education

Department:
Education
REPUBLIC OF SOUTH AFRICA

# NATIONAL CERTIFICATES (VOCATIONAL)

## ASSESSMENT GUIDELINES

## MECHATRONIC SYSTEMS

## NQF Level 3

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# CONTENTS

## SECTION A: PURPOSE OF THE SUBJECT ASSESSMENT GUIDELINES

This document provides the lecturer with guidelines to develop and implement a coherent, integrated assessment system for Mechatronic Systems in the National Certificates (Vocational). It must be read with the *National Policy Regarding Further Education and Training Programmes: Approval of the Documents, Policy for the National Certificates (Vocational) Qualifications at Levels 2 to 4 on the National Qualifications Framework (NQF)*. This assessment guideline will be used for National Qualifications Framework Levels 2-4.

This document explains the requirements for the internal and external subject assessment. The lecturer must use this document with the *Subject Guidelines: Mechatronic Systems* to prepare for and deliver Mechatronic Systems. Lecturers should use a variety of resources and apply a range of assessment skills in the setting, marking and recording of assessment tasks.

## SECTION B: ASSESSMENT IN THE NATIONAL CERTIFICATES (VOCATIONAL)

### 1 ASSESSMENT IN THE NATIONAL CERTIFICATES (VOCATIONAL)

Assessment in the National Certificates (Vocational) is underpinned by the objectives of the National Qualifications Framework (NQF). These objectives are to:

- Create an integrated national framework for learning achievements.
- Facilitate access to and progression within education, training and career paths.
- Enhance the quality of education and training.
- Redress unfair discrimination and past imbalances and thereby accelerate employment opportunities.
- Contribute to the holistic development of the student by addressing:
  - social adjustment and responsibility;
  - moral accountability and ethical work orientation;
  - economic participation; and
  - nation-building.

The principles that drive these objectives are:

- ***Integration***

To adopt a unified approach to education and training that will strengthen the human resources development capacity of the nation.

- ***Relevance***

To be dynamic and responsive to national development needs.

- ***Credibility***

To demonstrate national and international value and recognition of qualification and acquired competencies and skills.

- ***Coherence***

To work within a consistent framework of principles and certification.

- ***Flexibility***

To allow for creativity and resourcefulness when achieving Learning Outcomes, to cater for different learning styles and use a range of assessment methods, instruments and techniques.

- ***Participation***

To enable stakeholders to participate in setting standards and co-ordinating the achievement of the qualification.

- ***Access***

To address barriers to learning at each level to facilitate students' progress.

- ***Progression***

To ensure that the qualification framework permits individuals to move through the levels of the national qualification via different, appropriate combinations of the components of the delivery system.

- ***Portability***

To enable students to transfer credits of qualifications from one learning institution and/or employer to another institution or employer.

- ***Articulation***

To allow for vertical and horizontal mobility in the education system when accredited pre-requisites have been successfully completed.

- ***Recognition of Prior Learning***

To grant credits for a unit of learning following an assessment or if a student possesses the capabilities specified in the outcomes statement.

- ***Validity of assessments***

To ensure assessment covers a broad range of knowledge, skills, values and attitudes (SKVAs) needed to demonstrate applied competency. This is achieved through:

  - clearly stating the outcome to be assessed;
  - selecting the appropriate or suitable evidence;
  - matching the evidence with a compatible or appropriate method of assessment; and
  - selecting and constructing an instrument(s) of assessment.

- ***Reliability***

To assure assessment practices are consistent so that the same result or judgment is arrived at if the assessment is replicated in the same context. This demands consistency in the interpretation of evidence; therefore careful monitoring of assessment is vital.

- ***Fairness and transparency***

To verify that no assessment process or method(s) hinders or unfairly advantages any student. The following could constitute unfairness in assessment:

  - Inequality of opportunities, resources or teaching and learning approaches
  - Bias based on ethnicity, race, gender, age, disability or social class
  - Lack of clarity regarding Learning Outcome being assessed
  - Comparison of one student's work with another, based on learning styles and language

- ***Practicability and cost-effectiveness***

To integrate assessment practices within an outcomes-based education and training system and strive for cost and time-effective assessment.

