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**GOVERNMENT NOTICES**

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**SOUTH AFRICAN QUALIFICATIONS AUTHORITY**

. 676

19 June 2009

**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 Processes**

registered by Organising Field 06 – Manufacturing, Engineering and Technology, publishes the following Qualification 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. The full Qualification and Unit Standards can be accessed via the SAQA web-site at [www.saqqa.org.za](http://www.saqqa.org.za). Copies may also be obtained from the Directorate of Standards Setting and Development at the SAQA offices, SAQA House, 1067 Arcadia Street, Hatfield, Pretoria.

Comment on the Qualification and Unit Standards should reach SAQA at the address below and **no later than 20 July 2009**. All correspondence should be marked **Standards Setting – SGB for Manufacturing and Assembly Processes** and addressed to

The Director: Standards Setting and Development  
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D. MPHUTHING

ACTING DIRECTOR: STANDARDS SETTING AND DEVELOPMENT



## SOUTH AFRICAN QUALIFICATIONS AUTHORITY

**QUALIFICATION:**  
**National Certificate: Mechatronics**

<b>SAQA QUAL ID</b>	<b>QUALIFICATION TITLE</b>		
67629	National Certificate: Mechatronics		
<b>ORIGINATOR</b>		<b>PROVIDER</b>	
SGB Manufacturing and Assembly Processes			
<b>QUALIFICATION TYPE</b>	<b>FIELD</b>	<b>SUBFIELD</b>	
National Certificate	6 - Manufacturing, Engineering and Technology	Engineering and Related Design	
<b>ABET BAND</b>	<b>MINIMUM CREDITS</b>	<b>NQF LEVEL</b>	<b>QUAL CLASS</b>
Undefined	142	Level 2	Regular-Unit Stds Based

**This qualification replaces:**

Qual ID	Qualification Title	NQF Level	Min Credits	Replacement Status
22770	National Certificate: Mechatronics	Level 2	140	Will occur as soon as 67629 is registered

**PURPOSE AND RATIONALE OF THE QUALIFICATION**

Purpose:

Mechatronics is essentially about engineering, computer hardware, software and network systems and how they interface, in an integrated manner, to produce a consistent and functional outcome.

The primary skills that are recognized 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.

Entrants into a technical work and learning environment need to be exposed to both the theoretical and practical aspects of the discipline. 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.

On completion, qualifying learners are able to:

- Join engineering materials.
- Use engineering tools (hand and power), equipment.
- Operate a computer.

The Qualifying learner will be able to:

- Assemble mechanical components.
- Construct and test basic electronic circuits.

- Install, test, maintain and commission basic electrical circuits.
- Keep the work area safe and productive.
- Mark off basic engineering shapes.
- Use a Graphical User Interface based word processor to format documents.
- Perform basic welding/join metals.
- Read, interpret and produce basic engineering drawings.
- Select, use and care for engineering hand tools.
- Select, use and care for engineering measuring equipment.
- Select, use and care for engineering power tools.
- Explain and apply an understanding of basic digital circuits.

Through this qualification the learner gains competencies required for entry level work, as a technical assistant, in most fields of engineering.

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

#### Rationale:

This manufacturing industry is characterised by technologically sophisticated automation processes using Computerised Integrated Manufacturing systems (CIM's) that integrate the fields of mechanical, electrical, electronic, engineering, 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 regulation and legislation. People working in the Mechatronics field require specialized 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.

The NQF Level 2 Qualification is foundational in nature. It seeks to develop the necessary foundational theoretical, practical skills and orientation that learners require as the basis for further learning in the field of Mechatronics. It introduces the learner to key concepts that will be useful at higher levels in the qualification series.

In the South African context in line with global trends there is a growing need for technical workers from the lowest elementary levels of mechanised manufacturing to the highest level of sophisticated specialised work in robotics. For example motor manufacturers and other mechanised mass manufacturers are increasingly reliant on employees that are competent in the integrated fields that make up the field of Mechatronics. The fact that global players for example in the motor industry are increasingly using South Africa as a manufacturing base for export purposes is indicative of the continued growth outlook in the long-term.

#### **RECOGNIZE PREVIOUS LEARNING?**

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#### **LEARNING ASSUMED IN PLACE**

This Qualification assumes that learners are already competent in Communication and Mathematical Literacy at NQF Level 1 or equivalent.

Recognition of Prior Learning:

This Qualification can be achieved wholly or in part through Recognition of Prior Learning. Whether a learner attends formal courses or acquires the required skills through informal means, competency must be shown in the Unit Standard as set out in the rules of combination and in the Exit Level Outcomes of the Qualification.

The Qualification and the Unit Standards have been written in such a way that the learning has to be assessed in an integrated way. Assessors will assess evidence to establish what the learners know, understand and can do. Such evidence may be gathered through course related activities and/or through work related activities. In cases where learners do not attend formal learning programs, assessors should seek work related evidence as far as possible.

Assessors should ensure that learners submitting themselves to RPL are thoroughly briefed prior to assessment. Learners may be required to submit a Portfolio of Evidence in the prescribed format to be assessed for formal recognition.

Access to the Qualification:

Access is open.

#### **QUALIFICATION RULES**

The Qualification consists of Fundamental, Core and Elective Unit Standards. A minimum of 142 Credits is required to achieve this Qualification. The Credits are allocated as follows:

Fundamental Component:

The Fundamental component of this Qualification consists of 9 Unit Standards in both Communication and Mathematical Literacy. All the Fundamental Unit Standard totalling 36 Credits are compulsory for all learners.

Core Component:

The core component of this Qualification consists of 12 Unit Standards totalling 103 Credits are the Core Unit Standards totalling at least 3 Credits. All the Core Unit Standards are compulsory.

Elective Component:

The elective component consists of 9 elective Units Standards. The learner must choose Unit Standards totalling at least 3 Credits to complete the Qualification.

#### **EXIT LEVEL OUTCOMES**

1. Demonstrate an understanding of basic mechanical engineering in the joining and assembly of parts and mechanical installations.
2. Demonstrate an understanding of basic electrical/electronic engineering theory and the ability to install electrical and electronic components in a circuit.
3. Generate and retrieve files and store information using personal computers.
4. Recognise and respond to routine problems related to the assembly of components and the construction of circuits.
5. Communicate with peers and members at supervisory/management levels.

Critical Cross-Field Outcomes:

This will be achieved when qualifying learners:

Identify and solve problems:

- Identify tools, equipment, materials and components correctly.
- Identify and solve problems.
- Identify and bring options to mechanical situations.
- Identify key elements to own learning plan.
- Present solutions to problems identified.
- Testing and maintenance standards are met.

Work effectively with others as a member of a team or organisation:

- Maintain relationships with peers, supervisors and management.

Organise and manage oneself and one's activities responsibly and effectively:

- Respond appropriately to working conditions.
- Apply work procedures appropriately to meet work requirements.

Collect, analyse, organise and critically evaluate information:

- Observe safety electrical and mechanical standards.
- Assemble installations to meet quality standards.

Communicate effectively by using Mathematical and language skills in the modes of oral and written presentations:

- Communicate effectively with peers, supervisors and management.

Use Science and Technology effectively and critically, showing responsibility towards the environment and health of others:

- Apply occupational health, safety and environmental requirements in the workplace.
- Adhere to sector standards.
- Use and care for equipment properly.

Demonstrate an understanding of the world as a set of related systems by recognizing that problem solving contexts do not exist in isolation:

- Provide appropriate solutions to needs identified.
- Demonstrate relationships between components, systems and applications.
- Apply occupational health, safety and environmental requirements in the workplace.
- Assist team members.

#### **ASSOCIATED ASSESSMENT CRITERIA**

Associated Assessment Criteria for Exit Level Outcome 1:

- 1.1 Assemblies meet specifications according to quality requirements.
- 1.2 Safe working practices are adhered to according to worksite procedures.
- 1.3 Working drawings and instructions are interpreted according to drawing methods.
- 1.4 Materials and tools are selected according to assembly requirement.
- 1.5 Tools, equipment and materials are stored upon completion of assembly activity according to worksite procedures.
- 1.6 Issues related to the assembly of mechanical components are discussed.

Associated Assessment Criteria for Exit Level Outcome 2:

- 2.1 Components are selected according to drawing and circuit requirements.
- 2.2 Safe working practices are adhered to according to worksite procedures.
- 2.3 Cable installation meets quality standards.
- 2.4 Electrical safety practices are adhered to according to standard operating procedures.
- 2.5 Testing and measurement are done according to procedures.
- 2.6 Electrical and electronic circuits function to specifications and meets quality requirements.

Associated Assessment Criteria for Exit Level Outcome 3:

- 3.1 Issues related to the selection and use of computer hardware and software are discussed.
- 3.2 Documents are generated, saved and retrieved using a computer system.

