subject matter experience of the assessor can be established by recognition of prior learning
2. Appropriate experience and understanding of assessment theory, processes and practices
3. Good interpersonal skills and ability to balance the conflicting requirements of:
    - Maintaining national standards
    - The interests of the learner
    - The need for transformation and redressing the legacies of the past
    - The cultural background and language of the learner
4. Registration as an assessor with the MERS ETQA or any other relevant ETQA
5. Any other criteria required by the MERS ETQA or any other ETQA

NATIONAL CERTIFICATE IN MECHATRONICS: NQF LEVEL 3

Fundamental			
NLRD	**Title**	**Level**	**Credits**
	Communication		
8968	Accommodate audience and context needs in oral communication	3	5
8969	Interpret and use information from texts	3	5
8970	Write texts for a range of communicative contexts	3	5
9529	Compile feasibility and commissioning reports	3	3
9528	Communicate with clients	3	3
	Mathematics		
9010	Demonstrate an understanding of the use of different number bases and measurement units and an awareness of error in the context of relevant calculations	3	2
9014	Use mathematics to investigate and monitor the financial aspects of personal and business issues	3	5
9012	Investigate life-related problems using data and probabilities	3	5
9013	Measure, estimate and calculate physical quantities and explore, describe and represent, interpret and justify geometrical relationships in two and three dimensional space relevant to the life or workplace of the community	3	4
	Total fundamental		**37**
Core			
NLRD	**Title**	**Level**	**Credits**
	General		
	Operate and monitor a milling machine to produce simple components	2	12
	Operate and monitor a lathe to produce simple components	2	12
	Identify engineering materials, their characteristics and applications and common metals tests and treatments used in engineering	2	4
	Electrical		
	Install, test and maintain single phase AC /DC machines and control gear	3	15
	Hydraulics and Pneumatics		
	Install, test and maintain a basic hydraulics system	3	10
	Install, test and maintain a basic pneumatic system	3	10
	Programmable controllers		
	Install and programme basic programmable logic controllers	3	20
	Information technology		
	Install, use and test hardware and software	3	6
	Quality		
	Apply quality procedures	3	8
	Total Core		**97**
Elective			
NLRD	**Titles**		**Credits**
	General		
8038	Operate a lift truck	3	6

8039	Operate a crane	3	10
	Testing		
	Test the physical properties of engineering metals	3	4
	Perform non-destructive tests on metal parts and components	3	6
	Safety, health and environmental quality assurance		
	Perform the role of a safety, health and environmental protection representative	3	4
	People: interacting, leading, developing		
	Explain and use organisational procedures	3	6
9531	Show understanding of diversity in the workplace	3	3
9533	Use communication skills to handle and resolve conflict in the workplace	3	3
	Develop a personal financial plan	3	2
	Minimum elective credits required		**12**
	Total for qualification		**146**

National Diploma in Rubber Technology: NQF Level 5

Title	Level	Credits	NLRD ID
Communication			
Use communication techniques effectively	5	8	
Mathematics			
Use mathematical and statistical techniques effectively as a rubber technologist	5	34	
Total fundamental		**42**	

Title	Level	Credits	NLRD ID
Rubber Technology			
Test and analyse rubber materials, components and products	5	45	
Determine requirements for rubber applications	5	60	
Perform auditing activities	5	12	
Business skills			
Implement new projects in a rubber manufacturing and assembly process	5	30	
Quality			
Optimise the quality assurance system	5	6	
Business relations			
Maintain business processes	5	10	
People interacting, leading and developing			
Manage a team	5	4	9406
Total Core		**167**	
Titles		**Credits**	**NLRD ID**
Choice of a minimum of 30 elective credits to be drawn from the following learning areas:			
• Business management, e.g. purchasing, stock control, accounting			
• Technical drawing			
• Mercantile law			
• Physics			
Minimum elective credits towards qualification		**30**	
Total for qualification		**249**	

