education

Department:
Education
REPUBLIC OF SOUTH AFRICA

NATIONAL CERTIFICATES (VOCATIONAL)

ASSESSMENT GUIDELINES

REFRIGERATION AND AIR-CONDITIONING PROCESSES NQF Level 4

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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 Refrigeration Principles, Refrigeration Practice and Refrigeration and Air-conditioning Processes 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: Refrigeration and Air-conditioning Processes* to prepare for and deliver Refrigeration and Air-conditioning Processes. 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 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 their acquired knowledge.

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

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 for students who experience barriers to learning be customised 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 (PoE).

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 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 REFRIGERATION AND AIR-CONDITIONING PROCESSES

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 Refrigeration and Air-conditioning Processes 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

Refrigeration Principles, Refrigeration Practices, and Refrigeration and Air-conditioning Processes, as is the case for all the other Vocational subjects, are 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 Refrigeration and Air-conditioning Processes Level 4:

NUMBER OF UNITS	ASSESSMENT	COVERAGE
3	Formal written tests	One or more completed topics
1	Internal written exams	All completed topics
3	Practical assessments	The related Subject Outcomes: 1.8 Possible faults and comparison with similar components serving the same function, highlighting advantages and limitations and selection including mismatching of components and the methods in determining required adjustments 2.1 To select a chart for a given altitude and plot state points for a range of given conditions 2.8 A ducted system selecting instruments, identifying measuring points, conducting measurements on an operating system and indicating pressures obtained within determined parameters An assignment or task to explain the effects of friction in ducts 3.2 A refrigeration system selecting instruments, identifying measuring points, conducting measurements on an operating system and indicating readings within parameters 3.5 Practically service a plant and conduct testing, checks and settings and complete a report 3.6 Determine and set controls on an operating plant and conduct testing, checks and settings 3.7 Test controls and systems on an operational plant against specifications 4.2 Sketches of circuit diagrams for the types of starters, including protection and control devices 4.3 Demonstrate competency in a practical project involving the physical construction of a 3-phase refrigeration based circuit, including conductor selection, component connection and testing operation of circuit 4.6 Apply a safety lock out system to an electrical panel 4.7 Inspecting and maintaining electrical control panels and circuitry 5.8 Conducting inspection and maintenance of electrical panels circuitry and motors

ASSESSMENT OF REFRIGERATION AND AIR-CONDITIONING PROCESSES LEVEL 4

3 INTERNAL ASSESSMENT OF SUBJECT OUTCOMES IN REFRIGERATION AND AIR-CONDITIONING PROCESSES - LEVEL 4

Topic 1: Explain, analyse and apply refrigeration systems, controls and components

SUBJECT OUTCOME	
1.1 Explain the differences in operation between the basic and actual vapour compression refrigeration cycles	
ASSESSMENT STANDARDS	**LEARNING OUTCOMES**
• The basic and actual vapour compression refrigeration cycles are compared and the terms sub-cooling, superheating, line pressure drop, non-isentropic compression are explained. • The effects of the actual operating conditions on refrigerant mass flow, COP, power requirements and heat transfer are explained. • A flow diagram of an actual vapour compression cycle is sketched on a pressure-enthalpy chart and compared with the basic cycle. • The components of a heat pump cycle flow diagram are sketched and the system operation is explained. • The causes and effects of flash gas are explained.	• Compare the basic and actual vapour compression refrigeration cycles and explain the terms sub-cooling, superheating, line pressure drop and non-isentropic compression.Explain the effects of actual operating conditions on refrigerant mass flow, co-efficient of performance (COP), power requirements and heat transfer. • Sketch a flow diagram of an actual vapour compression cycle on a pressure-enthalpy chart and compare this with the basic cycle. • Sketch the components of a heat pump cycle flow diagram and explain the system operation. • Explain the causes and effects of flash gas.
ASSESSMENT TASKS OR ACTIVITIES	
• Observation sheets and a project to utilise sketch of a flow diagram of an actual vapour compression cycle to explain and demonstrate understanding of the aspects of the vapour compression cycle. • Class questions and case studies to explain the differences in operation between the basic and actual vapour compression refrigeration cycle.	

SUBJECT OUTCOME	
1.2 Compare the various types of vapour compression refrigeration systems	
ASSESSMENT STANDARDS	**LEARNING OUTCOMES**
• The operation of various types of actual vapour compression refrigeration systems and the component functions are explained by using a flow diagram. • Various systems, typical applications and their advantages and limitations are listed, compared and described.	• Explain the operation of various types of actual vapour compression refrigeration systems, and explain the component functions using a flow diagram. • List, compare and describe various systems, typical applications and their advantages and limitations.
ASSESSMENT TASKS OR ACTIVITIES	
• Investigations or research to conduct a comparative study, project or report. • Observation sheets and checklists on various similar components serving the same function/s, highlighting advantages, limitations and selection.	

