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NATIONAL CERTIFICATES (VOCATIONAL)

ASSESSMENT GUIDELINES

MECHATRONIC SYSTEMS

NQF Level 2

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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 • Class questions • Lecturer, student, parent discussions	• Assignments or tasks • Projects • Investigations or research • Case studies • Practical exercises • Demonstrations • Role-play • Interviews	• Examinations • Class tests • Practical examinations • Oral tests • Open-book tests
Assessment tools	• Observation sheets • Lecturer's notes • Comments	• Checklists • Rating scales • Rubrics	• Marks (e.g. %) • Rating scales (1-5)
Evidence	• Focus on individual students • Subjective evidence based on lecturer observations and impressions	**Open middle**: Students produce the same evidence but in different ways. **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 2:

NUMBER OF UNITS	ASSESSMENT	COVERAGE
3	Formal written tests	One or more completed topics
1	Internal written exam	All completed topics
3	Practical assessments	• 1.1 Practical mathematics exercises on the determination of speed with respect to gear trains and belt drives. • 1.2 Practical exercises and demonstrations on the breakdown of technical systems into various structure levels. • 2.2 Practical exercises on PLC control circuit elements. • 3.1 Practical exercises and demonstrations on connecting pneumatic components in accordance with a given circuit diagram, flow lines and connecting elements. • 3.2 Practical exercises on the application of component symbols • 3.3. Practical exercises and rubrics on design procedures and pneumatic task functions. • 4.2 Demonstrations and practical exercises on drawings used in electro-pneumatic technology, applications in the industry, the reasons why electro-pneumatics are used and electro-pneumatic circuit diagrams. • 5.1 Practical exercises and demonstrations on elimination of faults in an electro pneumatic system safely

ASSESSMENT OF MECHATRONIC SYSTEMS

LEVEL 2

3 INTERNAL ASSESSMENT OF SUBJECT OUTCOMES IN MECHATRONIC SYSTEMS – LEVEL 2

Topic 1: Analyse and apply basic technical systems.

<table>
<tr><th colspan="2">SUBJECT OUTCOME</th></tr>
<tr><td colspan="2">1.1 Define, analyse and apply technical systems (energy, information and matter)
Range: Energy types: Relationships between kinetic, potential, electrical, chemical, mechanical, thermal and nuclear energy types.
Range: Coupling types: Electro-technical, electro-mechanical, mechanical.
Range: Process types and matter as used in the manufacturing industry.
Range: Technical systems: Simple torch, hand held fan, hand held vacuum, portable hand held, automatic kettle, electrical toaster, automatic iron, drill machine, pedestal press drill, welding machine, gas welder, conveyor belt system, pneumatic compressor, battery charger, hydraulic pump.</td></tr>
<tr><th>ASSESSMENT STANDARDS</th><th>LEARNING OUTCOMES</th></tr>
<tr><td>• The following are explained:
▪ what a technical system is with reference to energy, information and matter flow (input, process and output).
▪ the principle of energy conversion.
▪ the process stages to convert different energy types into electrical energy and vice versa.
▪ the fundamental composition of a mechatronic technical system.
• The following are described:
▪ different energy types.
▪ various basic coupling systems that may be found in a technical system.
▪ the types of information that can be found in technical systems.
▪ the purpose and colour of information lamps on technical systems.
▪ the types of matter and related processes that can be found in technical systems.
• An ability to analyse basic technical systems in accordance to energy conversion, information and matter flow using block diagrams is demonstrated.
• Determination of speed with respect to gear trains and belt drives is applied with mathematics.</td><td>• Explain:
▪ what a technical system is with reference to energy, information and matter flow (input, process and output).
▪ the principle of energy conversion.
▪ the process stages to convert different energy types into electrical energy and vice versa.
▪ the fundamental composition of a mechatronic technical system.
• Describe:
▪ different energy types.
▪ various basic coupling systems that may be found in a technical system.
▪ the types of information that can be found in technical systems.
▪ the purpose and colour of information lamps on technical systems.
▪ the types of matter and related processes that can be found in technical systems.
• Demonstrate an ability to apply understanding to the analysis of basic technical systems in accordance with energy conversion, information and matter flow using block diagrams.
• Apply mathematics to determine speed with respect to gear trains and belt drives.</td></tr>
<tr><th colspan="2">ASSESSMENT TASKS OR ACTIVITIES</th></tr>
<tr><td colspan="2">• Practical mathematics exercises on the determination of speed with respect to gear trains and belt drives.
• Demonstration of the analysis of basic technical systems in accordance with energy conversion, information and matter flow using block diagrams.
• Oral test on the concepts that must be described.
• Open-book test on the concepts that must be explained.</td></tr>
</table>