Associated Assessment Criteria for Exit Level Outcome 4:

- 4.1 Various options are considered before a solution is chosen.
- 4.2 Lessons learnt in previous performances are used to improve performance and solve problem
- 4.3 Responses are appropriate to the nature of the problem.
- 4.4 Problems are accurately reported to relevant personnel in a timely manner.

Associated Assessment Criteria for Exit Level Outcome 5:

- 5.1 Communication is regular and ongoing in accordance with organization standard procedures.
- 5.2 Information is clear and accurate and conveyed in a timely manner.
- 5.3 Relationships with peers and supervisory/management levels are established and functioning.
- 5.4 The ability to summarise information is demonstrated in written and spoken form.

Integrated Assessment:

Integrated assessment evaluates the learner's ability to combine actions and ideas across a range of activities and knowledge areas. The integrated assessment must specifically assess the learner's ability to:

- Demonstrate competence by means of the practical application of the embedded knowledge in a manner that meets the required performance standards.
- Illustrate a clear understanding of the concepts, theory and principles that underpin the practical action taken.

The assessment will require assessment methods which measure and evaluate evidence generated during learning and on-the-job activities. Because assessment practices must be open and transparent, fair, valid and reliable; ensuring that no learner is disadvantaged in any way whatsoever, an integrated assessment approach is incorporated into the Qualification.

A variety of methods must be used in assessment tools and activities must be appropriate to the context in which the learner is working or will work. Where it is not possible to assess the learner at the workplace, simulations, case studies role plays and other similar techniques should be used to provide a context appropriate to the assessment.

The term integrated assessment implies that theoretical and practical components should be assessed together. Whenever possible, the assessment of knowledge, skills, attitudes and values shown in the Unit Standards should be integrated and, during integrated assessment, the assessor should make use of a range of formative and summative assessment tools and

methods. Combinations of practical, applied, foundational and reflective competencies should be assessed. Assessment should further ensure that all specific outcomes, embedded knowledge and Critical Cross Field Outcomes are evaluated in an integrated way.

Assessors must assess and give credit for the evidence of learning that has already been acquired through formal, informal and non-formal learning and work experience as the assessment process is capable of being applied to RPL, subject to the rules and criteria of the relevant ETQA.

### **INTERNATIONAL COMPARABILITY**

The comparative review is made from leading technology countries that have a competitive edge in Mechatronics, namely the United Kingdom (UK), the United States of America (USA) and Germany. The language barrier made it a challenge to access training in countries like Japan and South Korea.

In this international comparability survey, the various ways of achieving a Mechatronics qualification and the various course configuration sets are reviewed. Comparable aspects of the various programs in terms of entry requirements, credits awarded, approaches to learning and work, as well as Exit Level Outcomes are highlighted.

The United Kingdom (UK):

There are a number of avenues for a Higher National Certificate (HNC) Course code (HNC 6HHH; HNC/EMt) and the National Diploma (HND) Course code (HND 63HH; HND/EMt).

Various organisations approach the achievement of Mechatronics qualifications in different ways. For example, ASME's uses a case study-problem solving with video demonstrations. The emphasis is placed on physical understanding rather than being mathematically oriented.

Moray College Scotland [Scottish Qualifications Authority (SQA):

The SQA enables the provision of Mechatronics at Higher Level (Higher Engineering Frameworks) through the Higher National Certificate (HNC) Ref G87M 15 and the Higher National Diploma (HND) Ref G87M 16.

The following is a course outline for the Mowray College, in Scotland, for the HNC Mechatronics award:

Entrance Requirements.

Passes in:

- Three SQA standard grades.
- Two SQA at Higher grade.
- Five GCSE subjects including one at an advanced level.
- 'O' level passes should include English (Communication), Mathematics and Physics.

Duration: HNC full time 1 year; part time 2 years or more. HND full time 2 years, part time 4-5 years.

Progression: After HNC further study, one may include HND Mechatronics, BSc Mechatronics Engineering or a related course at Level 1. After the HND, further study may include BSc Mechatronics Engineering or a related course, with the possibility of entering at Level 2.

Key elements of the Scottish qualification in relation to the South African Qualification Scottish Qualifications Authority (SQA) HNC Mechatronics Engineering; G87L 15 Level 2; Core units (excluding optional units):

- Common Core.
- Communication.
- Mathematics for Engineering 1: Electronics and Electrical.
- Mechatronic Systems Elements.
- Mechatronic Systems.
- Interfacing Electronics.
- Electrical Engineering Principles 1.
- Engineering Principles.
- Computer Aided Draughting for Engineers.
- Robotics and Animatronics : An introduction.

Level 3; Core units (excluding optional units):

- Communication.
- Common core.
- Mathematics for Engineering 1: Electronics and Electrical.
- Mechatronic Systems Elements.
- Mechatronic Systems.
- Interfacing Electronics.
- Electrical Engineering Principles 1.
- Engineering Principles.
- Computer Aided Draughting for Engineers.
- Robotics and Animatronics : An introduction.

Level 4; Core units (excluding optional units):

- Communication.
- Common core.
- Mathematics for Engineering 1: Electronics and Electrical.
- Mechatronic Systems Elements.
- Mechatronic Systems.
- Interfacing Electronics.
- Electrical Engineering Principles 1.
- Engineering Principles.
- Computer Aided Draughting for Engineers.

Bridwater College, UK:

Higher National Certificate in Mechatronics Engineering:

Course Structure (Core modules-C): Business Management Techniques, Analytical methods for Engineers, Engineering, Project, Plant and process principles others, engineering design, pneumatics and hydraulics, programmable logic controllers, further Mechatronics, digital and analogue electronics.

Entry requirements: A Level 3 qualification, preferably in the numerate or engineering discipline.

Duration: 1 day a week for two years.

Post study opportunities; A broad range of opportunities in engineering systems, design and manufacturing, maintenance, electronics, maintenance, as a technician, Engineer, Technician or Project Leader.



#### United States of America (USA):

Mechatronics is of particular importance to the US military, where Congress ordered, in 2000, that a third of ground vehicles in the military must become robotic by 2015 (robots are currently being used by the US military in Iraq and Afghanistan). This is according to the Undergraduate Mechatronics course design project at the United States Military Academy (USMA).

There are number of community college level, undergraduate and graduate levels of study in Mechatronics. Community level college courses allow grade 12 level learners to study a semester based diploma program.

#### Germany:

##### SIEMENS Certified Mechatronic Systems Assistant Programme:

The international group, Siemens, runs the WORKFORCE SKILLS QUALIFICATIONS (WSQ) program. Its own elite international technical college (Siemens Technik Akademie Berlin) has developed the Siemens Mechatronic Systems Certifications Programme (SMSCP). It is offered by partnering schools worldwide including the Kentucky Community and Technical College System (North America), Nanjing College of Information Technology (China), Amatrol (U.S) and VCAT (Germany).

The course aims to equip workers in: precision engineering, mechatronics, medical technology, marine and electronics related industry sectors with up-to-date information in operations, maintenance and designing of an integrated mechatronic system.

Trainees are issued with the WSQ Certified Mechatronic Systems Assistant (WSQ CMSA) Certificate upon successful completion of the programme and passing the modular assessments and the Siemens Level 1 Certification Examination.

##### Siemens Technik Akademie Berlin:

##### Certified mechatronic systems assistant programme:

##### Level 1; Siemens Certified Mechatronic Systems Assistant:

- Electrical Components.
- Mechanical Components and Electric Drivers.
- (Electro) Pneumatic and Hydraulic Circuits.
- Digital Fundamentals and Programmable Logic Controllers (PLCs).

##### Level 2; Siemens Certified Mechatronic Systems Associate:

- Process control technologies.
- Introduction to Manufacturing processes.
- Totally Integrated Automation (TIA).
- Automation systems.
- Motor control.
- Mechanics and machine elements.

##### Level 3; Siemens Certified Mechatronic Systems Professional:

- Mechatronics.
- Customised Automation Solutions with TIA.
- System Design.

- Diagnostics, Control Systems and Optimisation.
- System Design.
- Diagnostics, Control Systems and Optimisation.
- Dynamics of Machinery and Kinematics.
- Learning assumed.

The SIEMENS Level 1 programme is tailored for workers who are currently employed or for those who wish to be employed in the manufacturing & automation industry as Mechatronic Systems Operator, Machine/Equipment Operator, and Line Leader.

Articulation:

The WSQ CMSA certification is jointly issued by WDA and SPE Berlin and is recognised both locally and internationally. In addition, trainees who complete Level 1 of the programme may attain the "Precision Engineering Workforce Skills Qualification Certificate" by completing another 9 modules of the PE WSQ programme, or the "Precision Engineering Workforce Skills Qualification Higher Certificate" by completing another 6 modules under the PE WSQ framework.