SUBJECT OUTCOME	
1.3 Explain the effect of operating conditions on component performance	
ASSESSMENT STANDARDS	**LEARNING OUTCOMES**
• The effects of superheat and sub-cooling on operating conditions and performance of components and accessories in the system are explained. • The effect of pipe pressure losses on operating conditions and the performance of components and accessories in the system are explained. • The effect of non-isentropic compression on the operating conditions and the performance of components and accessories in the system are explained.	• Explain the effects of superheat and sub-cooling on the operating conditions and the performance of components and accessories in the system. • Explain the effect of pipe pressure losses on the operating conditions and the performance of components and accessories in the system. • Explain the effect of non-isentropic compression on the operating conditions and the performance of components and accessories in the system.

ASSESSMENT TASKS OR ACTIVITIES
• Assignments or tasks on the effect of operating conditions on component performance

SUBJECT OUTCOME	
1.4 Define and analyse air-conditioning	
ASSESSMENT STANDARDS	**LEARNING OUTCOMES**
• Air-conditioning, its functions and benefits are explained. • Commonly applied types of air-conditioning equipment are named and described and their typical applications, advantages and disadvantages are listed and explained.	• Explain air-conditioning, its functions and benefits. • Name and describe the commonly applied types of air-conditioning equipment, and list and explain their typical applications, advantages and disadvantages
ASSESSMENT TASKS OR ACTIVITIES	
• A project on the commonly applied types of air-conditioning equipment, listing typical applications, and advantages and disadvantages for a particular type of application, listing alternatives, and giving final recommendations as to equipment most suited for application (for example a system for an executive office type application).	

SUBJECT OUTCOME	
1.5 Name categories of air-conditioning systems, explain their operation, and list the advantages and disadvantages of each	
ASSESSMENT STANDARDS	**LEARNING OUTCOMES**
• Commonly applied categories of air-conditioning systems are named, their operation and control explained, and their advantages and disadvantages stated. • The different sub-systems of an all-air system are named, their operation and control explained and their advantages and disadvantages listed. • The different sub-systems of an air-water system are named, their operation and control explained and their advantages and disadvantages listed. • The economy cycle is explained as applied to the all-air systems of air-conditioning, and the advantages and disadvantages thereof are listed. • The basic operation and control of an economy cycle is explained.	• Name the commonly applied categories of air-conditioning systems, explain their operation and control, and state their advantages and disadvantages. • Name the different sub-systems of an all-air system, explain their operation and control, and list their advantages and disadvantages. • Name the different sub-systems of an air-water system, explain their operation and control, and list their advantages and disadvantages. • Explain the economy cycle as applied to the all-air systems of air-conditioning and list the advantages and disadvantages thereof. • Explain the basic operation and control of an economy cycle.
ASSESSMENT TASKS OR ACTIVITIES	
• Case studies, observation sheets and a comparative study, project or report on the commonly applied categories of air-conditioning systems highlighting the reasons for and operation of an economy cycle	

SUBJECT OUTCOME	
1.6 List, identify and explain the purpose of refrigerant control devices	
ASSESSMENT STANDARDS	**LEARNING OUTCOMES**
• The purpose of refrigerant control devices in a refrigeration system is explained. • Examples of refrigerant control device applications in a refrigeration system are listed.Various methods of controlling refrigerant flow in a system are listedThe various refrigerant control devices are identified and their positions on a plant indicated. • The importance of correct positioning of a refrigerant control device in the system is explained. • Different makes and models of refrigerant control devices are identified.	• Explain the purpose of refrigerant control devices in a refrigeration system. • List examples of applications of refrigerant control devices in a refrigeration system.List and explain various methods of controlling refrigerant flow in a system. • Identify the various refrigerant control devices correctly and indicate their position on a plant. • Explain the importance of correct positioning of a refrigerant control device in the system. • Identify the different makes and models of refrigerant control devices.
ASSESSMENT TASKS OR ACTIVITIES	
• An assignment or task on the function of components and a comparative study on similar components serving the same function/s, highlighting advantages, limitations and selection. • Observation sheets and rubrics on the various refrigerant control devices and their positions on a plant.	

SUBJECT OUTCOME	
1.7 Explain the operation of refrigerant control devices	
ASSESSMENT STANDARDS	**LEARNING OUTCOMES**
• Possible faults on refrigerant metering devices during operation are listed. • The required adjustments to metering devices to ensure correct control action are explained. • The importance of correctly matching the refrigerant metering device to the system is explained.	• List possible faults on refrigerant metering devices during operation. • Explain adjustments to metering devices to ensure correct control action. • Explain the importance of correctly matching the refrigerant metering device to the system.
ASSESSMENT TASKS OR ACTIVITIES	
• Demonstrations and practical exercises on possible faults. Compare various refrigerant control devices highlighting advantages and limitations. Demonstrate the required measurements and adjustments to ensure correct operation.	