SOUTH AFRICAN QUALIFICATIONS AUTHORITY

National Certificate in Mechatronics: NQF Level 4

Field: Manufacturing, Engineering and Technology - NSB 06

Sub-field: Manufacturing & Assembly

Level: 4

Credit: 151

Issue date:

Review date:

Rationale for the qualification:

The manufacturing industry is characterised by technologically sophisticated automation processes using Computerised Integrated Manufacturing systems (CIM) that integrate the fields of mechanical, electrical and electronic engineering and control and information technology. The field of mechatronics deals with the installation, maintenance and commissioning of such CIM systems that must conform to all safety aspects as per regulations and legislation. People working in the mechatronics field require specialised technical skills and knowledge as well as highly developed hand skills to enable them to install, maintain and commission mechatronic systems.

This is the third qualification in a series for learners who want to follow a career in Mechatronics. This series reflects the skills, knowledge and understanding required to perform effectively in industry, whether in micro, small, medium or large operations.

For those who have been in the workplace for a long time, this qualification represents part of the RPL process that acknowledges workplace skills acquired without the benefit of formal education and training. For the new entrant, this qualification recognises the applied competence needed by a productive person in a structured workplace

This qualification forms the basis for further learning in the field of mechatronics within the higher education band.

Purpose of the qualification:

The purpose of this qualification is to provide learners, education providers, training providers and employers with the standard and range of learning required to work effectively in the mechatronics environment and meet the requirements of such an environment.

The primary skills that are recognised by this qualification include the ability to:

- Installation, test and commission three phase AC/DC machines, control and switch gear
- Use, operate and maintain an industrial robot system
- Install and programme variable speed control drives
- Install, test and maintain electro-pneumatic systems
- Install, test and maintain electro- hydraulic systems
- Install, test and configure bus systems
- Install and program industrial programmable logic controllers

Hand skills and advanced theoretical and analytical skills play a large role in this qualification.

Qualifying learners will also be able to relate what they see and experience to scientific and technological principles and concepts. They will also be able to maintain and

support the various policies and procedures related to the safety, health, environment and quality systems that govern their workplace.

What learners achieve in this qualification will also serve as a basis for further learning in the field of mechatronics within the higher education and training band.

Learning assumed to be in place:

This qualification assumes learners have attained a Mechatronics NQF level 3 qualification or have the relevant experience.

Access to qualification:

Open access

This qualification series recognises skills, knowledge and values relevant to the workplace. It is designed for learners who:

- Have attended courses and then apply the knowledge and skill gained to activities in the workplace
- Are already workers and have acquired the skills and knowledge without attending formal courses
- Are part of a learnership programme which integrates structured learning and work experience

Exit level Outcomes:

Exit level outcome 1

Demonstrate an understanding of and an ability to install, commission, test and maintain three phase AC/DC machines, control and switch gear, working safely and in an environmentally aware manner.

Associated Assessment Criteria

- AC/DC machine installation and commissioning meets specifications
- Testing and maintenance on AC/DC machines meets specifications
- Safe working practices are adhered to
- Can respond to questions and discuss issues related to AC/DC machines

Exit level outcome 2

Demonstrate an understanding of power electronics technology and an ability to install, test and configure manual and software driven variable speed control drives, working safely and in an environmentally aware manner

Associated Assessment Criteria

- Power electronic circuits constructed and tested meet specifications and quality requirements
- Appropriate variable speed control components are selected
- Electrical and mechanical installation meets quality standards
- Software variable speed control drives correctly configured
- Safe working practices are adhered to
- Can respond to questions and discuss issues related to power electronics technology and the installation, testing and configuration of variable speed control drives

Exit level outcome 3

Demonstrate the understanding and ability to install and configure local area network (LAN) and related bus systems

Associated Assessment Criteria

- Networked subsystems meet specifications
- Bus systems installed and configured to specifications
- Can respond to questions and discuss issues related to hardware and software

Exit level outcome 4

Demonstrate an understanding of and an ability to install and programme industrial programmable logic controllers (PLCs), working in a safe and environmentally aware manner

Associated Assessment Criteria

- PLC hardware, software and sensor/actuator addresses of a PLC are configured to specifications
- Advanced PLC control programmes are written to meet job specifications
- Advanced PLC circuits installation and programming meets specifications
- Programme and installations are tested and debugged according to requirements

- Can respond to questions and discuss issues related to industrial PLCs.