Up-skilling Opportunities: Workers can be up-skilled through hands-on training in complex mechatronic systems, systems management, troubleshooting and repair of systems malfunctions, systems design and process optimisation.

Career options on completion:

Level 1: Machine Operators can become Senior Machine Operators.

Level 2: A Mechatronic Systems Technician who completes Level 2 of the programme may progress to become a Supervisor or Senior Technician.

Level 3: An Assistant Engineer who completes Level 3 of the programme may move up to the position of Engineer.

Conclusion:

The international comparability exercise demonstrates that the courses, qualifications and learning programmes surveyed all have common outcomes and similar learning areas of focus. However content at equivalent levels may vary due to areas of emphasis, as well as the nature and nuanced application of study programmes related to a corporate programme, like that of SIEMENS workplace.

#### **ARTICULATION OPTIONS**

The qualification articulates horizontally to:

- ID 48473: National Certificate: Electrical Engineering, Level 2.

The Qualification articulates vertically to:

- ID 57877: National Certificate: Production Machining, Level 3.
- ID 58288: National Certificate: Electro-Mechanic, Level 3.
- ID 59569: National Certificate: Electronics, Level 3.
- ID 48475: National Certificate: Electrical Engineering, Level 3.

#### **MODERATION OPTIONS**

- Anyone assessing a learner or moderating the assessment of a learner against the qualification must be registered as an assessor with the relevant Education, Training, Quality, Assurance (ETQA) Body, or with an ETQA that has a Memorandum of Understanding with the relevant ETQA.

- Any institution offering learning that will enable the achievement of this qualification must be accredited as a provider with the relevant Education, Training, Quality, Assurance (ETQA) Body, or with an ETQA that has a Memorandum of Understanding with the relevant ETQA.

- Assessment and moderation of assessment will be overseen by the relevant Education, Training, Quality, Assurance (ETQA) Body, or by an ETQA that has a Memorandum of Understanding with the relevant ETQA, according to the ETQA's policies and guidelines for assessment and moderation.

- Moderation must include both internal and external moderation of assessments, unless ETQA policies specify otherwise. Moderation should also encompass achievement of the competence described in the associated unit standards.

- Anyone wishing to be assessed against this qualification may apply to be assessed by any assessment agency, assessor or provider institution that is accredited by the relevant ETQA.

#### CRITERIA FOR THE REGISTRATION OF ASSESSORS

The following criteria should be applied by the relevant ETQA:

- An appropriate qualification in the field of engineering, at NQF Level 3 or higher with a minimum of four years' experience in the field of Mechatronics.
- Registration as an assessor with the relevant ETQA.

#### NOTES

This qualification replaces qualification 22770, "National Certificate: Mechatronics", NQF Level 2, 140 Credits.

#### UNIT STANDARDS

	ID	UNIT STANDARD TITLE	LEVEL	CREDITS
Fundamental	119463	Access and use information from texts	Level 2	5
Fundamental	9009	Apply basic knowledge of statistics and probability to influence the use of data and procedures in order to investigate life related problems	Level 2	3
Fundamental	12461	Communicate at work	Level 2	5
Fundamental	7480	Demonstrate understanding of rational and irrational numbers and number systems	Level 2	3
Fundamental	9008	Identify, describe, compare, classify, explore shape and motion in 2-and 3-dimensional shapes in different contexts	Level 2	3
Fundamental	119454	Maintain and adapt oral/signed communication	Level 2	5
Fundamental	7469	Use mathematics to investigate and monitor the financial aspects of personal and community life	Level 2	2
Fundamental	9007	Work with a range of patterns and functions and solve problems	Level 2	5
Fundamental	119456	Write/present for a defined context	Level 2	5
Core	253440	Assemble mechanical components	Level 2	12
Core	264996	Construct and test basic electronic circuits	Level 2	16
Core	13136	Install, test, maintain and commission basic electrical circuits	Level 2	16
Core	13220	Keep the work area safe and productive	Level 2	8
Core	13238	Mark off basic engineering shapes	Level 2	2
Core	258679	Operate and monitor a lathe	Level 2	12
Core	119753	Perform basic welding/joining of metals	Level 2	8
Core	12215	Read, interpret and produce basic engineering drawings	Level 2	6
Core	119744	Select, use and care for engineering hand tools	Level 2	8
Core	12476	Select, use and care for engineering measuring equipment	Level 2	4
Core	12219	Select, use and care for engineering power tools	Level 2	6
Core	117924	Use a Graphical User Interface (GUI)-based word processor to format documents	Level 2	5

	<b>ID</b>	<b>UNIT STANDARD TITLE</b>	<b>LEVEL</b>	<b>CREDITS</b>
Elective	13217	Collect and use information	Level 2	5
Elective	12465	Develop a learning plan and a portfolio for assessment	Level 2	6
Elective	12466	Explain the individual's role within business	Level 2	4
Elective	9268	Manage basic personal finance	Level 2	6
Elective	12484	Perform basic fire fighting	Level 2	4
Elective	12483	Perform basic first aid	Level 2	4
Elective	12463	Understand and deal with HIV/AIDS	Level 2	3
Elective	9322	Work in a team	Level 2	3

**LEARNING PROGRAMMES RECORDED AGAINST THIS QUALIFICATION****None**



## SOUTH AFRICAN QUALIFICATIONS AUTHORITY

**QUALIFICATION:**  
**National Certificate: Mechatronics**

<b>SAQA QUAL ID</b>	<b>QUALIFICATION TITLE</b>		
67609	National Certificate: Mechatronics		
<b>ORIGINATOR</b>		<b>PROVIDER</b>	
SGB Manufacturing and Assembly Processes			
<b>QUALIFICATION TYPE</b>	<b>FIELD</b>	<b>SUBFIELD</b>	
National Certificate	6 - Manufacturing, Engineering and Technology	Manufacturing and Assembly	
<b>ABET BAND</b>	<b>MINIMUM CREDITS</b>	<b>NQF LEVEL</b>	<b>QUAL CLASS</b>
Undefined	141	Level 3	Regular-Unit Stds Based

*This qualification replaces:*

Qual ID	Qualification Title	NQF Level	Min Credits	Replacement Status
22771	National Certificate: Mechatronics	Level 3	141	Will occur as soon as 67609 is registered

**PURPOSE AND RATIONALE OF THE QUALIFICATION**

Purpose:

Mechatronics is essentially about engineering, computer hardware, software and network systems and how they interface, in an integrated manner, to produce a consistent and functional outcome.

Professionals working in the Mechatronics field are required to install, maintain and generally see to the effective running of the various aspects of the system.

The National Certificate: Mechatronics Level 3 develops competencies required to install, test, and commission systems. The systems involved are pneumatic, hydraulic and PLC control systems.

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

- Install, 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.

The Qualification enables the qualifying learner to:

- Identify engineering materials, their characteristics and applications and common metal tests used in engineering.
- Operate and monitor a lathe to produce simple components.
- Operate and monitor a milling machine to produce simple components.
- Apply quality procedures.
- Install and program basic programmable logic controllers.

- Install, test and maintain a basic hydraulic system.
- Install, test and maintain a basic pneumatic system.
- Install, test and maintain single phase AC/DC machines and control gear.
- Install, use and test hardware and software.
- Demonstrate an understanding of basic digital circuits.
- Explain the principles of computer networks.

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

Through this qualification, the learner gains competencies required to work, as a technical assistant in most fields of engineering, in the various sectors of the economy.

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.

#### Rationale:

The manufacturing industry is characterised by technologically sophisticated automation processes using Computerised Integrated Manufacturing systems (CIM's) that integrate the fields of mechanical, electrical, electronic, engineering, 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 level of the qualification is about installing, testing and commissioning Mechatronics systems. It is about enabling qualifying learners with the skills to perform basic installation and related functions in the various systems with which they operate.

In the South African context, in line with global trends there is a growing need for technical workers from the lowest elementary levels of mechanised manufacturing to the highest level of sophisticated specialised work in robotics. Motor manufacturers and other mechanised mass manufacturers are increasingly reliant on employees that are competent in the integrated fields that make up the field of Mechatronics. The fact that global players in e.g. the motor industry are increasingly using South Africa as a manufacturing base for export purposes is indicative of the continued growth outlook in the long-term.

#### **RECOGNIZE PREVIOUS LEARNING?**

Y

#### **LEARNING ASSUMED IN PLACE**

It is assumed that learners are competent in:

- Communication at NQF Level 2.
- Mathematical Literacy at NQF Level 2

#### Recognition of Prior Learning:

This Qualification can be achieved wholly or in part through Recognition of Prior Learning. Whether a learner attends formal courses or acquires the required skills through informal means, the same standards apply as per the matrix of unit standards and Exit Level Outcomes.