SUBJECT OUTCOME	
1.8 List controls and safety devices and explain their purpose and operation in refrigeration plants	
ASSESSMENT STANDARDS	**LEARNING OUTCOMES**
• Commonly used control and safety devices and their operation are explained. • The method of determining settings of devices is explained and demonstrated. • The importance of selecting the correct operating range for the devices is explained. • The consequences of faulty selection and operation, wrong settings and not including safety devices are explained.	• Explain the commonly used control and safety devices and their operation. • Explain the method of determining setting of devices. • Explain the importance of selecting the correct operating range for the devices. • Explain the consequences of faulty selection and operation, wrong settings and not including safety devices.
ASSESSMENT TASKS OR ACTIVITIES	
• Practical exercises with checklists on the possible faults and comparison with similar components serving the same function, highlighting advantages and limitations and selection including mismatching of components and the methods in determining required adjustments.	

SUBJECT OUTCOME	
1.9 List defrost systems and explain their purpose and operation	
ASSESSMENT STANDARDS	**LEARNING OUTCOMES**
• The purposes of defrosting coils are explained. • The various methods of defrosting, and the defrost cycle sequence of events are explained. • The consequences of extended, insufficient or no defrosting periods are listed. • The importance of heater elements on the drip tray and the drain line heater tape are explained.	• Explain the purposes of defrosting coils. • Explain the various methods of defrosting, and the defrost cycle sequence of events. • List the consequences of extended, insufficient or no defrosting periods. • Explain the importance of heater elements on the drip tray and the drain line heater tape.
ASSESSMENT TASKS OR ACTIVITIES	
• Observations and an assignment on defrosting. • A formal class test on Topic 1	

Topic 2: Explain and apply psychometric charts, heat and mass flow calculations and airflow

SUBJECT OUTCOME	
2.1 Define *psychometrics*, the properties of air, and plot an air condition on a psychometric chart	
ASSESSMENT STANDARDS	**LEARNING OUTCOMES**
• The term *'psychometrics'* is defined • The composition of air is explained • The properties of air are named and described. • A psychometric chart is selected for a particular altitude and temperature range. • The state point for a given air condition is plotted. • The properties of air are determined and recorded using the correct SI units and symbols.	• Define the term *'psychometrics'*. • Explain the composition of air. • Name and describe the properties of air. • Select a psychometric chart for a particular altitude and temperature range. • Plot the state point for a given air condition on the psychometric chart. • Determine and record the properties of air using the correct SI units and symbols.
ASSESSMENT TASKS OR ACTIVITIES	
• Student to explain the term psychometrics. • A project outlining the composition and properties of air using SI units. • Case studies and practical exercises to select a chart for a given altitude and plot state points for a range of given conditions.	

SUBJECT OUTCOME	
2.2 Calculate the amount of sensible, latent and total heat using enthalpy formulas	
ASSESSMENT STANDARDS	**LEARNING OUTCOMES**
• The sensible heat formula and the enthalpy formula are stated. • The mass flow of the air is calculated. • The amount of sensible heat removed is calculated using the enthalpy formula. • The amount of latent heat removed is calculated using the enthalpy formula. • The total amount of heat removed is calculated using the enthalpy formula.	• State the sensible heat formula and the enthalpy formula. • Calculate the mass flow of air. • Calculate the amount of sensible heat removed, using the enthalpy formula (in kilowatts). • Calculate the amount of latent heat removed using the enthalpy formula. • Calculate the total amount of heat removed using the enthalpy formula.
ASSESSMENT TASKS OR ACTIVITIES	
• Class questions and an open-book test on calculations using enthalpy formulae	

SUBJECT OUTCOME	
2.3 Calculate the amount of moisture added to or removed from air	
ASSESSMENT STANDARDS	**LEARNING OUTCOMES**
• The formula required to calculate the amount of moisture added to or removed from air is stated and explained. • The amount of water added to or removed from air is calculated in kilograms per second and in litres per hour.	• State and explain the formula required to calculate the amount of moisture added to or removed from air. • Calculate the amount of water added to or removed from air in kilograms per second and in litres per hour.
ASSESSMENT TASKS OR ACTIVITIES	
• Class questions and an open-book test	

SUBJECT OUTCOME	
2.4 Calculate the amount of chilled water required for a cooling or heating application	
ASSESSMENT STANDARDS	**LEARNING OUTCOMES**
• The formula required to calculate amount of water required for a cooling or heating application is stated and explained. • The amount of chilled water required for cooling loads and heating applications is calculated.	• State and explain the formula required to calculate amount of water required for a cooling or heating application. • Calculate the amount of chilled water required for cooling loads and heating applications.
ASSESSMENT TASKS OR ACTIVITIES	
• Class questions and an open-book test	

SUBJECT OUTCOME	
2.5 Calculate the amount of heat required to produce saturated steam	
ASSESSMENT STANDARDS	**LEARNING OUTCOMES**
• The formulae used to calculate the amount of heat required to produce saturated steam are stated. • The amount of heat required for the process is calculated in kilojoules and kilowatts.	• State the formulae used to calculate the amount of heat required to produce saturated steam. • Calculate the amount of heat required for the process in kilojoules and in kilowatts.
ASSESSMENT TASKS OR ACTIVITIES	
• Assignments and case studies on calculations of the amount of heat required to produce saturated steam	