Exit level outcome 5

Demonstrate an understanding of and an ability to install and maintain electro-pneumatic and electro-hydraulic systems by interpreting circuit diagrams, performing the necessary tests and installing components, working safely and in an environmentally aware manner.

Associated Assessment Criteria

- Installation meets specifications
- Appropriate tests are performed and results recorded
- Integrated PLC controlled circuit programming meets specifications
- Can respond to questions and discuss issues related to electro-pneumatic and electro-hydraulic systems

Exit level outcome 6

Demonstrate an understanding and ability to programme and use an industrial robot system

Associated Assessment Criteria

- Robot programming meets job requirements and specifications
- Robot is used appropriately meeting quality and output requirements
-
- Safe working practices are adhered to
- Can respond to questions and discuss issues related to the use and programming of industrial robots.

Exit level outcome 7

Maintain and support procedures to solve a variety of problems, both familiar and unfamiliar, within a mechatronics environment and operate within familiar and new situations, taking responsibility and making decisions

Associated Assessment Criteria

- Solutions to problems are based on a clear analysis of information gathered through diagnostic procedures.
- Procedures are modified to respond to unfamiliar problems where appropriate

- Can respond to questions and discuss issues related to familiar and unfamiliar problems arising in the mechatronics environment
- All actions related to problem solving are accurately recorded for future reference

Exit level outcome 8

Communicate and present information clearly and reliably and demonstrate the ability to analyse information to identify problems and determine trends

Associated Assessment Criteria

- Conditions, evidence and incidences are reported accurately in a timely manner and discussed with peers and management
- Data gathered through diagnostic procedures is examined systematically and analysis is repeated until problem is solved.
- Records are available for scrutiny and future reference

Exit level outcome 9

Demonstrate an understanding of options for further learning in this or a related field of learning and preparation requirements for such learning

Associated Assessment Criteria

- Options are explained
- Preparation requirements are explained.
- Learning plan is developed

International comparability:

As a starting point, the series of qualifications in the field of mechatronics of which this qualification forms a part, was compared to other, similar outcomes-based qualifications, certifications or skills standards in New Zealand and Australia. It was found to be difficult to compare the New Zealand and Australian narrow focus qualifications with these broad-based qualifications in the specialised field of mechantronics. Therefore, extensive reference was made to training materials from Germany and the United States when constructing these qualifications to ensure the relevance of the qualifications content and benchmarking with best practice world wide.

Integrated Assessment:

The integrated assessment must be based on a summative assessment guide. The guide must spell out how the assessor will assess different aspects of the performance and will include:

- Observing the learner at work (both in primary activities as well as other interactions) or by relevant simulations
- Asking questions and initiating short discussions to test understanding
- Looking at records and reports

The learner may choose in which language s/he wants to be assessed. This should be established as part of a process or preparing the learner for assessment and familiarising the learner on the approach being taken.

While this is primarily a workplace-based qualification, evidence from other areas of endeavour may be introduced if pertinent to any of the exit level outcomes.

The assessment process should cover both the explicit tasks required for the qualification as well as the understanding of the concepts and principles that underpin the activities required of Mechatronics. The assessment process should also establish how the learning process has advanced the critical outcomes

Recognition of prior learning:

This qualification may be obtained through the process of RPL. The learner should be thoroughly briefed prior to the assessment and support provided to assist in the process of developing a portfolio. While this is primarily a work-based qualification, evidence from other areas of endeavour may be introduced if pertinent to any of the exit level outcomes.