SUBJECT OUTCOME	
1.2 Define, analyse and apply technical systems (simple-, component-, sub-systems and complex systems) *Range: Simple technical systems: Torch, hand held fan, hand held drill, toaster, automatic kettle, pneumatic compressor etc.* *Range: Hybrid technical systems : Electrical–pneumatic; Electrical-hydraulic; Electrical–processor*; *Electrical–pneumatic–processor.* *Applications can include: Packaging, feeding, metering, door/chute control, transfer of materials, turning/inverting parts, sorting of parts, stacking of components, stamping, embossing components.*	
ASSESSMENT STANDARDS	**LEARNING OUTCOMES**
• The following are explained: ▪ the differences between a component, a simple system, a sub-system and a complex system. ▪ why it is necessary to be able to break down a simple technical system into component level or sub-component level ▪ how to break down and analyse a simple technical system into component lists, functional block diagrams and energy flow diagrams. ▪ what is meant by hybrid technical systems. ▪ what computer integrated manufacturing is, in relation to flexible manufacturing systems. • General application of technical systems in the industry is listed and explained. • The ability to break down a technical system to component level, subsystem level so as to determine component lists, function and operation thereof.	• Explain: ▪ the differences between a component, a simple system, a sub-system and a complex system. ▪ why it is necessary to be able to break down a simple technical system into component level or sub-system level. ▪ how to break down and analyse a simple technical system into component lists, functional block diagrams and energy flow diagrams. ▪ what is meant by hybrid technical systems. ▪ what computer integrated manufacturing is, in relation to flexible manufacturing systems. • List and explain general application of technical systems in industry. • Demonstrate the ability to break down a technical system to component level, sub-system level so as to determine component lists, function and operation thereof.
ASSESSMENT TASKS OR ACTIVITIES	
• Assignment or task on the general application of technical systems in the industry. • Practical exercises and demonstrations on the break down of technical systems to component level, subsystem level. • Oral test and open-book test on the concepts that must be explained.	

Topic 2: Analyse and connect basic control circuits for technical systems.

SUBJECT OUTCOME	
2.1 Explain and demonstrate fundamentals of basic control. *Range: Open Loop Control: Discontinuous (electric automatic kettle, electric pop-up toaster). Continuous (automatic iron, electric oven, electric geyser system) or any other related systems.* *Range: Relay logic control circuits: AND, OR, NOT, latching, simple control using timers, counters, input sensors, actuators, final drives, input devices* *Range: Input devices: (pushbuttons (NO.NC), limit switches, float switches, thermostat, inductive proximity switch, capacitive proximity switch.* *Range: Output devices: Indication lamps, actuators (relays, contactors, solenoid valves), final drives (electrical, pneumatic and hydraulic).*	
ASSESSMENT STANDARDS	**LEARNING OUTCOMES**
• The meanings of the following are explained: ▪ remote control. ▪ automatic systems. ▪ a main and control system. ▪ an open loop control system. ▪ a closed loop control system. ▪ a control signal. • The following is explained: ▪ the relationship between input, process and output in a control system. ▪ the differences between an open loop continuous and discontinuous system.	• Explain what is meant by: ▪ remote control. ▪ automatic systems. ▪ a main and control system. ▪ an open loop control system. ▪ a closed loop control system. ▪ a control signal. • Explain: ▪ the relationship between input, process and output in a control system. ▪ the differences between an open loop continuous and discontinuous system.

▪ relay logic control for simple applications. ▪ technical control systems in relation to input, process, output. • Control components are identified and their function explained. • Sensors are identified and minor adjustments for function are made. • Fundamental operation and use of control and switching elements are identified and described. • The construction, symbols, terminal markings and specifications of fundamental control and switching elements are described. • Relay logic control diagrams are read and interpreted for construction purposes. • Control circuits are connected for analysis. • Connections are made in accordance with regulation.	▪ relay logic control for simple applications. ▪ technical control systems in relation to input, process, output. • Identify: ▪ control components and explain their function. ▪ and make minor adjustments to sensors for function. ▪ and describe fundamental operation and use of control and switching elements. • Describe the construction, symbols, terminal markings and specifications of fundamental control and switching elements. • Demonstrate the ability to read and interpret relay logic control diagrams for construction purposes. • Connect control circuit for analysis. • Ensure all connections are made in accordance with regulation.
ASSESSMENT TASKS OR ACTIVITIES	
• Class questions on the meaning and explanation of concepts. • Demonstrations and role-play on connections in accordance with regulations • Class test on all the Learning Outcomes thus far. • Checklists on control components, sensors and control and switching elements. • Rubrics on relay logic control diagrams.	