## 2 ASSESSMENT FRAMEWORK FOR VOCATIONAL QUALIFICATIONS

The assessment structure for the National Certificates (Vocational) qualification is as follows:

### 2.1 Internal continuous assessment (ICASS)

Knowledge, skills values, and attitudes (SKVAs) are assessed throughout the year using assessment instruments such as projects, tests, assignments, investigations, role-play and case studies. The internal continuous assessment (ICASS) practical component is undertaken in a real workplace, a workshop or a "Structured Environment". This component is moderated internally, and externally quality assured by Umalusi. All internal continuous assessment (ICASS) evidence is kept in a Portfolio of Evidence (PoE) and must be readily available for monitoring, moderation and verification purposes.

### 2.2 External summative assessment (ESASS)

The external summative assessment is either a single paper or set of written papers set to the requirements of the Subject Learning Outcomes. The Department of Education administers the theoretical component according to relevant assessment policies.

A compulsory component of external summative assessment (ESASS) is the **integrated summative assessment task (ISAT).** This assessment task draws on the student's cumulative learning throughout the year. The task requires **integrated application of competence** and is executed under strict assessment conditions. The task should take place in a simulated or "Structured Environment". The integrated summative assessment task is the most significant test of students' ability to apply acquired knowledge.

The integrated assessment approach allows students to be assessed in more than one subject with the same integrated summative assessment task (ISAT).

External summative assessments will be conducted annually between October and December, with provision made for supplementary sittings.

## 3 MODERATION OF ASSESSMENT

### 3.1 Internal moderation

Assessment must be moderated according to the internal moderation policy of the Further Education and Training (FET) college. Internal college moderation is a continuous process. The moderator's involvement starts with the planning of assessment methods and instruments and follows with continuous collaboration with and support to the assessors. Internal moderation creates common understanding of Assessment Standards and maintains these across vocational programmes.

### 3.2 External moderation

External moderation is conducted by the Department of Education, Umalusi and, where relevant, an Education and Training Quality Assurance (ETQA) body according to South African Qualifications Authority (SAQA) and Umalusi standards and requirements.

The external moderator:

- monitors and evaluates the standard of all summative assessments;
- maintains standards by exercising appropriate influence and control over assessors;
- ensures proper procedures are followed;
- ensures summative integrated assessments are correctly administered;
- observes a minimum sample of ten (10) to twenty-five (25) percent of summative assessments;
- gives written feedback to the relevant quality assuror; and
- moderates in case of a dispute between an assessor and a student.

Policy on inclusive education requires that assessment procedures be customised for students who experience barriers to learning, and supported to enable these students to achieve their maximum potential.

## 4 PERIOD OF VALIDITY OF INTERNAL CONTINUOUS ASSESSMENT (ICASS)

The period of validity of the internal continuous assessment mark is determined by the *National Policy on the Conduct, Administration and Management of the Assessment of the National Certificates (Vocational).*

The internal continuous assessment (ICASS) must be re-submitted with each examination enrolment for which it constitutes a component.

## 5 ASSESSOR REQUIREMENTS

Assessors must be subject specialists and should ideally be declared competent against the standards set by the ETDP SETA. If the lecturer conducting the assessments has not been declared a competent assessor, an assessor who has been declared competent may be appointed to oversee the assessment process to ensure the quality and integrity of assessments.

## 6 TYPES OF ASSESSMENT

Assessment benefits the student and the lecturer. It informs students about their progress and helps lecturers make informed decisions at different stages of the learning process. Depending on the intended purpose, different types of assessment can be used.

### 6.1 Baseline assessment

At the beginning of a level or learning experience, baseline assessment establishes the knowledge, skills, values and attitudes (SKVAs) that students bring to the classroom. This knowledge assists lecturers to plan learning programmes and learning activities.