The Qualification and the Unit Standards have been written in such a way that the learning has to be assessed in an integrated way. Assessors will assess evidence to establish what the learners know, understand and can do. Such evidence may be gathered through course related activities and/or through work related activities. In cases where candidates do not attend formal learning programs, assessors should seek work related evidence as far as possible.

Assessors should ensure that learners submitting themselves to RPL are thoroughly briefed prior to assessment. Learners could be required to submit a Portfolio of Evidence in the prescribed format to be assessed for formal recognition.

Access to the qualification:

- Access to the qualification is open to all learners who have completed the National Certificate: Mechatronics, Level 2 .

### **QUALIFICATION RULES**

The Qualification consists of Fundamental, Core and Elective Unit Standards. A minimum of 141 credits is required to achieve this Qualification. The credits are allocated as follows:

Fundamental Component:

- The Fundamental component of this Qualification consists of 9 Unit Standards in both Communication and Mathematical Literacy. All Unit Standards totalling 36 Credits are compulsory for all learners.

Core Component:

- The Core component consists of 11 Unit Standards totalling 99 Credits. All the core Unit Standards are compulsory for all the learners.

Elective Component:

- The Elective Component consists of 9 elective Units Standards. The qualifying learner must choose elective Unit Standards totalling a minimum of 6 Credits in order to meet the Qualification requirements.

### **EXIT LEVEL OUTCOMES**

1. Demonstrate an understanding of a variety of machining methods and an ability to produce simple components.
2. Demonstrate understanding of and an ability to install, test and commission basic hydraulic and pneumatic systems.
3. Install, test, maintain and programme Programmable Logic Controllers (PLCs).
4. Install and configure PC hardware and software.
5. Solve familiar problems within a Mechatronics environment.
6. Communicate in the Mechatronics environment.

Critical Cross-field Outcomes:

This will be achieved when qualifying learners:

- Identify and solve problems:
  - Identify key elements to own learning plan.
  - Present solutions to problems identified.
  - Testing and maintenance standards are met.
  
- Work effectively with others as a member of a team or organisation:
  - Contribute to team and operational goals.
  - Adhere to operational procedures.
  - Support team members in adhering to procedures relating to work roles to be carried out.
  - Adhere to team and organisational protocols.
  
- Organise and manage oneself and one's activities responsibly and effectively:
  - Install systems test and commission related work in a compliant manner.
  - Install PLC's, test and commission related work in a compliant manner.
  - Install software and hardware related work in a compliant manner.
  
- Collect, analyse, organise and critically evaluate information:
  - Conduct tests to systems, software and hardware.
  
- Communicate effectively by using mathematical and language skills in the modes of oral and written presentations:
  - Gather and use information related to own and team's work from a range of sources.
  - Present information in the prescribed format to role players.
  
- Use science and technology effectively and critically, showing responsibility towards the environment and health of others. This will be achieved when qualifying learners:
  - Install systems in a compliant manner.
  
- Demonstrate an understanding of the world as a set of related systems by recognizing that problem solving contexts do not exist in isolation:
  - Provide appropriate solutions to needs identified.
  - Apply occupational safety rules.

#### **ASSOCIATED ASSESSMENT CRITERIA**

Associated Assessment Criteria for Exit Level Outcome 1:

- 1.1. Output and quality requirements are met according to worksite requirements.
- 1.2. Safe working practices are adhered to during working procedures.
- 1.3. Machining is discussed according to theoretical and practical principles, and functioning of machinery.

Associated Assessment Criteria for Exit Level Outcome 2:

- 2.1. Hydraulic and pneumatic system installation, testing and commissioning meets specifications.
- 2.2. Pneumatic and Hydraulic systems are discussed according to theoretical and practical principles, and installation requirements.

Associated Assessment Criteria for Exit Level Outcome 3:

- 3.1. PLC installation, testing and maintenance meet specifications.
- 3.2. PLC programming meets specifications.
- 3.3. PLC's are discussed according to PLC systems, principles and requirements.

Associated Assessment Criteria for Exit Level Outcome 4:



- 4.1. Hardware and software interfaces, compatibility of hardware components and system requirements for software are checked according to system requirements.
- 4.2. System components are installed and hardware is configured according to specifications.
- 4.3. Software is installed and configured to software manufacturer's specifications.
- 4.4. PC hardware and software installation and configuration are discussed according to system requirements.

Associated Assessment Criteria for Exit Level Outcome 5:

- 5.1. Appropriate procedures are selected to solve problems in an efficient and effective manner.
- 5.2. Unfamiliar problems are accurately reported to appropriate personnel.
- 5.3. Familiar problems in the Mechatronics environment are discussed according to their impact and possible solutions.

Associated Assessment Criteria for Exit Level Outcome 6:

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

Integrated assessment:

Integrated assessment evaluates the learner's ability to combine actions and ideas across a range of activities and knowledge areas. The integrated assessment must specifically assess the learner's ability to:

- Demonstrate competence by means of the practical application of the embedded knowledge in a manner that meets the required performance standards required.
- Illustrate a clear understanding of the concepts, theory and principles that underpin the practical action taken.

The assessment will require assessment methods which measure and evaluate evidence generated during learning and on-the-job activities. Because assessment practices must be open and transparent, fair, valid and reliable; ensuring that no learner is disadvantaged in any way whatsoever, an integrated assessment approach is incorporated into the Qualification.

A variety of methods must be used in assessment tools and activities must be appropriate to the context in which the learner is working or will work. Where it is not possible to assess the learner at the workplace, simulations, case studies role plays and other similar techniques should be used to provide a context appropriate to the assessment.

The term integrated assessment implies that theoretical and practical components should be assessed together. Whenever possible, the assessment of knowledge, skills, attitudes and values shown in the Unit Standards should be integrated and, during integrated assessment, the assessor should make use of a range of formative and summative assessment tools and methods. Combinations of practical, applied, foundational and reflective competencies should be assessed. Assessment should further ensure that all specific outcomes, embedded knowledge and critical cross field outcomes are evaluated in an integrated way.

Assessors must assess and give credit for the evidence of learning that has already been acquired through formal, informal and non-formal learning and work experience as the

assessment process is capable of being applied to RPL, subject to the rules and criteria of the relevant ETQA.

### **INTERNATIONAL COMPARABILITY**

Introduction:

Mechatronics is an engineering discipline that combines, in a synergistic way, aspects of electronics, electrical engineering, computers and mechanical engineering. It is the application of complex decision making to the operation of physical systems.

The comparative review is made from leading technology countries that have a competitive edge in Mechatronics, namely the United Kingdom (UK), the United States of America (USA) and Germany. The language barrier made it a challenge to access countries like Japan and South Korea.

In this international comparability survey, the various ways of achieving a Mechatronics qualification and the various course configuration sets are reviewed. Comparable aspects of the various programs in terms of entry requirements, credits awarded, approaches to learning and work, as well as exit level outcomes are highlighted.

The United Kingdom (UK):

There are a number of avenues for a Higher National Certificate (HNC) Course code (HNC 6HHH; HNC/EMt) and the National Diploma (HND) Course code (HND 63HH; HND/EMt).

Various organisations approach the achievement of Mechatronics qualifications in different ways. For example, ASME's uses a case study-problem solving with video demonstrations. The emphasis is placed on physical understanding rather than being mathematically oriented.

Moray College Scotland (Scottish Qualifications Authority (SQA).

The SQA enables the provision of Mechatronics at Higher Level (Higher Engineering Frameworks) through the Higher National Certificate (HNC) Ref G87M 15 and the Higher National Diploma (HND) Ref G87M 16.

The following is a course outline for the Mowray College, in Scotland, for the HNC Mechatronics award.

Entrance Requirements:

Passes in:

- Three SQA Standard Grades.
- Two SQA at Higher Grade.
- Five GCSE subjects including one at an advanced level.
- 'O' level passes should include English (Communication), Mathematics and Physics.

Duration: Higher National Certificate (HNC) full time 1 year; part time 2 years or more. Higher National Diploma full time 2 years, part time 4-5 years.

Progression: After Higher National Certificate (HNC) further study, one may include Higher National Diploma (HND) Mechatronics, BSc Mechatronics Engineering or a related course at level 1. After the Higher National Diploma (HND), further study may include BSc Mechatronics Engineering or a related course, with the possibility of entering at level 2.

Key elements of the Scottish qualification in relation to the South African Qualification Scottish Qualifications Authority (SQA) HNC Mechatronics Engineering: G87L 15.

Level 2: Core units (excluding optional units):

- Common Core.
- Communication.
- Mathematics for Engineering 1: Electronics and Electrical.
- Mechatronic Systems Elements.
- Mechatronic Systems.
- Interfacing Electronics.
- Electrical Engineering Principles 1.
- Engineering Principles.
- Computer Aided Draughting for Engineers.
- Robotics and Animatronics :An introduction.