Articulation possibilities:

The qualification has been designed and structured so that qualifying learners can move from one context to another. Employers or institutions should be able to evaluate the outcomes of this qualification against the needs of their context and structure top-up learning appropriately

Equally, holders of other qualifications may be evaluated against this qualification for the purpose of RPL.

Moderation options:

Moderators for the qualification should be qualified and accredited with an appropriate ETQA and have a qualification in engineering.

To assure the quality of the assessment process, the moderation should cover one of the following:

- Assessor credentials
- The assessment instrument
- The assessment process

Where assessment and moderation are taking place in sectors other than the MERSETA, assessment and moderation should be in terms of a memorandum of understanding negotiated with the MERS ETQA

Criteria for registration of assessors:

The following criteria should be applied by the relevant ETQA:

1. Appropriate qualification in the field of engineering- with a minimum of four years in a mechatronics environment. The subject matter experience of the assessor can be established by recognition of prior learning
2. Appropriate experience and understanding of assessment theory, processes and practices
3. Good interpersonal skills and ability to balance the conflicting requirements of:
    - Maintaining national standards
    - The interests of the learner
    - The need for transformation and redressing the legacies of the past
    - The cultural background and language of the learner
4. Registration as an assessor with the MERS ETQA or any other relevant ETQA
5. Any other criteria required by the MERS ETQA or any other ETQA

NATIONAL CERTIFICATE IN MECHATRONICS: NQF LEVEL 4

Fundamental			
NLRD	**Title**	**Level**	**Credits**
	Communication		
8968	Engage in sustained oral communication and evaluate spoken texts	4	5
8969	Read, analyse and respond to a variety of texts	4	5
8970	Write for a wide range of contexts	4	5
9529	Write a technical report	4	4
9528	Communicate in an assertive manner with clients and fellow workers	4	4
	Mathematics		
9014	Use mathematics to investigate and monitor the financial aspects of personal, business and national issues	4	4
9015	Apply knowledge of statistics and probability to critically interrogate and effectively communicate findings on life related problems	4	6
9016	Measure, estimate and calculate physical quantities and explore, critique and prove geometrical relationships in two and three dimensional space in the life and workplace of the adult with increasing responsibilities	4	6
	Total fundamental		**41**
Core			
NLRD	**Title**	**Level**	**Credits**
	Electrical		
	Install, test and maintain three phase AC/DC machines and control gear	4	10
	Robot Technology		
	Programme, use and maintain an industrial robot	4	10
	Pneumatics and Hydraulics		
	Install, test and maintain an electro-pneumatic system	4	20
	Install, test and maintain an electro-hydraulic system	4	15
	Programmable Logic Controllers		
	Install and programme advanced industrial programmable logic controllers	4	20
	Power Electronics		
	Install, test and configure variable speed control drives	4	10
	Information Technology		
	Install, test and configure Bus systems	4	10
	Quality		
	Maintain the quality assurance system	4	5
	Total Core		**100**

SOUTH AFRICAN QUALIFICATIONS AUTHORITY

National Certificate in Mechatronics: NQF Level 5

Field: Manufacturing, Engineering and Technology - NSB 06

Sub-field: Manufacturing & Assembly

Level: 5

Credit: 123

Issue date:

Review date:

Rationale for the qualification:

The manufacturing industry is characterised by technologically sophisticated automation processes using Computerised Integrated Manufacturing systems (CIM) that integrate the fields of mechanical, electrical and electronic engineering and control and information technology. The field of mechatronics deals with the installation, maintenance and commissioning of such CIM systems that must conform to all safety aspects as per regulations and legislation. People working in the mechatronics field require specialised technical skills and knowledge as well as highly developed hand skills to enable them to install, maintain and commission mechatronic systems.

This is the fourth qualification in the certificate series for learners who want to follow a career in mechatronics. This series will reflect the skills, knowledge and understanding required to perform effectively in industry, whether in micro, small, medium or large operations.

For those who have been in the workplace for a long time, this qualification represents part of the RPL process that acknowledges workplace skills acquired without the benefit of formal education and training. For the new entrant, this qualification recognises the applied competence needed by a productive person in a structured workplace.