### 6.2 Diagnostic assessment

This assessment diagnoses the nature and causes of learning barriers experienced by specific students. It is followed by guidance, appropriate support and intervention strategies. This type of assessment is useful to make referrals for students requiring specialist help.

### 6.3 Formative assessment

This assessment monitors and supports teaching and learning. It determines student strengths and weaknesses and provides feedback on progress. It determines if a student is ready for summative assessment.

### 6.4 Summative assessment

This type of assessment gives an overall picture of student progress at a given time. It determines whether the student is sufficiently competent to progress to the next level.

## 7 PLANNING ASSESSMENT

An assessment plan should cover three main processes:

### 7.1 Collecting evidence

The assessment plan indicates which Subject Outcomes and Assessment Standards will be assessed, what assessment method or activity will be used and when this assessment will be conducted.

### 7.2 Recording

Recording refers to the assessment instruments or tools with which the assessment will be captured or recorded. Therefore, appropriate assessment instruments must be developed or adapted.

### 7.3 Reporting

All the evidence is put together in a report to deliver a decision for the subject.

## 8 METHODS OF ASSESSMENT

Methods of assessment refer to who carries out the assessment and includes lecturer assessment, self-assessment, peer assessment and group assessment.

| | |
|---|---|
| **LECTURER ASSESSMENT** | The lecturer assesses students' performance against given criteria in different contexts, such as individual work, group work, etc. |
| **SELF-ASSESSMENT** | Students assess their own performance against given criteria in different contexts, such as individual work, group work, etc. |
| **PEER ASSESSMENT** | Students assess another student's or group of students' performance against given criteria in different contexts, such as individual work, group work, etc. |
| **GROUP ASSESSMENT** | Students assess the individual performance of other students within a group or the overall performance of a group of students against given criteria. |

## 9 INSTRUMENTS AND TOOLS FOR COLLECTING EVIDENCE

All evidence collected for assessment purposes is kept or recorded in the student's Portfolio of Evidence.

The following table summarises a variety of methods and instruments for collecting evidence. A method and instrument is chosen to give students ample opportunity to demonstrate that the Subject Outcome has been attained. This will only be possible if the chosen methods and instruments are appropriate for the target group and the Specific Outcome being assessed.

| | METHODS FOR COLLECTING EVIDENCE | | |
|---|---|---|---|
| | **Observation-based** (Less structured) | **Task-based** (Structured) | **Test-based** (More structured) |
| **Assessment instruments** | • Observation<br>• Class questions<br>• Lecturer, student, parent discussions | • Assignments or tasks<br>• Projects<br>• Investigations or research<br>• Case studies<br>• Practical exercises<br>• Demonstrations<br>• Role-play<br>• Interviews | • Examinations<br>• Class tests<br>• Practical examinations<br>• Oral tests<br>• Open-book tests |
| **Assessment tools** | • Observation sheets<br>• Lecturer's notes<br>• Comments | • Checklists<br>• Rating scales<br>• Rubrics | • Marks (e.g. %)<br>• Rating scales (1-5) |
| **Evidence** | • Focus on individual students<br>• Subjective evidence based on lecturer observations and impressions | **Open middle**: Students produce the same evidence but in different ways.<br>**Open end**: Students use same process to achieve different results. | Students answer the same questions in the same way, within the same time. |

## 10 TOOLS FOR ASSESSING STUDENT PERFORMANCE

**Rating scales** are marking systems where a symbol (such as 1 to 5) or a mark (such as 5/10 or 50%) is defined in detail. The detail is as important as the coded score. Traditional marking, assessment and evaluation mostly used rating scales without details such as what was right or wrong, weak or strong, etc.

**Task lists** and **checklists** show the student what needs to be done. These consist of short statements describing the expected performance in a particular task. The statements on the checklist can be ticked off when the student has adequately achieved the criterion. Checklists and task lists are useful in peer or group assessment activities.