SUBJECT OUTCOME	
2.2 Explain and demonstrate the role of computers in industry. *Range: Intelligent devices (programmable sensors, robots, speed controllers); Programmable Logic Controllers (stand alone units, modular units); circuit diagrams (simple PLC electrical switching circuit connections).*	
ASSESSMENT STANDARDS	**LEARNING OUTCOMES**
• A flexible manufacturing system (FMS) is described. • The following are explained: ▪ advantages and disadvantages of computers being used in industry. ▪ what is meant by a CAD system. ▪ what is meant by a CAM/CIM system. ▪ what is meant by an intelligent device in a technical system. ▪ the construction and function of a programmable logic controller (PLC). ▪ what is meant by a safety circuit. • PLC control circuit elements are identified, selected and connected from a circuit diagram. • Connections are made in accordance with regulation.	• Describe what a flexible manufacturing system (FMS) is. • Explain: ▪ advantages and disadvantages of computers being used in industry. ▪ what is meant by a CAD system. ▪ what is meant by a CAM/CIM system. ▪ what is meant by an intelligent device in a technical system. ▪ the construction and function of a programmable logic controller (PLC). ▪ what is meant by a safety circuit. • Identify, select and connect PLC control circuit elements from a circuit diagram. • Ensure that connections are made in accordance with regulation.
ASSESSMENT TASKS OR ACTIVITIES	
• Lecturer-student discussions and class questions on the concepts that must be explained. • A project on a flexible manufacturing system (FMS). • Practical exercises on PLC control circuit elements. • Observation sheets and practical examination on connections in accordance with regulation.	

Topic 3: Analyse and connect basic pneumatic technical systems.

SUBJECT OUTCOME

3.1 Describe and apply pneumatic technology.

Range: Choice of working media: Electrics, hydraulics, pneumatics and/or a combination thereof.

Range: Working criteria selection: Force, stroke, type of motion, speed, size, service life, sensitivity, safety and reliability, energy costs, controllability, handling, storage.

Range: Choice of control media: Mechanical, electrical, electronic, pneumatic (low/high pressure), hydraulic.

Range: Selection criteria for control section: Reliability, sensitivity, ease of maintenance and repair, switching time, signal speed, space requirements, service life.

Range: System component: Actuating devices: pneumatic cylinders, rotary motors, indicators).

Range: Final control elements: direction control valves.

Range: Processing elements: directional control valves, logic elements, pressure control valves.

Range: Input elements: Sensors: directional control valves, limit switches, pushbuttons, proximity switches.

Range: Air supply system components: (air service unit – air filter, regulator, lubricator); directional control valves (signalling elements, processing elements, power, elements); non-return valves, flow control valves, pressure control valves, combinational valves.

ASSESSMENT STANDARDS	LEARNING OUTCOMES
• The term pneumatics is defined. • The terms preparation, compressibility, force requirements, noise levels and costs are defined and described. • The four functions of compressed air applications (status of processes, information processing, switching final control elements and performing work function) are stated. • The following are listed and explained: ▪ the three types of motion that can be performed by pneumatic components (linear, swivel and rotary). ▪ general methods of material handling (clamping, shifting, positioning and orientation). ▪ the factors that have to be considered when selecting pneumatic technical systems (work/output requirements, preferred control methods, resource requirements, new/integrated into old system. ▪ the operation of basic pneumatic system components. • Air generation and distribution in a pneumatic system (quality of air and possible malfunctions) are explained. • The function of components that make up an air supply system is identified and explained. • Components that make up a pneumatic technical sub-system are identified and a materials list drawn up. • Pneumatic components are connected in accordance with a given circuit diagram. • Flow lines are connected in accordance with regulation. • Connecting elements (friction, clamping and crimping types) are used.	• Define: ▪ what is meant by the term pneumatics. ▪ and describe the terms preparation, compressibility, force requirements, noise levels and costs. • State the four functions of compressed air applications (status of processes, information processing, switching final control elements, performing work function). • List and explain: ▪ the three types of motion that can be performed by pneumatic components (linear, swivel and rotary). ▪ general methods of material handling (clamping, shifting, positioning and orientation). ▪ the factors that must be considered when selecting pneumatic technical systems (work/output requirements, preferred control methods, resource requirements, new/integrated into old system. ▪ the operation of basic pneumatic system components. • Explain the air generation and distribution in a pneumatic system (quality of air and possible malfunctions). • Identify: ▪ and explain the function of components that make up an air supply system. ▪ components that make up a pneumatic technical sub-system and draw up a materials list. • Connect pneumatic components in accordance with a given circuit diagram. • Connect flow lines in accordance with regulation. • Use connecting elements, friction, clamping and crimping types.