SUBJECT OUTCOME	
2.6 Calculate volumes of square and round ducts	
ASSESSMENT STANDARDS	**LEARNING OUTCOMES**
• The areas of square and round ducts are calculated. • The diameter of a round duct is calculated from a given area. • The sizes and volumes of square, rectangular and round ducts are calculated for given areas.	• Calculate the area of square and round ducts. • Calculate the diameter of a round duct from a given area. • Calculate, for given areas, the sizes and volumes of square, rectangular and round ducts.
ASSESSMENT TASKS OR ACTIVITIES	
• Assignments and case studies on calculations of sizes and volumes of square and round ducts	

SUBJECT OUTCOME	
2.7 Calculate elementary airflow	
ASSESSMENT STANDARDS	**LEARNING OUTCOMES**
• The volumes of air flowing in a duct are calculated for given areas and velocities. • The velocity of air flow is calculated for given volumes and areas. • The velocity pressure of air is calculated. • The velocity of air in a duct is calculated from a given velocity pressure.	• Calculate the volumes of air flowing in a duct for given areas and velocities. • Calculate, for given volumes and areas, the velocity of air flow. • Calculate the velocity pressure of the air. • Calculate the velocity of air in a duct from a given velocity pressure.
ASSESSMENT TASKS OR ACTIVITIES	
• Class questions and an open-book test on calculations of elementary airflow	

SUBJECT OUTCOME	
2.8 Measure air pressure in a duct	
ASSESSMENT STANDARDS	**LEARNING OUTCOMES**
• The common instruments used for measuring duct pressures and velocities are listed and their purposes explained. • The correct instrumentation is selected for various measurements. • The most suitable measuring points in a duct are selected. • Negative and positive pressures are measured at measuring points. • The effects and significance of the different pressures are explained. • The effects of density on air pressure are explained. • The effects of friction on air pressure in the ducts are explained. • The normal range of pressures in a duct is indicated.	• List the common instruments used and explain the purpose thereof in measuring duct pressures and velocities. • Select the correct instrumentation for various measurements. • Select the most suitable measuring points in a duct. • Measure negative and positive pressures at measuring points. • Explain the effects and significance of different pressures. • Explain the effects of density on air pressure. • Explain the effects of friction on air pressure in the ducts. • Indicate the normal range of pressures in a duct.
ASSESSMENT TASKS OR ACTIVITIES	
• Practical exercises on a ducted system, selecting instruments, identifying measuring points, conducting measurements on an operating system and indicating pressures obtained within determined parameters. • An assignment or task to explain the effects of friction in ducts. • A class test on Topic 2.	

Topic 3: Explain operating parameters and servicing of Heating-, Ventilation-, Air-Conditioning and Refrigeration (HVAC&R) systems

SUBJECT OUTCOME	
3.1 Explain terminology for operating parameters of air-conditioning and refrigeration systems	
ASSESSMENT STANDARDS	**LEARNING OUTCOMES**
• Operating parameter terminology is explained: temperature (including saturation temperature and temperature difference), heat, relative humidity, pressure, vacuum, superheat and sub-cooling	• Explain the terminology for operating parameters: temperature (including saturation temperature and temperature difference), heat, relative humidity, pressure, vacuum, superheat and sub-cooling.
ASSESSMENT TASKS OR ACTIVITIES	
• An assignment on operating parameter terminology.	

SUBJECT OUTCOME	
3.2 Measure and determine operating parameters of refrigeration systems	
ASSESSMENT STANDARDS	**LEARNING OUTCOMES**
• Tools and instruments required to measure the operating parameters of a refrigeration system are listed. • Refrigerant and water pressures of a system are measured and recorded. • Refrigerant, water, air and surface temperatures of a system are measured and recorded. • The relative humidity of a room is measured and recorded • Superheat and sub-cooling of a refrigerant are measured at various positions. • The consequences of not or incorrectly determining operating parameters are listed and explained.	• List tools and instruments required to measure the operating parameters of a refrigeration system. • Measure and record refrigerant and water pressures of a system. • Name, measure and record refrigerant, water, air and surface temperatures of a system. • Measure and record the relative humidity of a room. • Measure superheat and sub-cooling of a refrigerant at various positions. • List and explain the consequences of not or incorrectly determining operating parameters.
ASSESSMENT TASKS OR ACTIVITIES	
• Demonstrations, practical exercises and rubrics on a refrigeration system, selecting instruments, identifying measuring points, conducting measurements on an operating system, and indicating readings within parameters. • Class questions and observation sheets on the consequences of incorrectly determining operating parameters.	