**Rubrics** are a hierarchy (graded levels) of criteria with benchmarks that describe the minimum level of acceptable performance or achievement for each criterion. Use of rubrics provides a different way of assessing that cannot be compared to tests. Each criterion described in the rubric must be assessed separately. Mainly two types of rubrics, namely holistic and analytical, are used.

## 11 SELECTING AND/OR DESIGNING RECORDING AND REPORTING SYSTEMS

The selection or design of recording and reporting systems depends on the purpose of recording and reporting student achievement. **Why** particular information is recorded and **how** it is recorded determine which instrument will be used.

Computer-based systems, for example spreadsheets, are cost and time effective. The recording system should be user-friendly and information should be easily accessed and retrieved.

## 12 COMPETENCE DESCRIPTIONS

All assessment should award marks to evaluate specific assessment tasks. However, marks should be awarded against rubrics and not be simply a total of ticks for right answers. Rubrics should explain the competence level descriptors for the skills, knowledge, values and attitudes (SKVAs) that a student must demonstrate to achieve each level of the rating scale.

When lecturers or assessors prepare an assessment task or question, they must ensure that the task or question addresses an aspect of a Subject Outcome. The relevant Assessment Standard must be used to create the rubric to assess the task or question. The descriptions must clearly indicate the minimum level of attainment for each category on the rating scale.

## 13 STRATEGIES FOR COLLECTING EVIDENCE

A number of different assessment instruments may be used to collect and record evidence. Examples of instruments that can be (adapted and) used in the classroom include:

### 13.1 Record sheets

The lecturer observes students working in a group. These observations are recorded in a summary table at the end of each project. The lecturer can design a record sheet to observe students' interactive and problem-solving skills, attitudes towards group work and involvement in a group activity.

### 13.2 Checklists

Checklists should have clear categories to ensure that the objectives are effectively met. The categories should describe how the activities are evaluated and against which criteria they are evaluated. Space for comments is essential.

## SECTION C: ASSESSMENT IN MECHATRONIC SYSTEMS

## 1 SCHEDULE OF ASSESSMENT

At NQF levels 2, 3 and 4, lecturers will conduct assessments as well as develop a schedule of formal assessments that will be undertaken in the year. All three levels also have an external examination that accounts for 50 percent of the total mark. The marks allocated to assessment tasks completed during the year, kept or recorded in a Portfolio of Evidence account for the other 50 percent.

The Portfolio of Evidence and the external assessment include practical and written components. The practical assessment in Mechatronic Systems must, where necessary, be subjected to external moderation by Umalusi or an appropriate Education and Training Quality Assurance (ETQA) body, appointed by the Umalusi Council in terms of Section 28(2) of the *General and Further Education and Training Quality Assurance Act, 2001 (Act No. 58 of 2001).*

## 2 RECORDING AND REPORTING

Mechatronic Systems, as is the case for all the other Vocational subjects, is assessed according to five levels of competence. The level descriptions are explained in the following table.

***Scale of Achievement for the Vocational component***

| RATING CODE | RATING | MARKS % |
|---|---|---|
| 5 | Outstanding | 80-100 |
| 4 | Highly competent | 70-79 |
| 3 | Competent | 50-69 |
| 2 | Not yet competent | 40-49 |
| 1 | Not achieved | 0-39 |

The programme of assessment should be recorded in the Lecturer's Portfolio of Assessment for each subject. The following at least should be included in the Lecturer's Assessment Portfolio:

- A contents page
- The formal schedule of assessment
- The requirements for each assessment task
- The tools used for each assessment task
- Recording instrument(s) for each assessment task
- A mark sheet and report for each assessment task

The college must standardise these documents.

The student's Portfolio of Evidence must include at least:

- A contents page
- The assessment tasks according to the assessment schedule
- The assessment tools or instruments for the task
- A record of the marks (and comments) achieved for each task

Where a task cannot be contained as evidence in the Portfolio of Evidence, its exact location must be recorded and it must be readily available for moderation purposes.