This qualification forms the basis for further development in the higher education and training band in the field of engineering.

Purpose of the qualification:

The purpose of this qualification is to provide learners, education providers, training providers and employers with the standard and range of learning required to work effectively in the mechatronics environment and meet the requirements of such an environment.

The primary skills that are recognised by this qualification include the ability to:

- Install, maintain, commission and hand over a complex computer integrated manufacturing system
- Ensure optimum quality of production

Hand skills and advanced theoretical and analytical skills play a large role in this qualification.

Qualified learners will also understand:

- How to maintain and influence relationships in a complex production environment
- How to achieve change
- How to work with a range of information sources to optimise performance and quality

With this understanding learners will be able to participate in workplace activities.

Qualifying learners will also be able to relate what they see and experience to scientific and technological principles and concepts. They will also be able to maintain and support the various policies and procedures related to the safety, health, environment and quality systems that govern their workplace.

Learning assumed to be in place:

This qualification assumes learners have attained a Mechatronics NQF level 4 qualification or have the relevant experience.

Access to the qualification:

Open access

This qualification series recognises skills, knowledge and values relevant to the workplace. It is designed for learners who:

- Have attended courses and then apply the knowledge and skill gained to activities in the workplace
- Are already workers and have acquired the skills and knowledge without attending formal courses
- Are part of a learnership programme which integrates structured learning and work experience

Exit level Outcomes:

Exit level outcome 1

Install, test and commission a complex integrated computer manufacturing system

Associated Assessment Criteria

- System parameters are met
- Bus parameterisation is correctly done
- Software is installed and configured to specification
- PLC Programming of system meets specifications
- Can respond to questions and discuss issues related to the installation, testing and commissioning of a complex integrated computer manufacturing system

Exit level outcome 2

Demonstrate the ability to handover computer integrated systems to customers

Associated Assessment Criteria

- Appropriate communication procedures and internal communication systems are used to communicate operating instructions and demonstrate the use of product manuals
- System demonstrations and presentations on equipment are given

Exit level outcome 3

Demonstrate an understanding of how to maintain the efficiencies of an automotive manufacturing and assembly process and how to identify opportunities for optimising such a process

Range: Maintaining and optimising the process includes maintaining and optimising aspects of equipment operation, materials usage and inventory management, the utilisation of personnel, quality, safety, health, and environmental practices

Associated Assessment Criteria

- Production efficiencies are maintained.
- Performance and training issues affecting quality, safety, health, and the environment are identified and reported
- Process output is recorded and trends mapped
- Options to achieve process improvements are generated and tested and reflect a clear understanding of issues

Exit level outcome 4

Demonstrate an understanding of options for further learning in this or a related field of learning and preparation requirements for such learning

Associated Assessment Criteria

- Options are explained
- Preparation requirements are explained
- Learning plan is developed

International comparability:

As a starting point, the series of qualifications in the field of mechatronics of which this qualification forms a part, was compared to other, similar outcomes-based qualifications, certifications or skills standards in New Zealand and Australia. It was found to be difficult to compare the New Zealand and Australian narrow focus qualifications with

these broad-based qualifications in the specialised field of mechatronics. Therefore, extensive reference was made to training materials from Germany and the United States when constructing these qualifications to ensure the relevance of the qualifications content and benchmarking with best practice world wide.

Integrated Assessment:

The integrated assessment must be based on a summative assessment guide. The guide must spell out how the assessor will assess different aspects of the performance and will include:

- Observing the learner at work (both in primary activities as well as other interactions) or by relevant simulations
- Asking questions and initiating short discussions to test understanding
- Looking at records and reports

The learner may choose in which language s/he wants to be assessed. This should be established as part of a process or preparing the learner for assessment and familiarising the learner on the approach being taken.