ASSESSMENT TASKS OR ACTIVITIES

- Assignment or task on the components of a pneumatic technical sub-system and a materials list.
- Practical exercises and demonstrations on connecting pneumatic components in accordance with a given circuit diagram, flow lines and connecting elements.
- Oral test and open-book test on defined and described terms.
- Observation sheets and rating scales on lists of the three types of motion that can be performed by pneumatic components, the general methods of material handling, the factors that must be considered when selecting pneumatic technical systems, and preferred control methods & resource requirements.
- A rubric on the operation of a basic pneumatic system.

SUBJECT OUTCOME	
3.2 Identify and apply pneumatic component symbols. *Range: Characteristics (function, actuation methods, connection number, switching positions, general operating principles, simplified flow representation); Non–characteristics (size, dimension of component, orientation of ports, physical details of elements, any connections)*	
ASSESSMENT STANDARDS	**LEARNING OUTCOMES**
• Symbol characteristics as used in pneumatic diagrams are drawn and described. • Information that is not represented by the symbols is listed. • Pneumatic symbols are read and interpreted for basic function purposes and connection.	• Draw and describe the symbol characteristics as used in pneumatic diagrams. • List the information that is not represented by the symbols. • Read and interpret pneumatic symbols for basic function purposes and connection.
ASSESSMENT TASKS OR ACTIVITIES	
• A project and case studies on the description and application of component symbols • Practical exercises on the application of component symbols.	

SUBJECT OUTCOME	
3.3 **Connect basic pneumatic manual control systems.** *Range: Basic pneumatic design and connectivity tasks. Direct control, indirect control, logic AND, OR functions.*	
ASSESSMENT STANDARDS	**LEARNING OUTCOMES**
• Design procedure to determine task function (control, problem analysis, solution design, implementation, evaluation and maintenance) is explained. • Pneumatic task function is designed and connected.	• Explain design procedure to determine task function (control, problem analysis, solution design, implementation, evaluation and maintenance). • Design and connect pneumatic task function.
ASSESSMENT TASKS OR ACTIVITIES	
• Practical exercises and rubrics on design procedures and pneumatic task functions.	

Topic 4: Analyse and connect basic electro-pneumatic hybrid control systems.

SUBJECT OUTCOME	
4.1 Explain and demonstrate electro-pneumatic technology. *Range: Basic electrics, pneumatics and combinations thereof. Symbology and equipment (switches, indication lamps, timers, counters and sensors, power supplies), circuit diagrams (pneumatic and electrical, schematic, system, connection, internal wiring, assembly, layout), identification letters of parts and devices.*	
ASSESSMENT STANDARDS	**LEARNING OUTCOMES**
• The following concepts are explained: ▪ why electricity is used for the control signal for remote control applications. ▪ how identification letters are used in electro-pneumatics applications. ▪ what is meant by a delay on and/or delay off timer. ▪ the purpose of using a step diagram in the design of an electro-pneumatic control circuit. • The fundamental principles used in electro-pneumatics are listed and explained. • The fundamental operation of parts and equipment used in electro pneumatics are listed and explained. • The different drawings used in electro-pneumatic technology and their purposes are identified and explained. • Applications in the industry are identified and the reasons for using electro-pneumatics explained. • Different electro-pneumatic circuit diagrams are identified. • Various electro-pneumatic parts are identified. • Application circuits that employ timers and counters in their control circuit are described. • Various electro-pneumatics circuit symbology is redrawn. • A step diagram is used to develop an electro-pneumatic control circuit.	• Explain: ▪ why electricity is used for the control signal for remote control applications. ▪ how identification letters are used in electro-pneumatics applications. ▪ what is meant by a delay on and/or delay off timer. ▪ the purpose of using a step diagram in the design of an electro-pneumatic control circuit. • List and explain: ▪ the fundamental principles used in electro-pneumatics. ▪ the fundamental operation of parts and equipment used in electro pneumatics. • Identify: ▪ and explain the different drawings used and their purposes. ▪ applications in industry and explain why electro-pneumatics are used. ▪ different electro-pneumatic circuit diagrams. ▪ various electro-pneumatic parts. • Describe application circuits that employ timers and counters in their control circuit. • Redraw various electro-pneumatics circuit symbology. • Use a step diagram to develop an electro-pneumatic control circuit.
ASSESSMENT TASKS OR ACTIVITIES	
• Assignments or tasks on the application of circuits that employ timers and counters in their control circuit. • A project on a step diagram used to develop an electro-pneumatic control circuit. • Demonstrations and practical exercises on drawings used in electro-pneumatic technology, applications in the industry, the reasons for use of electro-pneumatics, and electro-pneumatic circuit diagrams. • Demonstrations on the various electro-pneumatic parts. • A class test on electro-pneumatic circuit symbology. • An oral test and open-book test on the concepts addressed. • Rating scales on the fundamental principles used in electro-pneumatics and the fundamental operation of parts and equipment used.	