The following units guide internal assessment in Mechatronic Systems Level 3:

| NUMBER OF UNITS | ASSESSMENT | COVERAGE |
|---|---|---|
| 3 | Formal written tests | One or more completed topics |
| 1 | Internal written exam | All completed topics |
| 3 | Practical assessments | The related Subject Outcomes:<br>1.1 Fundamental electronic control circuits and testing of input and output of electronic control circuits.<br>2.1 Correct electric drives, control circuits and testing for function.<br>3.2 Connecting basic hydraulic manual control systems.<br>4.2 The connection of electro-hydraulic control systems.<br>5.1 The application of trouble shooting techniques on electro-hydraulic hybrid control systems. |

# ASSESSMENT OF MECHATRONIC SYSTEMS

# LEVEL 3

## 3 INTERNAL ASSESSMENT OF SUBJECT OUTCOMES IN MECHATRONIC SYSTEMS – LEVEL 3

### Topic 1: Analyse electronics as a form of control in mechatronic sub-systems

| SUBJECT OUTCOME | |
|---|---|
| **1.1 Describe and apply electronic control technology**<br>*Range: Analogue, digital and microprocessor. Circuits: P, D and I control using op-amps, Linear resistive control, multi-vibrator control (A, BI and A stable). Timer/Counter using electronic circuits. Speed control, position control, thyristor control, phase control, cyclotronic control, RC servo control, PC control, choppers (flow, pressure, measurement, level, etc* | |
| **ASSESSMENT STANDARDS** | **LEARNING OUTCOMES** |
| • The differences between analogue, digital and microprocessor electronics are listed and explained.<br>• Basic operation of electronic control circuits are explained using block diagrams and/or at component circuit level.<br>• The use of electronic control technology in mechatronic systems (temperature, pressure, level, flow measurement, final control, tele-metering, kinetic control) is explained.<br>• The terms positioning control, servo-mechanism, system response, dampening, overshoot, offset, reset, stabilising, feedback" are defined.<br>• Appropriate electronic control circuits are identified and selected to achieve function.<br>• Fundamental electronic control circuits are constructed.<br>• Input and output of electronic control circuits are tested to determine operation (black box approach) when troubleshooting. | • List and explain<br>▪ the differences between analogue, digital and microprocessor electronics.<br>▪ basic operation of electronic control circuits using block diagrams and/or at component circuit level.<br>• Explain<br>▪ how electronic control technology is used in mechatronic systems (temperature, pressure, level, flow measurement, final control, tele-metering, kinetic control).<br>▪ what is meant by the terms positioning control, servo-mechanism, system response, dampening, overshoot, offset, reset, stabilising, feedback.<br>• Identify and select appropriate electronic control circuits to achieve function.<br>• Construct fundamental electronic control circuits.<br>• Test input and output of electronic control circuits to determine operation (black box approach) when troubleshooting. |
| **ASSESSMENT TASKS OR ACTIVITIES** | |
| • An assignment or task on the analysis of electronics as a form of control in mechatronic sub-systems.<br>• Practical exercises on fundamental electronic control circuits, and testing of input and output of electronic control circuits | |

### Topic 2: Analyse and connect electric drives as used in control technology

| SUBJECT OUTCOME | |
|---|---|
| **2.1 Describe and apply electric drive control technology**<br>*Range: Drives: Permanent magnet DC drives, stepper motors, brushless AC and DC drives, tacho-generators. Control: speed, reversal of direction, position. Circuits: Resistive, electronic, digital* | |
| **ASSESSMENT STANDARDS** | **LEARNING OUTCOMES** |
| • The following are explained:<br>▪ the fundamental operation of electric drive construction and operation.<br>▪ the application of electric drive types.<br>▪ how each drive type is controlled.<br>▪ how the PC is used to control the stepper drive.<br>▪ what is meant by the terms PWM, H bridge motor control, PIC based controller, motor control logic, phase control.<br>▪ how a tacho-generator is used in an electronic control circuit.<br>• Correct electric drives are selected and identified for specified function.<br>• Control circuits are constructed using correct electric drives.<br>• Circuits are tested and checked for function. | • Explain<br>▪ the fundamental operation of electric drive construction and operation.<br>▪ the application of electric drive types.<br>▪ how each drive type is controlled.<br>▪ how the PC is used to control the stepper drive.<br>▪ what is meant by the terms PWM, H bridge motor control, PIC based controller, motor control logic, phase control.<br>▪ how a tacho-generator is used in an electronic control circuit.<br>• Select and identify correct electric drives for specified function.<br>• Construct control circuits using correct electric drives.<br>• Test and check circuits for function. |