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4. Registration as an assessor with the MERS ETQA or any other relevant ETQA
5. Any other criteria required by the MERS ETQA or any other ETQA

NATIONAL CERTIFICATE IN MECHATRONICS: NQF LEVEL 5

Fundamental			
NLRD	**Title**	**Level**	**Credits**
	Communication		
	Use communication techniques effectively	5	8
	Mathematics		
	Use mathematical and statistical techniques effectively	5	20
	Total fundamental		**28**

Core			
NLRD	**Title**	**Level**	**Credits**
	General		
	Optimise the production process	5	24
	Computer Integrated Manufacturing System		
	Install, test and maintain a complex integrated manufacturing system	5	20
	Business Relations		
	Maintain business processes	5	10
	Quality		
	Optimise the quality assurance system	5	6
	Total core		**60**

Elective			
NLRD	**Titles**	**Level**	**Credits**
	Robot Technology		
	Install, commission and maintain an industrial robot system	5	15
	General		
	Write computer numerical controlled (CNC) programmes for CNC machining centres using proprietary software	5	30
	Safety, health & environmental quality assurance		
	Optimise the safety, health and environmental protection system	5	6
	People: interacting, leading developing		
9406	Manage a team	5	4
	Develop the skills of the work group	5	10
	Working with information		
9405	Analyse work requirements and plan ahead	5	4
	Minimum elective credits towards qualification		**35**
	Total for qualification		**123**

NATIONAL CERTIFICATE IN MECHATRONICS – NQF LEVEL 2

UNIT STANDARDS ON NQF LEVEL 2

CORE

Title 1: Construct and test basic electronic circuits

Title 2: Install, test, maintain and commission basic electrical circuits

UNIT STANDARDS AND SPECIFIC OUTCOMES FOR THE NATIONAL CERTIFICATE IN MECHATRONICS – NQF LEVEL 2

Title 1: Construct and test basic electronic circuits

Specific outcome 1.1: Discuss and explain the principles of electronics

Specific outcome 1.2: Demonstrate an understanding of the operation of basic electronic circuits

Specific outcome 1.3: Read and interpret basic electronic circuit diagrams

Specific outcome 1.4: Select electronic and related components for circuit construction

- Explain the functions of electronic and related components

Specific outcome 1.5: Test electronic and related components for short circuit and open circuit conditions

- Use appropriate measuring equipment

Specific outcome 1.6: Construct basic electronic circuits

- Diagnose electronic faults

Title 2: Install, test, maintain and commission basic electrical circuits

Specific outcome 2.1: Read and interpret basic electric circuit diagrams and select electrical components

Specific outcome 2.2: Select, terminate and join electric cables

Specific outcome 2.3: Install wire-ways

Specific outcome 2.4: Install basic electrical circuits in accordance with relevant regulations

Specific outcome 2.5: Maintain electrical installations

Specific outcome 2.6: Apply relevant safety practices and procedures when working with electrical equipment

Specific outcome 2.7: Discuss and report incidents and problems related to electrical work

NATIONAL CERTIFICATE IN MECHATRONICS – NQF LEVEL 3

UNIT STANDARDS ON NQF LEVEL 3

CORE

Title 1: Install, test and maintain single phase AC/DC machines and control gear

Title 2: Install, test and maintain a basic hydraulic system

Title 3: Install, test and maintain a basic pneumatic system

Title 4: Install and programme basic programmable logic controllers

Title 5: Install, use and test hardware and software

UNIT STANDARDS AND SPECIFIC OUTCOMES FOR THE NATIONAL CERTIFICATE IN MECHATRONICS – NQF LEVEL 3

Title 1: Install, test and maintain single phase AC/DC machines and control gear

Specific outcome 1.1: Select and install single phase AC/DC machines

Specific outcome 1.2: Test and maintain machines

Specific outcome 1.3: Install control gear

Specific outcome 1.4: Test and maintain control gear

Specific outcome 1.5: Connect machine and switch gear

Specific outcome 1.6: Record information on work done

Specific outcome 1.7: Work safely with due care for self, fellow workers, machines, equipment, materials and the environment