SUBJECT OUTCOME	
3.3 Compare observations with the design parameters for a plant	
ASSESSMENT STANDARDS	**LEARNING OUTCOMES**
• Superheat and sub-cooling deviations and the desirability for correct superheat and sub cooling are explained. • Causes and consequences of high, low or no superheating and sub cooling are listed • Reasons for high and low temperature and pressure readings are listed and explained. • The effects of high and low room temperature and relative humidity are explained.	• Explain superheat and sub-cooling deviations and the desirability for correct superheat and sub-cooling. • List causes and consequences of high, low or no superheating and sub-cooling. • List and explain reasons for high and low temperature and pressure readings. • Explain the effects of high and low room temperature and relative humidity.
ASSESSMENT TASKS OR ACTIVITIES	
• Projects to compare observations with the design parameters for a plant	

SUBJECT OUTCOME	
3.4 Operate the valves in a typical refrigeration system	
ASSESSMENT STANDARDS	**LEARNING OUTCOMES**
• Service valves on a plant are back-seated, front-seated and crack serviced. • Refrigerant and water valves are opened and closed when required. • Correct isolation procedures are demonstrated for refrigeration components and accessories. • The consequences of valves in incorrect positions in an operational plant are listed and explained.	• Back-seat, front-seat and crack service valves on a plant. • Open and close refrigerant and water valves when required. • Demonstrate correct isolation procedures for refrigeration components and accessories. • List and explain the consequences of valves in incorrect positions in an operational plant.
ASSESSMENT TASKS OR ACTIVITIES	
• Practical exercises and demonstrations on the operation of valves in a typical refrigeration system	

SUBJECT OUTCOME	
3.5 Service a refrigeration system	
ASSESSMENT STANDARDS	**LEARNING OUTCOMES**
• A system is checked for safe and effective operation. • All operating parameters are measured and recorded against the operating manual under normal operating conditioning. • All operating and safety controls are checked, reset and calibrated. • A practical compressor efficiency test is performed. • The system is examined for non-condensables and moisture. • The drier is removed and replaced. • Possible reasons for non-standard performances are explained. • Results are recorded and reported according to worksite procedures.	• Check a system for safe and effective operation. • Measure and record all operating parameters against the operating manual under normal operating conditions. • Check, reset and calibrate all operating and safety controls. • Perform a practical compressor efficiency test. • Examine the system for non-condensables and moisture. • Remove and replace the drier. • Explain possible reasons for non-standard performance. • Record and report results according to worksite procedures.
ASSESSMENT TASKS OR ACTIVITIES	
• Practical exercises, case studies and rubrics to practically service a plant and conduct testing, checks and settings, and complete a report.	

SUBJECT OUTCOME	
3.6 Benchmark and set pressure switches in a plant *Range: High pressure, low pressure, oil pressure and condensing pressure control switches.*	
ASSESSMENT STANDARDS	**LEARNING OUTCOMES**
• Various LP and HP pressure switches are identified. • The purpose and reasons for using automatic and manual reset switches are explained. • The operation and method of checking the oil pressure switch is explained with time delay included. • The cut-in and cut-out pressures for cold and freezer room temperature control are determined and set. • The cut-out pressures for high pressure, low pressure and oil pressure switches are determined and set • The cut-in and cut-out pressures for condenser fan control switches are determined and set. • The consequences of incorrect settings are listed and explained.	• Identify various low pressure (LP) and high pressure (HP) switches. • Explain the purpose and reasons for using automatic and manual reset switches. • Explain the operation and method of checking the oil pressure switch with time delay included. • Determine and set the cut-in and cut-out pressures for cold and freezer room temperature control. • Determine and set the cut-out pressures for high pressure (HP), low pressure (LP) and oil pressure switches. • Determine and set the cut-in and cut-out pressures for condenser fan control switches. • List and explain the consequences of incorrect settings.
ASSESSMENT TASKS OR ACTIVITIES	
• Practical exercises to determine and set controls on an operating plant and conduct testing, checks and settings. • Assignments to explain consequences for incorrect settings.	

SUBJECT OUTCOME	
3.7 Check and explain the purpose and operation of a defrost system *Range: Electric and hot gas defrost systems initiated by time, pressure and temperature*	
ASSESSMENT STANDARDS	**LEARNING OUTCOMES**
• The purposes of defrosting and defrost control are explained. • The various methods of defrosting evaporator coils are stated and explained. • The equipment and controls required for various systems, their purpose and positions in the system are explained. • The settings for controls and reasons for these settings are explained. • The operation of the defrost system on a plant are tested against specifications or worksite standards. • Reasons for non-standard performance are explained. • Results are recorded and reported according to worksite procedures.	• Explain the purposes of defrosting and defrost control. • Name and explain the various methods of defrosting evaporator coils. • Explain the equipment and controls required for the various systems, their purpose and positions in the system. • Explain the settings for controls and the reasons for these settings. • Test the operation of the defrost system on a plant against specifications or worksite standards. • Explain possible reasons for non-standard performance. • Record and report results according to worksite procedures.
ASSESSMENT TASKS OR ACTIVITIES	
• Observations and case studies to explain the various methods, purposes and settings. • Practical exercises and checklists to test controls and systems on an operational plant against specifications.	