Level 3: Core units (excluding optional units):

- Communication.
- Common core.
- Mathematics for Engineering 1: Electronics and Electrical.
- Mechatronic Systems Elements.
- Mechatronic Systems.
- Interfacing Electronics.
- Electrical Engineering Principles 1.
- Engineering Principles.
- Computer Aided Draughting for Engineers.
- Robotics and Animatronics :An introduction.

Level 4: Core units (excluding optional units):

- Communication.
- Common core.
- Mathematics for Engineering 1: Electronics and Electrical.
- Mechatronic Systems Elements.
- Mechatronic Systems.
- Interfacing Electronics.
- Electrical Engineering Principles 1.
- Engineering Principles.
- Computer Aided Draughting for Engineers.

Bridwater College, UK:

Higher National Certificate in Mechatronics Engineering:

Course Structure (Core modules; C): Business Management Techniques, Analytical methods for Engineers, Engineering, Project, Plant and process principles others: engineering design, pneumatics and hydraulics, programmable logic controllers, further Mechatronics, digital and analogue electronics.

Entry requirements; A Level 3 qualification, preferably in the numerate or engineering discipline.  
Duration: 1 day a week for two years.

Post study opportunities; A broad range of opportunities in engineering systems, design and manufacturing, maintenance, electronics, maintenance, as a technician, Engineer, Technician or Project Leader.

United States of America (USA):

Mechatronics is of particular importance to the US military, where Congress ordered, in 2000, that a third of ground vehicles in the military must become robotic by 2015 (robots are currently being used by the US military in Iraq and Afghanistan). This is according to the Undergraduate Mechatronics course design project at the United States Military Academy (USMA).

There are number of community college level, undergraduate and graduate levels of study in Mechatronics. Community level college courses allow Grade 12 level learners to study a semester based diploma program.

Germany:

Siemens Certified Mechatronic Systems Assistant Programme.

The international group, Siemens, runs the Workforce Skills Qualification (WSQ) program. Its own elite international technical college (Siemens Technik Akademie Berlin) has developed the Siemens Mechatronic Systems Certifications Programme (SMSCP). It is offered by partnering schools worldwide including the Kentucky Community and Technical College System (North America), Nanjing College of Information Technology (China), Amatrol (U.S) and VCAT (Germany).

The course aims to equip workers in: precision engineering, mechatronics, medical technology, marine and electronics related industry sectors with up-to-date information in operations, maintenance and designing of an integrated mechatronic system.

Trainees are issued with the WSQ Certified Mechatronic Systems Assistant (WSQ CMSA) Certificate upon successful completion of the programme and passing the modular assessments and the Siemens Level 1 Certification Examination.

Siemens Technik Akademie Berlin.

Certified mechatronic systems assistant programme:

Level 1: Siemens Certified Mechatronic Systems Assistant:

- Electrical Components.
- Mechanical Components and Electric Drivers.
- (Electro) Pneumatic and Hydraulic Circuits.
- Digital Fundamentals and Programmable Logic Controllers (PLCs).

Level 2: Siemens Certified Mechatronic Systems Associate:

- Process control technologies.
- Introduction to Manufacturing processes.
- Totally Integrated Automation (TIA).
- Automation systems.
- Motor control.
- Mechanics and machine elements.

Level 3: Siemens Certified Mechatronic Systems Professional:

- Mechatronics.
- Customised Automation Solutions with TIA.
- System Design.
- Diagnostics, Control Systems and Optimisation.

- System Design.
- Diagnostics, Control Systems and Optimisation.
- Dynamics of Machinery and Kinematics.
- Learning assumed.

The Siemens Level 1 programme is tailored for workers who are currently employed or for those who wish to be employed in the manufacturing and automation industry as Mechatronic Systems Operator, Machine/Equipment Operator, and Line Leader.

Articulation:

The WSQ CMSA certification is jointly issued by WDA and SPE Berlin and is recognised both locally and internationally. In addition, trainees who complete Level 1 of the programme may attain the "Precision Engineering Workforce Skills Qualification Certificate" by completing another 9 modules of the PE WSQ programme, or the "Precision Engineering Workforce Skills Qualification Higher Certificate" by completing another 6 modules under the PE WSQ framework.

Up-skilling Opportunities; Workers can be up-skilled through hands-on training in complex mechatronic systems, systems management, troubleshooting and repair of systems malfunctions, systems design and process optimisation.

Career options on completion:

- Level 1; Machine Operators can become Senior Machine Operators.
- Level 2; A Mechatronic Systems Technician who completes NQF Level 2 of the programme may progress to become a Supervisor or Senior Technician.
- Level 3; An Assistant Engineer who completes NQF Level 3 of the programme may move up to the position of Engineer.

Conclusion:

The international comparability exercise demonstrates that the courses, qualifications and learning programs surveyed all have common outcomes and similar learning areas of focus. However content at equivalent levels may vary due to areas of emphasis, as well as the nature and nuanced application of study programmes related to a corporate program, like that of Siemens workplace.

### **ARTICULATION OPTIONS**

Articulation options:

The Qualification articulates horizontally to:

- ID 57877: National Certificate: Production Machining, Level 3.
- ID 58288: National Certificate: Electro-Mechanic, Level 3.
- ID 59569: National Certificate: Electronics, Level 3.

Vertically option:

- ID 57885: Further Education Training College: CNC Production Machining.
- ID 58861: Further Education Training College: Electro-Mechanical Winding.
- ID 58270: Further Education Training College: Electro-Mechanics.
- ID 58697: Further Education Training College: Electronic Security Installation Practices.
- ID 63849: Further Education Training College: Electronics.

### **MODERATION OPTIONS**

- Anyone assessing a learner or moderating the assessment of a learner against the qualification must be registered as an assessor with the relevant Education, Training, Quality, Assurance (ETQA) Body, or with an ETQA that has a Memorandum of Understanding with the relevant ETQA.
- Any institution offering learning that will enable the achievement of this qualification must be accredited as a provider with the relevant Education, Training, Quality, Assurance (ETQA) Body, or with an ETQA that has a Memorandum of Understanding with the relevant ETQA.
- Assessment and moderation of assessment will be overseen by the relevant Education, Training, Quality, Assurance (ETQA) Body, or by an ETQA that has a Memorandum of Understanding with the relevant ETQA, according to the ETQA's policies and guidelines for assessment and moderation.
- Moderation must include both internal and external moderation of assessments, unless ETQA policies specify otherwise. Moderation should also encompass achievement of the competence described in the associated unit standards.
- Anyone wishing to be assessed against this qualification may apply to be assessed by any assessment agency, assessor or provider institution that is accredited by the relevant ETQA.

#### **CRITERIA FOR THE REGISTRATION OF ASSESSORS**

- Anyone assessing a learner against this qualification must be registered with the relevant ETQA as an assessor.
- Any institution offering learning that will enable the achievement this Qualification must be accredited as a provider with the relevant ETQA. Assessment will be overseen by the relevant ETQA according to the policies and guidelines for assessment of that ETQA, in terms of agreements reached around assessment and between various ETQA's (including professional bodies).
- Anyone wishing to be assessed against this Qualification may apply to be assessed by any assessment agency, assessor or provider institution that is accredited by the relevant ETQA.

The options as listed above provide the opportunity to ensure that assessment and moderation can be transparent, affordable, valid reliable and non-discriminatory.

For an applicant to register as an assessor or moderator of this Qualification, the applicant needs:

- To be registered as an assessor with the relevant ETQA.
- To be in possession of a relevant Qualification at NQF Level 4 or higher.

#### **NOTES**

This qualification replaces qualification 22771, "National Certificate: Mechatronics", Level 3, 141 credits.