| ASSESSMENT TASKS OR ACTIVITIES |
|---|
| • Practical exercises on correct electric drives, control circuits and testing for function.<br>• An open-book test on the terms and theoretical concepts. |

## Topic 3: Analyse and connect basic hydraulic technical systems

| SUBJECT OUTCOME | |
|---|---|
| **3.1 Describe and apply hydraulic technology**<br>*Range: Physical quantities and units used (force, mass, weight, pressure, acceleration, gravity, atmospheric pressure); Physical laws hydrostatics (fluids at rest) hydraulic transmission of forces, hydraulic amplifiers (fluid in motion), law of volume control, hydraulic energy, friction and flow. Power pack: hydraulic gear pump, electric motor, reservoir, pressure relief valve, pipes and unions. Hydraulic circuit elements: Pressure relief valve (direct control), directional control valves (2/2, 3/2, 4/2, 5/2), check valve, cylinders (single/double), valves (pilot control, flow control, throttle control, 4/3 directional control).* | |
| **ASSESSMENT STANDARDS** | **LEARNING OUTCOMES** |
| • Applications of hydraulics, advantages and disadvantages of using hydraulics, and the fundamental physical quantities used in hydraulics are listed<br>• The following are explained:<br>▪ what is meant by the term hydraulics<br>▪ the energy conversion in hydraulic applications using block diagrams<br>▪ the construction of hydraulic systems, using block diagrams<br>▪ the basic physical laws related to hydraulics<br>▪ the tasks of fluid, reservoir and filter pressure gauge<br>▪ pump characteristics<br>▪ the operation of hydraulic circuit elements and related symbols<br>• A hydraulic pump is identified, its function described and the construction of related elements and circuit diagrams drawn<br>• Formulae are applied for fundamental physical quantities as used in hydraulics<br>• The components that make up a hydraulic pump are identified and listed<br>• Power pack symbols are read and interpreted | • List<br>▪ applications where hydraulics can be used<br>▪ advantages and disadvantages of using hydraulics.<br>▪ and use fundamental physical quantities in hydraulics<br>• Explain<br>▪ what is meant by the term hydraulics<br>▪ the energy conversion in hydraulic applications, using block diagrams<br>▪ the construction of hydraulic systems using block diagrams<br>▪ the basic physical laws related to hydraulics<br>▪ the tasks of fluid, reservoir and filter pressure gauge<br>▪ pump characteristics<br>▪ the operation of hydraulic circuit elements and related symbols<br>• Identify and describe function, and draw the construction of a hydraulic pump and related elements and circuit diagram<br>• Apply formulae for fundamental physical quantities as used in hydraulics<br>• Identify and list the components that make up a hydraulic pump<br>• Read and interpret related power pack symbols |
| **ASSESSMENT TASKS OR ACTIVITIES** | |
| • An assignment on the theory, formulae and power pack symbols.<br>• Demonstrations and observation sheets on a hydraulic pump and related elements and circuit diagrams. | |