SUBJECT OUTCOME	
3.8 Set a refrigeration system in operation	
ASSESSMENT STANDARDS	**LEARNING OUTCOMES**
• A system is leak tested. • A system is evacuated using deep and triple evacuation methods. • A system is charged with oil and refrigerant. • Settings of all safety and operational controls are verified as per system specifications. • The entire plant is checked for safe and effective operation. • Start up procedure is conducted on the plant. • Follow-up action that may be required is arranged in accordance with workplace procedures.	• Leak test a system. • Evacuate a system using deep and triple evacuation methods. • Charge a system with oil and refrigerant. • Verify the settings of all safety and operational controls as per system specifications. • Check the entire plant for safe and effective operation. • Conduct start up procedure on the plant. • Arrange any follow-up action that may be required in accordance with workplace procedures.
ASSESSMENT TASKS OR ACTIVITIES	
• Observation sheets, individual practical exercises and rubrics on setting a refrigeration system in operation. • Class test on Topic 3.	

Topic 4: Explain, analyse and apply three-phase circuits, electrical control panels and circuitry in air-conditioning, refrigeration and ventilation installations

SUBJECT OUTCOME	
4.1 Identify symbols, components and loads	
ASSESSMENT STANDARDS	**LEARNING OUTCOMES**
• Symbols for switching devices, protective devices, three-phase motors, controls and electrical control panel accessories are identified and tabulated. • Resistive and inductive loads are explained. • The importance of correct electrical diagrams is explained.	• Identify and tabulate symbols for switching devices, protective devices, three-phase motors, controls and electrical control panel accessories. • Explain resistive and inductive loads • Explain the importance of correct electrical diagrams.

ASSESSMENT TASKS OR ACTIVITIES
• An assignment or task to identify and explain symbols on given diagrams, resistive and inductive loads and the importance of accuracy

SUBJECT OUTCOME	
4.2 Sketch and interpret three-phase circuit diagrams	
ASSESSMENT STANDARDS	**LEARNING OUTCOMES**
• The purpose of control devices is explained. • Circuit diagrams for starter types, including the protection and control devices, are sketched. • The advantages and disadvantages of various methods of starting three-phase motors are listed and explained.	• Explain the purpose of control devices. • Sketch circuit diagrams for the types of starters, including protection and control devices. • List and explain the advantages and disadvantages of the various methods of starting three-phase motors.
ASSESSMENT TASKS OR ACTIVITIES	
• An investigation or research to conduct a comparative study on the various methods of starting three-phase motors. • Case studies and practical exercises on sketches of circuit diagrams for the types of starters, including protection and control devices.	

SUBJECT OUTCOME	
4.3. Design and construct three-phase circuit diagrams	
ASSESSMENT STANDARDS	**LEARNING OUTCOMES**
• Three-phase circuit diagrams are constructed. • Required components and conductor sizes are selected taking cognisance of load and fault current requirements. • Components are connected according to a diagram. • Circuit is connected to the power supply and operation evaluated.	• Construct three-phase circuit diagrams. • Select components required and conductor sizes taking cognisance of load and fault current requirements. • Connect components according to a diagram. • Connect circuit to the power supply and evaluate operation.
ASSESSMENT TASKS OR ACTIVITIES	
• Practical exercises to demonstrate competence in a practical project involving the physical construction of a three-phase refrigeration based circuit, including conductor selection, component connection and testing operation of circuit.	

SUBJECT OUTCOME	
4.4 Convert an electrical line diagram to a drawing that complies with national standards	
ASSESSMENT STANDARDS	**LEARNING OUTCOMES**
• Circuit components are marked with the correct symbols. • Separate power and control circuits are drawn one from the other. • The circuit is drawn in its sequence of operation. • Electrical line diagrams are converted to drawings that comply with national standards. • The advantages of diagrams that comply with national standards are explained.	• Mark circuit components with the correct symbols. • Draw separate power and control circuits one from the other. • Draw the circuit in its sequence of operation. • Convert electrical line diagrams to drawings that comply with national standards. • Explain the advantages of diagrams that comply with national standards.
ASSESSMENT TASKS OR ACTIVITIES	
• Projects on converting given refrigeration based electrical line diagrams into drawings that comply with national standards. • An assignment to explain the advantages of standardising diagrams	

SUBJECT OUTCOME	
4.5 Plan to maintain electric motors, circuitry and controls	
ASSESSMENT STANDARDS	**LEARNING OUTCOMES**
• Maintenance is planned to conform to maintenance schedules, integrating other disciplines and associated equipment. • Maintenance is planned according to equipment operating history reports and failure rate, and in accordance with plant availability and customer requirements. • Consequences of inadequate maintenance are listed and explained.	• Plan maintenance to conform to maintenance schedules, integrating other disciplines and associated equipment. • Plan maintenance according to equipment operating history reports and failure rate, and in accordance with plant availability and customer requirements. • List and explain consequences of inadequate maintenance.
ASSESSMENT TASKS OR ACTIVITIES	
• Case studies and an assignment to develop a maintenance plan. Student is given the outline of a maintenance schedule. • A project on the consequences of inadequate maintenance	