#### **UNIT STANDARDS**

	ID	UNIT STANDARD TITLE	LEVEL	CREDITS
Fundamental	119472	Accommodate audience and context needs in oral/signed communication	Level 3	5
Fundamental	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	Level 3	2
Fundamental	9013	Describe, apply, analyse and calculate shape and motion in 2-and 3-dimensional space in different contexts	Level 3	4

	ID	UNIT STANDARD TITLE	LEVEL	CREDITS
Fundamental	119457	Interpret and use information from texts	Level 3	5
Fundamental	9012	Investigate life and work related problems using data and probabilities	Level 3	5
Fundamental	119467	Use language and communication in occupational learning programmes	Level 3	5
Fundamental	7456	Use mathematics to investigate and monitor the financial aspects of personal, business and national issues	Level 3	5
Fundamental	119465	Write/present/sign texts for a range of communicative contexts	Level 3	5
Core	12477	Identify engineering materials, their characteristics and applications and common metal tests used in engineering	Level 2	4
Core	258678	Operate and monitor a milling machine	Level 2	12
Core	13234	Apply quality procedures	Level 3	8
Core	253074	Demonstrate an understanding of basic digital circuits	Level 3	6
Core	14913	Explain the principles of computer networks	Level 3	5
Core	13134	Install and program basic programmable logic controllers	Level 3	20
Core	260723	Install, test and maintain a basic fluid power system	Level 3	8
Core	13139	Install, test and maintain a basic pneumatic system	Level 3	10
Core	13141	Install, test and maintain single phase AC/DC machines and control gear	Level 3	10
Core	13138	Install, use and test hardware and software	Level 3	6
Core	13154	Install, test and maintain three phase AC/DC machines and control gear	Level 4	10
Elective	12429	Develop a personal financial plan	Level 3	2
Elective	12456	Explain and use organisational procedures	Level 3	6
Elective	8039	Operating cranes	Level 3	10
Elective	8038	Operating lift trucks	Level 3	6
Elective	13260	Perform non-destructive tests on metal parts and components	Level 3	6
Elective	12455	Perform the role of a safety, health and environmental protection representative	Level 3	4
Elective	116720	Show understanding of diversity in the workplace	Level 3	3
Elective	13274	Test the physical properties of engineering metals	Level 3	4
Elective	9533	Use communication skills to handle and resolve conflict in the workplace	Level 3	3

### LEARNING PROGRAMMES RECORDED AGAINST THIS QUALIFICATION

None



## SOUTH AFRICAN QUALIFICATIONS AUTHORITY

### QUALIFICATION:

### *Further Education and Training Certificate: Mechatronics*

SAQA QUAL ID		QUALIFICATION TITLE	
67649		Further Education and Training Certificate: Mechatronics	
ORIGINATOR		PROVIDER	
SGB Manufacturing and Assembly Processes			
QUALIFICATION TYPE	FIELD	SUBFIELD	
Further Ed and Training Cert	6 - Manufacturing, Engineering and Technology	Manufacturing and Assembly	
ABET BAND	MINIMUM CREDITS	NQF LEVEL	QUAL CLASS
Undefined	157	Level 4	Regular-Unit Stds Based

***This qualification does not replace any other qualification and is not replaced by another qualification.***

#### **PURPOSE AND RATIONALE OF THE QUALIFICATION**

Purpose:

Mechatronics is essentially about engineering, computer hardware, software and network systems and how they interface, in an integrated manner, to produce a consistent and functional outcome.

For this reason, professionals working in the Mechatronics field are required to install, maintain and generally see to the effective running of the various aspects of the system.

The Mechatronics NQF Level 4 qualification is about competencies required to install, test, and configure systems at an advanced level. The various systems include industrial network systems, electro-hydraulic systems, electro-pneumatic systems, industrial robot systems.

At this level, learners get involved with large systems that are typically used in a modern manufacturing plant that makes use of robotics for large scale manufacturing production.

The Qualification will enable qualifying learners to:

- Install and programme advanced industrial programmable logic controllers.
- Install, test and configure industrial network systems.
- Install, test and configure variable speed control devices.
- Install, test and maintain electro-hydraulic system.
- Install, test and maintain electro-pneumatic system.
- Install, test and maintain three phase AC/DC machines and control gear.
- Maintain the quality assurance system.
- Programme, use and maintain an industrial robot system.
- Maintain Specialized Sensing Devices.

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

Qualifying learners 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.



Through this qualification, the learner gains competencies required for industrial systems work, as a technical assistant, in most fields of engineering, in the various sectors of the economy. At NQF Level 4, however, the learner is able to function with minimum supervision. Depending on the work context, the qualifying person is able to pursue learning opportunities as an apprentice.

**Rationale:**

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. In addition to being able to operate systems, the learner should be able to understand and apply sensing devices, as well as variable speed control devices. This will enable the qualifying person to operate in an automated industrial production setting.

In the South African context-in line with global trends-there is a growing need for technical workers from the lowest elementary levels of mechanised manufacturing to the highest level of sophisticated specialised work in robotics. Motor manufacturers and other mechanised mass manufacturers are increasingly reliant on employees that are competent in the integrated fields that make up the field of Mechatronics.

The fact that global players in the motor industry are increasingly using South Africa as a manufacturing base for export purposes is indicative of the continued growth outlook in the long-term.

**RECOGNIZE PREVIOUS LEARNING?**

Y

**LEARNING ASSUMED IN PLACE**

This assume that learners are competent in:

- Communication at NQF Level 3.
- Mathematical Literacy at NQF Level 3.

**Recognition of Prior Learning:**

This Qualification can be achieved wholly or in part through Recognition of Prior Learning. Whether a learner attends formal courses or acquires the required skills through informal means, the same standards apply as per the matrix of Unit Standards and Exit Level Outcomes.

The Qualification and the Unit Standards have been written in such a way that the learning has to be assessed in an integrated way. Assessors will assess evidence to establish what the learners know, understand and can do. Such evidence may be gathered through course related activities and/or through work related activities. In cases where candidates do not attend formal learning programs, assessors should seek work related evidence as far as possible.

Assessors should ensure that learners submitting themselves to RPL are thoroughly briefed prior to assessment. Learners will be required to submit a Portfolio of Evidence in the prescribed format to be assessed for formal recognition.

Where courses are provided for learners, institutions can use the Unit Standards and this Qualification to assess learning achievements. For learners who are not able to achieve the outcomes, providers can then use the Unit Standards and Qualification to determine a specific learning program to suit the learning needs of the candidate.

Access to the qualification:

Access to the qualification is open to learners who have completed the National Certification: Mechatronics at NQF Level 3.

#### **QUALIFICATION RULES**

The Qualification consists of Fundamental, Core and Elective Unit Standards. A minimum of 157 Credits is required to achieve this Qualification. The credits are allocated as follows:

Fundamental Component:

The Fundamental Component consists of the following, which is compulsory for all learners:

- Unit standards at NQF Level 4, totalling 16 Credits in Mathematical Literacy.
- Unit standards at NQF Level 4, totalling 20 Credits in Communication in a First South African Language.
- Unit standards at NQF Level 3, totalling 20 Credits in Communication in a Second South African Language.

All fundamental unit standards are compulsory (56 Credits).

It is therefore compulsory for learners to do Communication in two different South African Languages, one at NQF Level 4 and the other at NQF Level 3.

Core Component:

The core component consists of 4 Unit Standards totalling 51 Credits. All the Unit Standards are compulsory for all the learners.

Elective Component:

There are 3 areas of specialization:

- Automation and Controls (44 Credits).
- Hydraulics and Pneumatics (40 Credits).
- Sensors and Measurement (25 Credits).

Learners are to do all the unit standards prescribed for one specialisation and choose of additional unit standard from one of the other specialisation to give a total of at least 50 Credits for the Elective Component.

Specialisation Area 1: Controls/Automation has 4 Unit Standards with 44 Credits:

- ID 13154: Install, test and maintain three phase AC/DC machines and control gear 10 Credits.
- ID 13334: Install, test and configure variable speed control devices 10 Credits.
- ID 13315: Write simple computer numerical controlled (CNC) programmes and set and operate a CNC machine 24 Credits.

Specialisation Area 2: Hydraulics/Pneumatics/Automation with 2 Unit Standards and 40 Credits:

- ID 13115: Install, test and maintain an electro-hydraulic system 20 Credits.
- ID 13116: Install, test and an electro-pneumatic system 20 Credits.

Specialisation Area 3: Sensors and measurement with 2 Unit Standards and 25 Credits:

- ID 259139: Demonstrate and apply knowledge of basic digital electronic principles 10 Credits.
- ID 116059: Maintain Specialisation Sensing Devices 15 Credits.

### **EXIT LEVEL OUTCOMES**

1. Install, commission, test and maintain three phase AC/DC machines, control and switch gear.
2. Demonstrate an understanding of power electronics technology and an ability to install, test and configure manual and software driven variable speed control drives.
3. Demonstrate the understanding and ability to install and configure local area network (LAN) and related industrial network systems.
4. Install and programme sensors, industrial Programmable Logic Controllers (PLC's) and Human Machine Interface (HMI).
5. Install and maintain electro-pneumatic and electro-hydraulic systems.
6. Demonstrate an understanding and ability to programme and use industrial robotic systems.
7. Solve a variety of problems, both familiar and unfamiliar, within a Mechatronics environment.
8. Communicate and present information.

Critical Cross-field Outcomes:

This will be achieved when qualifying learners:

Identify and solve problems:

- Select appropriate variable speed control components.
- Present solutions to problems identified:
  - Configure PLC hardware, software and sensor/actuator addresses specifications correctly.
  - Configure software variable speed control.
  - Carry out installations in a manner that meets specification.

Work effectively with others as a member of a team or organisation:

- Contribute to team and operational goals.
- Adhere to operational procedures for installations and maintenance.

Organise and manage oneself and one's activities responsibly and effectively:

- Install systems, test and commission related work in a compliant manner.
- Install PLC's, test and commission related work in a compliant manner.
- Install software and hardware related work in a compliant manner.