Title 2: Install, test and maintain a basic hydraulic system

Specific outcome 2.1: Read and interpret basic hydraulic circuit diagrams and related component symbols

Specific outcome 2.2: Identify and select hydraulic components

Specific outcome 2.3: Install basic hydraulic circuits

Specific outcome 2.4: Test basic hydraulic circuits and record results

Specific outcome 2.5: Maintain basic hydraulic circuits

Specific outcome 2.6: Work safely with due care for self, fellow workers, machines, equipment, materials and the environment

Title 3: Install, test and maintain a basic pneumatic system

Specific outcome 3.1:	Read and interpret basic pneumatic circuit diagrams and related component symbols
Specific outcome 3.2:	Identify and select pneumatic components
Specific outcome 3.3:	Install basic pneumatic circuits
Specific outcome 3.4:	Maintain basic pneumatic circuits
Specific outcome 3.5:	Work safely with due care for self, fellow workers, machines, equipment, materials and the environment

Title 4: Install and programme basic programmable logic controllers

Specific outcome 4.1:	Identify and explain the function of PLC input devices (sensors) and output devices (actuators)
Specific outcome 4.2:	Design basic PLC sequential control programmes
Specific outcome 4.3:	Install basic PLC circuits
Specific outcome 4.4:	Configure inputs/outputs and test and run the PLC programme
Specific outcome 4.5:	Record information on work done
Specific outcome 4.6:	Work safely with due care for self, fellow workers, machines, equipment, materials and the environment

Title 5: Install, use and test hardware and software

Specific outcome 5.1:	Discuss and explain the installation, use and testing of hardware and software within the context of mechatronics
Specific outcome 5.2:	Install and configure hardware and software
Specific outcome 5.3:	Check hardware and software interfaces
Specific outcome 5.4:	Check compatibility of hardware components and system requirements
Specific outcome 5.5:	Carry out required changes to hardware and software
Specific outcome 5.6:	Document changes made

NATIONAL CERTIFICATE IN MECHATRONICS – NQF LEVEL 4

UNIT STANDARDS ON NQF LEVEL4

CORE

Title 1: Install, test and maintain three phase AC/DC machines and control gear

Title 2: Programme, use and maintain an industrial robot

Title 3: Install, test and maintain an electro-pneumatic system

Title 4: Install, test and maintain an electro-hydraulic system

Title 5: Install and programme advanced industrial programmable logic controllers

Title 6: Install, test and configure variable speed control drives

Title 7: Install, test and configure Bus systems

UNIT STANDARDS AND SPECIFIC OUTCOMES FOR THE NATIONAL CERTIFICATE IN MECHATRONICS – NQF LEVEL 4

Title 1: Install, test and maintain three phase AC/DC machines and control gear

Specific outcome 1.1: Select and install three phase AC/DC machines

Specific outcome 1.2: Test and maintain machines

Specific outcome 1.3: Install control gear

Specific outcome 1.4: Test and maintain control gear

Specific outcome 1.5: Connect machine and switch gear

Specific outcome 1.6: Record information on work done

Specific outcome 1.7: Work safely with due care for self, fellow workers, machines, equipment, materials and the environment

Title 2: Programme, use and maintain an industrial robot system

Specific outcome 2.1: Demonstrate an understanding of and an ability to apply the relevant robot safety

Specific outcome 2.2: Identify and explain the function of the various parts of an industrial robot

Specific outcome 2.3: Demonstrate an understanding of and an ability to use the handheld teach pendant

Specific outcome 2.4: Demonstrate an understanding of and an ability to maintain the manipulator

Specific outcome 2.5: Remove and install in-line wrist, toothed belts and motor units

Specific outcome 2.6: Programme the industrial robot using simple motion programmes

Specific outcome 2.7: Run and test industrial robot motion programmes

Title 3: Install, test and maintain an electro-pneumatic system

Specific outcome 3.1: Read and interpret electro-pneumatic circuit diagrams and related component symbols