SUBJECT OUTCOME	
4.6 Prepare to inspect and maintain electrical panels, electric motors, circuitry and controls	
ASSESSMENT STANDARDS	**LEARNING OUTCOMES**
• Location choice and the purpose of installing warning signs are explained • Electrical testing instruments and portable cleaning equipment are selected and checked. • Correct cleaning solvents and materials are selected as per workplace procedures. • The panel to be cleaned and maintained is identified. • Situations where it is necessary to obtain written permission to carry out maintenance work are described. • The consequences of incorrect use of cleaning materials, methods and solvents are explained. • Electric motors, circuitry and controls to be maintained are identified as per worksite instructions. • A safety and security lock-out system is applied as per worksite instructions.	• Explain the choice of location and the purpose of installing warning signs. • Select and check electrical testing instruments and portable cleaning equipment. • Select correct cleaning solvents and materials as per workplace procedures. • Identify the panel to be cleaned and maintained. • Describe situations where it is necessary to obtain written permission to carry out maintenance work. • Explain the consequences of incorrect use of cleaning materials, methods and solvents. • Identify electric motors, circuitry and controls to be maintained as per worksite instructions. • Apply a safety and security lock-out system as per worksite instructions.
ASSESSMENT TASKS OR ACTIVITIES	
• A project on safety aspects in planning maintenance, the importance of correct component identification, the importance of the correct selection and usage of cleaning equipment and consumables. • A practical exercise to apply a safety lock-out system to an electrical panel	

SUBJECT OUTCOME	
4.7 Inspect and maintain electrical control panels and circuitry *Range : including ac-motors, circuitry and controls*	
ASSESSMENT STANDARDS	**LEARNING OUTCOMES**
• Panels are isolated and locked out as per worksite procedures. • Panel enclosures, hinges, locking devices and weather seals are inspected for defects. • Panel is cleaned using approved cleaning materials and solvents as per workplace standards. • Electrical control panel labels are checked. • The presence of electrical wiring diagram and operating instructions is checked. • All connections are checked for tightness, proper contact and correct size. • Electrical control panel components are blown out or vacuumed using the appropriate equipment and safety procedures. • Ac-motors, circuitry and controls are maintained according to work site instructions and/or manufacturer's instructions. • All indication lights, components and instruments are checked for proper working order. • Faulty components are identified and replaced. • Sequence operation of all components is checked per operating instructions. • Any changes made to the electrical control panel are recorded on the wiring diagram and the operating instruction.	• Isolate and lock out panels as per worksite procedures. • Inspect panel enclosures, hinges, locking devices and weather seals for defects. • Clean panel using approved cleaning materials and solvents as per workplace standards. • Check all electrical control panel labels. • Check for presence of electrical wiring diagram and operating instructions. • Check all connections for tightness, proper contact and correct size. • Blow out or vacuum electrical control panel components using the appropriate equipment and safety procedures. • Maintain ac-motors, circuitry and controls according to worksite instructions and/or manufacturer's instructions. • Check all indication lights, components and instruments for proper working order. • Identify and replace faulty components. • Check sequence operation of all components per operating instructions. • Record any changes made to the electrical control panel on the wiring diagram and the operating instructions.
ASSESSMENT TASKS OR ACTIVITIES	
• A practical assignment on inspecting and maintaining electrical control panels and circuitry	

SUBJECT OUTCOME	
4.8 Conduct inspection and maintenance of electrical panel circuitry and motors	
ASSESSMENT STANDARDS	**LEARNING OUTCOMES**
• An electrical control panel is re-energised and locked. • Defects and suspected faults are recorded and reported in line with work site instructions. • Cleaning solvents are seal/closed correctly and stored properly to prevent hazardous fumes, substance spillage and risk of fire.	• Re-energise and lock an electrical control panel. • Record and report all defects and suspected faults in line with worksite instructions. • Properly close, seal and correctly store cleaning solvents to prevent hazardous fumes, substance spillage and risk of fire.
ASSESSMENT TASKS OR ACTIVITIES	
• A practical assignment on conducting inspection and maintenance of electrical panels circuitry and motors	

Topic 5: Explain and conduct operational fault finding, remedial and corrective actions.

SUBJECT OUTCOME	
5.1 Conduct fault finding: Identify faults	
ASSESSMENT STANDARDS	**LEARNING OUTCOMES**
• The purpose of faultfinding is explained • Various types of operational faults are stated and explained and their interaction in relation to design, mechanical, electrical and operational faults identified. • The effects of faults on the operation of components and systems are listed and explained. • Plant operation and faults are determined. • Correct sequence of operation is determined and observed using control diagrams or job instructions. • Applicable testing instruments, tools, equipment, materials and components are selected according to job requirements. • Possible causes of faults are identified by plant operational observation. • Circuit drawings are interpreted to determine possible causes of fault. • Faultfinding is conducted by making use of logical methods according to faultfinding techniques. • Faults are repaired according to worksite procedures. • Fault-finding results are recorded according to worksite procedures.	• Explain the purpose of faultfinding. • State and explain the various types of operational faults and identify their interaction in relation to design, mechanical, electrical and operational faults. • List and explain the effects of faults on the operation of components and systems. • Determine plant operation and faults. • Determine and observe the correct sequence of operation from control diagrams or per job instructions. • Select applicable testing instruments, tools, equipment, materials and components according to job requirements. • Identify possible causes of faults by plant operational observation. • Interpret applicable circuit drawings to determine possible causes of fault. • Conduct faultfinding by making use of logical methods according to faultfinding techniques. • Repair faults according to worksite procedures. • Record fault-finding results according to worksite procedures.
ASSESSMENT TASKS OR ACTIVITIES	
• A practical project and an assignment on identifying faults	