Collect, analyse, organise and critically evaluate information:

- Conduct analysis, interpret software, hardware and program challenges.

- Evaluate system requirements.
- Conduct tests.

Communicate effectively by using mathematical and language skills in the modes of oral and written presentations:

- Gather and use information related to own and team's work from a range of sources.
- Present information in the prescribed format to role players.

Use science and technology effectively and critically, showing responsibility towards the environment and health of others:

This will be achieved when qualifying learners:

- Provide appropriate solutions to needs identified.
- Apply occupational safety rules.

Demonstrate an understanding of the world as a set of related systems by recognizing that problem solving contexts do not exist in isolation:

This will be achieved when qualifying learners:

- Provide appropriate solutions to needs identified.
- Apply occupational safety rules.

#### **ASSOCIATED ASSESSMENT CRITERIA**

Associated Assessment Criteria for Exit Level Outcomes 1:

- 1.1 AC/DC machine installation and commissioning is done according to specifications and circuit diagrams.
- 1.2 Testing and maintenance on AC/DC machines meets specifications.
- 1.2 Safe working practices are adhered to in accordance with organizational working standards.
- 1.4 Implications of not adhering to the sequence of activities and operations as per operational procedures are explained.

Associated Assessment Criteria for Exit Level Outcomes 2:

- 2.1 Power electronic circuits are constructed and tested to meet specifications and quality requirements.
- 2.2 Variable speed control components are selected according to circuit diagrams.
- 2.3 Electrical and mechanical installation are done to meet quality standards.
- 2.4 Software variable speed control drives are configured according to specifications.
- 2.5 Power electronics technology and the installation, testing and configuration of variable speed control drives are discussed.

Associated Assessment Criteria for Exit Level Outcomes 3:

- 3.1 Networked subsystems meet specifications.
- 3.2 Industrial network systems are installed and configured to specifications.
- 3.3 Hardware and software are discussed according to network requirements.

Associated Assessment Criteria for Exit Level Outcomes 4:

- 4.1 PLC hardware, software and sensor/actuator addresses of a PLC are configured to specifications.

- 4.2 Advanced PLC control programmes are written to meet job specifications.
- 4.3 Advanced PLC circuit installation and programming meets specifications.
- 4.4 Programme and installations are tested and debugged according to requirements.
- 4.5 Industrial PLC's are explained according to manufacturer specifications.

Associated Assessment Criteria for Exit Level Outcomes 5:

- 5.1 Installation is done to meets specifications.
- 5.2 Tests are performed and results recorded according to procedure.
- 5.3 Integrated PLC controlled circuit programming meets specifications.
- 5.4 Electro-pneumatic and electro-hydraulic systems are discussed according to manufacturer specifications.

Associated Assessment Criteria for Exit Level Outcomes 6:

- 6.1 Robot programming meets job requirements and specifications.
- 6.2 Robot is used to meet quality and output requirements.
- 6.3 Issues related to the use and programming of industrial robots are discussed.

Associated Assessment Criteria for Exit Level Outcomes 7:

- 7.1 Solutions to problems are based on a clear analysis of information gathered through diagnostic procedures.
- 7.2 Procedures are modified to respond to unfamiliar problems where appropriate.
- 7.3 Issues related to familiar and unfamiliar problems arising in the Mechatronics environment are discussed.
- 7.4 All actions related to problem solving are accurately recorded for future reference.

Associated Assessment Criteria for Exit Level Outcomes 8:

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

Integrated Assessment:

Integrated assessment evaluates the learner's ability to combine actions and ideas across a range of activities and knowledge areas. The integrated assessment must specifically assess the learner's ability to:

- Demonstrate competence by means of the practical application of the embedded knowledge in a manner that meets the required performance standards required.
- Illustrate a clear understanding of the concepts, theory and principles that underpin the practical action taken.

The assessment will require assessment methods which measure and evaluate evidence generated during learning and on-the-job activities. Because assessment practices must be open and transparent, fair, valid and reliable; ensuring that no learner is disadvantaged in any way whatsoever, an integrated assessment approach is incorporated into the Qualification.

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The term integrated assessment implies that theoretical and practical components should be assessed together. Whenever possible, the assessment of knowledge, skills, attitudes and values shown in the Unit Standards should be integrated and, during integrated assessment, the assessor should make use of a range of formative and summative assessment tools and methods. Combinations of practical, applied, foundational and reflective competencies should be assessed. Assessment should further ensure that all Specific Outcomes, embedded knowledge and Critical Cross Field Outcomes are evaluated in an integrated way.

Assessors must assess and give credit for the evidence of learning that has already been acquired through formal, informal and non-formal learning and work experience.

### **INTERNATIONAL COMPARABILITY**

Introduction:

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Comparable aspects of the various programs in terms of entry requirements, credits awarded, approaches to learning and work, as well as Exit Level Outcomes are highlighted.

The United Kingdom:

There are a number of avenues for a Higher National Certificate (HNC) Course code (HNC 6HHH; HNC/EMt) and the National Diploma (HND Course code (HND 63HH; HND/ EMT).

Various organisations approach the achievement of Mechatronics qualifications in different ways. For example, ASME's uses a case study problem-solving with video demonstrations. The emphasis is placed on physical understanding rather than being mathematically oriented.

Moray College Scotland (Scottish Qualifications Authority (SQA):

The SQA enables the provision of Mechatronics at Higher Level (Higher Engineering Frameworks) through the Higher National Certificate (HNC) Ref G87M 15 and the Higher National Diploma (HND) Ref G87M 16.

The following is a course outline for the Mowray College, in Scotland, for the HNC Mechatronics award:

Entrance Requirements:

Passes in:

- Three SQA standard grades.
- Two SQA at Higher grade.
- Five GCSE subjects including one at an advanced level.
- 'O' level passes should include English (Communication), Mathematics and Physics.

Duration: HNC full time 1 year; part time 2 years or more. HND full time 2 years, part time 4-5 years.

Progression: After HNC further study, one may include HND Mechatronics, BSc Mechatronics Engineering or a related course at Level 1. After the HND, further study may include BSc Mechatronics Engineering or a related course, with the possibility of entering at Level 2.

Key elements of the Scottish qualification in relation to the South African Qualification Scottish Qualifications Authority (SQA) HNC Mechatronics Engineering: G87L 15, Level 2: Core units (excluding optional units):

- Common Core.
- Communication.
- Mathematics for Engineering 1: Electronics and Electrical.
- Mechatronic Systems Elements.
- Mechatronic Systems.
- Interfacing Electronics.
- Electrical Engineering Principles 1.
- Engineering Principles.
- Computer Aided Draughting for Engineers.
- Robotics and Animatronics: An introduction.

Level 3: Core units (excluding optional units):

- Communication.
- Common core.
- Mathematics for Engineering 1: Electronics and Electrical.
- Mechatronic Systems Elements.
- Mechatronic Systems.
- Interfacing Electronics.
- Electrical Engineering Principles 1.
- Engineering Principles.
- Computer Aided Draughting for Engineers.
- Robotics and Animatronics :An introduction.

Level 4: Core units (excluding optional units):

- Communication.
- Common core.
- Mathematics for Engineering 1: Electronics and Electrical.
- Mechatronic Systems Elements.
- Mechatronic Systems.
- Interfacing Electronics.
- Electrical Engineering Principles 1.
- Engineering Principles.
- Computer Aided Draughting for Engineers.

Bridwater College, Uk:

Higher National Certificate in Mechatronics Engineering.

Course Structure (Core modules-C): Business Management Techniques, Analytical methods for Engineers, Engineering, Project, Plant and process principles others: Engineering design, pneumatics and hydraulics, programmable logic controllers, further Mechatronics, digital and analogue electronics.

Entry requirements: a Level 3 Qualification, preferably in the numerate or engineering discipline.  
Duration: 1 day a week for two years.

Post study opportunities: A broad range of opportunities in engineering systems, design and manufacturing, maintenance, electronics, maintenance, as a technician, Engineer, Technician or Project Leader.

United States of America:

Mechatronics is of particular importance to the US military, where Congress ordered, in 2000, that a third of ground vehicles in the military must become robotic by 2015 (robots are currently being used by the US military in Iraq and Afghanistan). This is according to the Undergraduate Mechatronics course design project at the United States Military Academy (USMA).

There are number of community college level, undergraduate and graduate levels of study in Mechatronics. Community level college courses allow grade 12 Level learners to study a semester based diploma program.

Germany:

Siemens Certified Mechatronic Systems Assistant Programme:

The international group, Siemens, runs the Workforce Skills Qualifications (WSQ) program. Its own elite international technical college (Siemens Technik Akademie Berlin) has developed the Siemens Mechatronic Systems Certifications Programme (SMSCP). It is offered by partnering schools worldwide including the Kentucky Community and Technical College System (North America), Nanjing College of Information Technology (China), Amatrol (U.S) and VCAT (Germany).