SUBJECT OUTCOME	
4.2 Explain and perform electro-pneumatic co-ordinated motion control. *Range: Motion control (direct control, impulse valve, indirect control, self-holding circuits, alternating controls, logic functions).*	
ASSESSMENT STANDARDS	**LEARNING OUTCOMES**
• The following are explained: ▪ the term "motion control". ▪ the various motion control types encountered in electro-pneumatics. ▪ sequential timer and cascaded timer circuits, with the aid of a sketch ▪ the purpose and importance of sensors used in electro pneumatic control. ▪ how electric – pneumatic conversion control is achieved. • Applications where counters are used in electro-pneumatic control are listed. • Applications where timers are used in electro-pneumatic control are listed. • Electro-pneumatic symbols are read and interpreted for basic function purposes and connection. • Fundamental electro-pneumatic circuit diagrams are designed and implemented using step diagrams. • Fault finding is performed on electro-pneumatic control circuits.	• Explain: ▪ what is meant by the term "motion control". ▪ the various motion control types encountered in electro-pneumatics. ▪ with the aid of a sketch what is meant by sequential timer and cascaded timer circuits. ▪ the purpose and importance of sensors used in electro-pneumatic control. ▪ how electric – pneumatic conversion control is achieved. • List applications where: ▪ counters are used in electro-pneumatic control. ▪ timers are used in electro-pneumatic control. • Read and interpret electro-pneumatic symbols for basic function purposes and connection. • Design and implement fundamental electro-pneumatic circuit diagrams using step diagrams. • Perform fault finding on electro-pneumatic control circuits.
ASSESSMENT TASKS OR ACTIVITIES	
• A project on the interpretation of electro-pneumatic symbols. • A case study on the design of fundamental electro-pneumatic circuit diagrams and practical exercises on the implementation thereof. • Demonstrations and an assignment on fault finding on electro-pneumatic control circuits. • Oral tests and open-book tests on the terms and concepts that are explained and defined. • Observation sheets and role-play on the applications where counters are used in electro-pneumatic control and where timers are used in electro-pneumatic control.	

Topic 5: Apply troubleshooting techniques on electro-pneumatic control systems.

SUBJECT OUTCOME	
5.1 Apply trouble shooting electro-pneumatic sub-systems. *Range: drive section, energy control section, tubes and pipes, service unit, energy supply section.* *Techniques: program flowchart, sequential function chart, function chart, circuit diagrams, measuring techniques, diagnostic programs, fault tree analysis.*	
ASSESSMENT STANDARDS	**LEARNING OUTCOMES**
• Common faults that can normally occur in a drive section (cylinders and motors) are listed. • Common faults that can occur in energy control, energy supply, tubes and pipes, service unit and electrical control sections are listed. • Faults in an electro pneumatic system are safely eliminated.	• List common faults that ▪ can normally occur in a drive section (cylinders and motors). ▪ can occur in energy control, energy supply, tubes and pipes, service unit and electrical control sections. ▪ Safely eliminate faults in an electro pneumatic system
ASSESSMENT TASKS OR ACTIVITIES	
• Case studies and a practical test on common faults that can normally occur in a drive section (cylinders and motors) and faults that can occur in energy control, energy supply, tubes and pipes, service unit and electrical control sections. • Practical exercises and demonstrations of safe elimination of faults in an electro pneumatic system • A practical examination of all assignments. • Class test on all the work.	

4 SPECIFICATIONS FOR EXTERNAL ASSESSMENT IN MECHATRONIC SYSTEMS – LEVEL 2

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 2	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 and apply basic technical systems.	20
Question 2:	Analyse and connect basic control circuits for technical systems.	20
Question 3:	Analyse and connect basic pneumatic technical systems.	20
Question 4:	Analyse and connect basic electro-pneumatic hybrid control systems.	20
Question 5:	Apply troubleshooting techniques on electro-pneumatic control systems.	20
	TOTAL	100%