Specific outcome 3.2: Identify and select electro-pneumatic components

Specific outcome 3.3: Install manual electro- pneumatic circuits

Specific outcome 3.4: Construct and programme an integrated PLC controlled electro-pneumatic circuit

Specific outcome 3.5: Maintain electro-pneumatic circuits

Specific outcome 3.6: Work safely with due care for self, fellow workers, machines, equipment, materials and the environment

Title 4: Install, test and maintain an electro-hydraulic system

Specific outcome 4.1: Read, interpret electro- hydraulic circuit diagrams and related component symbols

Specific outcome 4.2: Identify and select electro-hydraulic components

Specific outcome 4.3: Install electro- hydraulic circuits

Specific outcome 4.4: Test electro-hydraulic circuits and record results

Specific outcome 4.5: Construct and programme an integrated PC controlled electro-pneumatic circuit

Specific outcome 4.6: Maintain electro-hydraulic circuits

Title 5: Install and programme advanced industrial programmable logic controllers

Specific outcome 5.1: Identify and explain the function of PLC sensors/actuators

Specific outcome 5.2: Configure PLC hardware and software

Specific outcome 5.3: Design advanced PLC control programmes

Specific outcome 5.4: Install and programme advanced PLC circuits

Specific outcome 5.5: Test and run advanced PLC programmes

Title 6: Install, test and maintain variable speed control drives

Specific outcome 6.1: Read and interpret power electronic circuit diagrams

Specific outcome 6.2: Build power electronic circuits

Specific outcome 6.3: Install industrial variable speed control units

Specific outcome 6.4: Maintain installations

Title 7: Install, test and configure Bus systems

Specific outcome 7.1: Install Local Area Networks and bus systems

Specific outcome 7.2: Install Bus hardware

Specific outcome 7.3: Configure Bus software

Specific outcome 7.4: Install input/output units

Specific outcome 7.5: Record information on work done

NATIONAL CERTIFICATE IN MECHATRONICS – NQF LEVEL 5

UNIT STANDARDS ON NQF LEVEL 5

CORE

Title 1: Optimise the production process

Title 2: Install, test and maintain a complex computer integrated manufacturing system

ELECTIVE

Title 3: Install, commission and maintain and industrial robot system

UNIT STANDARDS AND SPECIFIC OUTCOMES FOR THE NATIONAL CERTIFICATE IN MECHATRONICS – NQF LEVEL 5

Title 1: Optimise the production process

Specific outcome 1.1: Analyse data to identify opportunities for improvement

Specific outcome 1.2: Generate and test options to achieve improvement

Specific outcome 1.3: Generate plan for optimisation

- Make recommendations in a way that draws support for process improvement

Specific outcome 1.4: Implement improved recommendations

- Ensure all stakeholders understand their role in process improvement

Specific outcome 1.5: Adjust and update operating procedures

Specific outcome 1.6: Explain and discuss optimising issues with workgroup and other partners

Specific outcome 1.7: Understand the impact and the interrelationship of changes on production quality and output and production costs

Title 2: Install, test and maintain a complex computer integrated manufacturing system

Specific outcome 2.1: Read and interpret CIM system installation diagrams

Specific outcome 2.2: Identify, select, install and integrate CIM sub-systems

Specific outcome 2.3: Test, measure and record information

Specific outcome 2.4: Programme CIM systems

Specific outcome 2.5: Maintain complex CIM systems

Specific outcome 2.6: Work safely with due care for self, fellow workers, machines, equipment, materials and the environment

Title 3:	**Install, commission and maintain and industrial robot system**
Specific outcome 3.1:	Demonstrate an understanding of and an ability to install an industrial robot system and peripherals
Specific outcome 3.2:	Demonstrate an understanding of commissioning and an ability to commission an industrial robot system • Configure software
Specific outcome 3.3:	Demonstrate an understanding of and an ability to maintain the industrial controller • Read and interpret controller circuit diagrams • Perform fault analysis
Specific outcome 3.4:	Record information on work done