The course aims to equip workers in: precision engineering, mechatronics, medical technology, marine and electronics related industry sectors with up-to-date information in operations, maintenance and designing of an integrated mechatronic system.

Trainees are issued with the WSQ Certified Mechatronic Systems Assistant (WSQ CMSA) Certificate upon successful completion of the programme and passing the modular assessments and the Siemens Level 1 Certification Examination.  
Siemens Technik Akademie Berlin.

Certified mechatronic systems assistant programme:

Level 1: Siemens Certified Mechatronic Systems Assistant:

- Electrical Components.
- Mechanical Components and Electric Drivers.
- (Electro) Pneumatic and Hydraulic Circuits.
- Digital Fundamentals and Programmable Logic Controllers (PLCs).

Level 2: Siemens Certified Mechatronic Systems Associate:

- Process control technologies.
- Introduction to Manufacturing processes.
- Totally Integrated Automation (TIA).
- Automation systems.
- Motor control.
- Mechanics and machine elements.

Level 3: Siemens Certified Mechatronic Systems Professional:



- Mechatronics.
- Customised Automation Solutions with TIA.
- System Design.
- Diagnostics, Control Systems and Optimisation.
- System Design.
- Diagnostics, Control Systems and Optimisation.
- Dynamics of Machinery and Kinematics.
- Learning assumed.

The Siemens Level 1 programme is tailored for workers who are currently employed or for those who wish to be employed in the manufacturing & automation industry as Mechatronic Systems Operator, Machine/Equipment Operator, and Line Leader.

Articulation:

The WSQ CMSA certification is jointly issued by WDA and SPE Berlin and is recognised both locally and internationally. In addition, trainees who complete Level 1 of the programme may attain the "Precision Engineering Workforce Skills Qualification Certificate" by completing another 9 modules of the PE WSQ programme, or the "Precision Engineering Workforce Skills Qualification Higher Certificate" by completing another 6 modules under the PE WSQ framework.

Up-skilling Opportunities: Workers can be up-skilled through hands-on training in complex mechatronic systems, systems management, troubleshooting and repair of systems malfunctions, systems design and process optimisation.

Career options on completion:

Level 1: Machine Operators can become Senior Machine Operators.

Level 2: A Mechatronic Systems Technician who completes Level 2 of the programme may progress to become a Supervisor or Senior Technician.

Level 3: An Assistant Engineer who completes Level 3 of the programme may move up to the position of Engineer.

Conclusion:

The international comparability exercise above demonstrates that the courses, qualifications and learning programs surveyed all have common outcomes and similar learning areas of focus. However content at equivalent levels may vary due to areas of emphasis, as well as the nature and nuanced application of study program related to a corporate program, like that of SIEMENS workplace.

### **ARTICULATION OPTIONS**

The qualification articulates horizontally to:

- ID 57885: Further Education and Training Certificate: CNC Production Machining.
- ID 58861: Further Education and Training Certificate: Electro-Mechanical Winding.
- ID 58270: Further Education and Training Certificate: Electro-Mechanics.
- ID 58697: Further Education and Training Certificate: Electronic Security Installation Practices.
- ID 63849: Further Education and Training Certificate: Electronics.

There are no qualifications that articulate vertically with this series of qualifications.

### **MODERATION OPTIONS**

- Anyone assessing a learner or moderating the assessment of a learner against the qualification must be registered as an assessor with the relevant Education, Training, Quality,

Assurance (ETQA) Body, or with an ETQA that has a Memorandum of Understanding with the relevant ETQA.

- Any institution offering learning that will enable the achievement of this qualification must be accredited as a provider with the relevant Education, Training, Quality, Assurance (ETQA) Body, or with an ETQA that has a Memorandum of Understanding with the relevant ETQA.
- Assessment and moderation of assessment will be overseen by the relevant Education, Training, Quality, Assurance (ETQA) Body, or by an ETQA that has a Memorandum of Understanding with the relevant ETQA, according to the ETQA's policies and guidelines for assessment and moderation.
- Moderation must include both internal and external moderation of assessments, unless ETQA policies specify otherwise. Moderation should also encompass achievement of the competence described in the associated unit standards.
- Anyone wishing to be assessed against this qualification may apply to be assessed by any assessment agency, assessor or provider institution that is accredited by the relevant ETQA.

#### **CRITERIA FOR THE REGISTRATION OF ASSESSORS**

The following criteria should be applied by the relevant ETQA:

An appropriate qualification in the field of engineering at NQF Level 5 or higher with a minimum of four years' experience in the field of Mechatronics.

Registration as an assessor with the relevant ETQA.

#### **NOTES**

N/A

#### **UNIT STANDARDS**

	ID	UNIT STANDARD TITLE	LEVEL	CREDITS
Fundamental	119472	Accommodate audience and context needs in oral/signed communication	Level 3	5
Fundamental	119457	Interpret and use information from texts	Level 3	5
Fundamental	119467	Use language and communication in occupational learning programmes	Level 3	5
Fundamental	119465	Write/present/sign texts for a range of communicative contexts	Level 3	5
Fundamental	9015	Apply knowledge of statistics and probability to critically interrogate and effectively communicate findings on life related problems	Level 4	6
Fundamental	119462	Engage in sustained oral/signed communication and evaluate spoken/signed texts	Level 4	5
Fundamental	119469	Read/view, analyse and respond to a variety of texts	Level 4	5
Fundamental	9016	Represent analyse and calculate shape and motion in 2- and 3-dimensional space in different contexts	Level 4	4
Fundamental	119471	Use language and communication in occupational learning programmes	Level 4	5
Fundamental	7468	Use mathematics to investigate and monitor the financial aspects of personal, business, national and international issues	Level 4	6
Fundamental	119459	Write/present/sign for a wide range of contexts	Level 4	5
Core	13118	Install and programme advanced industrial programmable logic controllers	Level 4	20
Core	265094	Install, test and configure industrial network systems	Level 4	16
Core	13235	Maintain the quality assurance system	Level 4	5
Core	243070	Programme, use and maintain an industrial robot system	Level 4	10
Elective	116714	Lead a team, plan, allocate and assess their work	Level 3	4
Elective	9526	Manage basic business finance	Level 3	6

	<b>ID</b>	<b>UNIT STANDARD TITLE</b>	<b>LEVEL</b>	<b>CREDITS</b>
Elective	9530	Manage work time effectively	Level 3	3
Elective	13254	Contribute to the implementation and maintenance of business processes	Level 4	10
Elective	259139	Demonstrate and apply knowledge of basic digital electronic principles	Level 4	10
Elective	13334	Install, test and configure variable speed control drives	Level 4	10
Elective	13115	Install, test and maintain an electro-hydraulic system	Level 4	20
Elective	13116	Install, test and maintain an electro-pneumatic system	Level 4	20
Elective	13154	Install, test and maintain three phase AC/DC machines and control gear	Level 4	10
Elective	116059	Maintain Specialized Sensing Devices	Level 4	15
Elective	13315	Write simple computer numerical controlled (CNC) programmes and set and operate a CNC machine	Level 4	24

**LEARNING PROGRAMMES RECORDED AGAINST THIS QUALIFICATION**

**None**



## SOUTH AFRICAN QUALIFICATIONS AUTHORITY

**UNIT STANDARD:*****Install, test and configure industrial network systems***

<b>SAQA US ID</b>	<b>UNIT STANDARD TITLE</b>		
265094	Install, test and configure industrial network systems		
<b>ORIGINATOR</b>	<b>PROVIDER</b>		
SGB Manufacturing and Assembly Processes			
<b>FIELD</b>	<b>SUBFIELD</b>		
6 - Manufacturing, Engineering and Technology	Manufacturing and Assembly		
<b>ABET BAND</b>	<b>UNIT STANDARD TYPE</b>	<b>NQF LEVEL</b>	<b>CREDITS</b>
Undefined	Regular	Level 4	16

***This unit standard does not replace any other unit standard and is not replaced by another unit standard.***

**SPECIFIC OUTCOME 1**

Install industrial network systems.

**SPECIFIC OUTCOME 2**

Install industrial network systems hardware.

**SPECIFIC OUTCOME 3**

Configure industrial network system components.

**SPECIFIC OUTCOME 4**

Install input/output units.

**SPECIFIC OUTCOME 5**

Record information on work done.

**SPECIFIC OUTCOME 6**

Work safely with care for self, fellow workers, machines, equipment, materials and the environment.

**QUALIFICATIONS UTILISING THIS UNIT STANDARD**

	<b>ID</b>	<b>QUALIFICATION TITLE</b>	<b>LEVEL</b>
Core	67649	Further Education and Training Certificate: Mechatronics	Level 4