| SUBJECT OUTCOME | |
|---|---|
| **3.2 Connect basic hydraulic manual control systems**<br>*Range: Circuits: Directional control, check valves, pressure control, flow control, pressure compensated control, two-pump control, sequential control, regenerative control* | |
| **ASSESSMENT STANDARDS** | **LEARNING OUTCOMES** |
| • A sound understanding of hydraulic symbols, and the ability to read hydraulic circuits is demonstrated<br>• Hydraulic control circuit diagrams are read and interpreted<br>• Hydraulic control circuits are connected for functional operation in accordance with regulation<br>• Safety is applied for self and others, and tools and equipment used with care | • Demonstrate a sound understanding of hydraulic symbols and an ability to read hydraulic circuits<br>• Read and interpret hydraulic control circuit diagrams<br>• Connect hydraulic control circuits for functional operation in accordance with regulation<br>• Apply safety for self and others<br>• Use tools and equipment with care |

| ASSESSMENT TASKS OR ACTIVITIES |
|---|
| • Practical exercises, observation sheets and rubrics on connecting basic hydraulic manual control systems. |

## Topic 4: Analyse and connect electro-hydraulic control systems

| SUBJECT OUTCOME | |
|---|---|
| **4.1 Describe and apply electro-hydraulic technology**<br>*Range: Electro-hydraulic systems (electric power supply/ amplifier, proportional solenoid, directional/ pressure/ flow control valve, hydraulic actuator (cylinder/ motor) block diagram of proportional hydraulics, related components (proportional valves directional/ pressure/ flow), electrics (amplifiers with and without feedback), fundamentals of open loop control, control loop, servo control technology.* | |
| **ASSESSMENT STANDARDS** | **LEARNING OUTCOMES** |
| • The following are explained.<br>▪ what is meant by the term electro-hydraulics<br>▪ what the term proportional control means<br>▪ the construction of an electro-hydraulic system, using block diagrams<br>▪ closed and open loop characteristics as used in proportional control.<br>▪ the operation of electro-hydraulic circuit elements and related symbols<br>• Applications where electro-hydraulics can be used, the advantages and disadvantages of using electro-hydraulics, and fundamental physical quantities used in hydraulics are listed and the different control signals used in proportional control (digital, analogue V/A, A/D, and D/A converters) explained.<br>• Basic formulae of proportional control are used.<br>• The function of a proportional control technical system is identified and described, and the block diagram drawn.<br>• The components of an electro-hydraulic system are identified<br>• Correct electronic controls (pilot, P, I, D, PID) are identified and selected<br>• Formulae for fundamental physical quantities are applied as used in hydraulics (read flow, force and pressure with respect to poppet diameter and spring force).<br>• Electro-hydraulic control circuit symbology is read and interpreted. | • Explain<br>▪ what is meant by the term electro-hydraulics<br>▪ what the term proportional control means<br>▪ the construction of an electro-hydraulic system, using block diagrams<br>▪ closed and open loop characteristics as used in proportional control<br>▪ the operation of electro-hydraulic circuit elements and related symbols<br>• List<br>▪ applications where electro-hydraulics can be used<br>▪ Advantages and disadvantages of using electro-hydraulics<br>▪ and use the fundamental physical quantities used in hydraulics<br>▪ and explain the different control signals used in proportional control (digital, analogue V/A)(A/D, D/A converters)<br>• Use basic formulae of proportional control<br>• Identify<br>▪ and describe function, and draw the block diagram of a proportional control technical system<br>▪ and list the components that make up an electro-hydraulic system<br>▪ and select correct electronic controls (pilot, P, I, D, PID)<br>• Apply formulae for fundamental physical quantities as used in hydraulics (read flow, force and pressure with respect to poppet diameter and spring force)<br>• Read and interpret electro-hydraulic control circuit symbology |
| **ASSESSMENT TASKS OR ACTIVITIES** | |
| • Investigation or research into the analysis and connection of electro-hydraulic hybrid control systems | |