SUBJECT OUTCOME	
5.2. Conduct fault finding: Diagnose the fault	
ASSESSMENT STANDARDS	**LEARNING OUTCOMES**
• A general description of the complaint is obtained from the plant operator and/or owner. • Possible causes of faults are diagnosed from a description given by operators, owners or users • All operating parameters are observed and recorded • All components are examined for evidence of malfunction, in a logical and systematic sequence. • The impact of making quick decisions and temporary fixes is explained in terms of costs and goodwill. • Possible causes of the faults are identified using sensory skills (odours, heat and noise).	• Obtain a general description of the complaint from the plant operator and/or owner. • Diagnose possible causes of faults from a description given by operators, owners or users. • Observe and record all operating parameters. • Examine all components for any evidence of malfunction, in a logical and systematic sequence. • Explain the impact of making quick decisions and temporary fixes in terms of costs and goodwill. • Identify possible causes of the faults using sensory skills (odours, heat and noise).
ASSESSMENT TASKS OR ACTIVITIES	
• A project outlining a general description of the complaint by the plant operator and/or owner or conduct practical fault finding assignment in workshop. • An assignment to compile report explaining the impact of making quick decisions and temporary fixes in terms of costs and goodwill, identifying possible causes of the faults using sensory skills (odours, heat and noise), and observing and recording all operating parameters.	

SUBJECT OUTCOME	
5.3 Demonstrate the use of trouble shooting procedures	
ASSESSMENT STANDARDS	**LEARNING OUTCOMES**
• Trouble shooting procedures, tables and charts from suppliers are used.The problem or complaint is explained in terms of possible causes and symptoms. • Symptoms are analysed and remedial action taken.	• Use trouble shooting procedures, tables and charts from suppliers.Explain the problem or complaint in terms of possible causes and symptoms. • Analyse symptoms and take remedial action
ASSESSMENT TASKS OR ACTIVITIES	
• A practical project analysing possible faults using trouble shooting procedures, tables and charts from suppliers	

SUBJECT OUTCOME	
5.4 Correct faults and replace faulty components	
ASSESSMENT STANDARDS	**LEARNING OUTCOMES**
• The diagnosed fault is corrected. • The result of the correction is checked. • Faulty components are replaced with suitable, correctly sized and functioning ones, using techniques or procedures approved by the manufacturer and using good electrical and mechanical practice.	• Correct the diagnosed fault. • Check the result of the correction. • Replace faulty components with suitable, correctly sized and functioning ones, using techniques or procedures approved by the manufacturer and using good electrical and mechanical practice.
ASSESSMENT TASKS OR ACTIVITIES	
• Case studies and a practical exercise on correcting faults and replacing faulty components	

SUBJECT OUTCOME	
5.5 Set plant in operation	
ASSESSMENT STANDARDS	**LEARNING OUTCOMES**
• Circuitry and control gear are re-commissioned and checked for correct operating sequence. • Panels, enclosure doors and/or covers are properly secured or locked to restrict unauthorized access. • Lockout devices and warning signs are removed. • Job cards and work orders are completed, sheets checked and the maintenance report is submitted. • Relevant wiring diagrams, drawings and operating instructions are updated if changes have been made. • Operating parameters are compared with original parameters to evaluate improvement.	• Re-commission circuitry and control gear and check for correct operating sequence. • Secure or lock panels, enclosure doors and/or covers properly to restrict unauthorized access. • Remove lockout devices and warning signs. • Complete job cards and work orders, check sheets and submit the maintenance report. • Update relevant wiring diagrams, drawings and operating instructions if changes have been made. • Compare operating parameters with original parameters to evaluate improvement.
ASSESSMENT TASKS OR ACTIVITIES	
• Assignments or tasks and practical exercises on setting a plant in operation	

4 SPECIFICATIONS FOR EXTERNAL ASSESSMENT IN REFRIGERATION AND AIR CONDITIONING PROCESSES - LEVEL 4

4.1 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.

4.2 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:

	KNOWLEDGE AND COMPREHENSION	APPLICATION	ANALYSIS, SYNTHESIS AND EVALUATION
LEVEL 4	35%	45%	20%

MARK ALLOCATION PER QUESTION		
All questions are compulsory		
Question 1:	Explain, analyse and apply refrigeration systems, controls and components	20
Question 2:	Explain and apply psychometric charts, heat and mass flow calculations and airflow	20
Question 3:	Explain operating parameters and servicing of Heating-, Ventilation-, Air-Conditioning and Refrigeration (HVAC& R) systems	20
Question 4:	Explain, analyse and apply three-phase circuits, electrical control panels and circuitry in air-conditioning, refrigeration and ventilation installations	20
Question 5:	Explain and conduct operational fault finding, remedial action and corrective actions	20
	TOTAL	**100%**