| SUBJECT OUTCOME | |
|---|---|
| **4.2 Connect electro-hydraulic control systems**<br>*Range: Circuits: Clamping, flow control, pressure control, speed control, logic element control* | |
| **ASSESSMENT STANDARDS** | **LEARNING OUTCOMES** |
| • Electro-hydraulic symbols are described, and electro-hydraulic circuits read for control applications and connectivity<br>• Electro-hydraulic control circuit diagrams are read and interpreted<br>• Electro-hydraulic control circuits are connected for functional operation in accordance with regulation<br>• Safety is applied for self and others and tools and equipment used with care. | • Describe electro-hydraulic symbols, and read electro-hydraulic circuits for control applications and connectivity<br>• Read and interpret electro-hydraulic control circuit diagrams<br>• Connect electro-hydraulic control circuits for functional operation in accordance with regulation<br>• Apply safety for self and others<br>• Use tools and equipment with care |
| **ASSESSMENT TASKS OR ACTIVITIES** | |
| • Practical exercises and tasks on the connection of electro-hydraulic control systems | |

## Topic 5: Apply trouble shooting techniques on electro-hydraulic control systems

| SUBJECT OUTCOME | |
|---|---|
| **5.1 Name and apply trouble shooting on electro-hydraulic sub-systems**<br>*Range: Drive section, energy control section, tubes and pipes, service unit, energy supply section.*<br>*Techniques: program flowchart, sequential function chart, function chart, circuit diagrams, measuring techniques, diagnostic programs, fault tree analysis* | |
| **ASSESSMENT STANDARDS** | **LEARNING OUTCOMES** |
| • Common faults that occur in a drive section (cylinders/ motors), energy control, energy supply, tubes and pipes, service unit and electrical control sections are listed<br>• Faults in an electro hydraulic system are safely eliminated. | • List common faults<br>▪ that occur in a drive section (cylinders/ motors)<br>▪ that occur in energy control, energy supply, tubes and pipes, service unit and electrical control sections<br>• Safely eliminate faults in an electro hydraulic system |
| **ASSESSMENT TASKS OR ACTIVITIES** | |
| • Role-play, oral tests and practical exercises on the application of trouble shooting techniques on electro-hydraulic hybrid control systems | |

## 4 SPECIFICATIONS FOR EXTERNAL ASSESSMENT IN MECHATRONIC SYSTEMS – LEVEL 3

### 4.2 Integrated summative assessment task (ISAT)

A compulsory component of the external assessment (ESASS) is the **integrated summative assessment task (ISAT)**. The integrated summative assessment task draws on the student's cumulative learning achieved throughout the year. The task requires **integrated application of competence** and is executed and recorded in compliance with assessment conditions.

Two approaches to the integrated summative assessment task may be as follows:

- The students are assigned a task at the beginning of the year which they will have to complete in phases throughout the year to obtain an assessment mark. A final assessment is made at the end of the year when the task is completed.

**OR**

- Students achieve the competencies throughout the year but the competencies are assessed cumulatively in a single assessment or examination session at the end of the year.

The integrated summative assessment task is set by an externally appointed examiner and is conveyed to colleges in the first quarter of the year.

The integrated assessment approach enables students to be assessed in more than one subject with the same integrated summative assessment task.

### 4.3 National Examination

A national examination is conducted annually in October or November by means of a paper(s) set and moderated externally. The following distribution of cognitive application is suggested:

| LEVEL 3 | KNOWLEDGE AND COMPREHENSION | APPLICATION | ANALYSIS, SYNTHESIS AND EVALUATION |
|---|---|---|---|
| | 30% | 50% | 20% |

| MARK ALLOCATION PER QUESTION | | |
|---|---|---|
| **Section 1: Compulsory (must cover all topics)** | | |
| Question 1: | Analyse electronics as a form of control in mechatronic sub-systems. | 20 |
| Question 2: | Analyse and connect electric drives as used in control technology | 20 |
| Question 3: | Analyse and connect basic hydraulic technical systems. | 20 |
| Question 4: | Analyse and connect basic hydraulic technical systems. | 20 |
| Question 5: | Apply trouble shooting techniques on electro-hydraulic hybrid control systems | 20 |
| | **TOTAL** | 100% |