education

Department:
Education
REPUBLIC OF SOUTH AFRICA

NATIONAL CERTIFICATES (VOCATIONAL)

SUBJECT GUIDELINES

REFRIGERATION AND AIR-CONDITIONING PROCESSES NQF Level 4

April 2008

REFRIGERATION AND AIR-CONDITIONING PROCESSES - LEVEL 4

CONTENTS

INTRODUCTION

A. What is Refrigeration and Air-Conditioning Processes?

Refrigeration and Air-Conditioning Processes is the advanced study and application of cooling equipment and the associated electrical power and control gear, including thermal processes and calculations, pressure and temperature settings, parameters, adjustments and fault repairs.

B. Why is Refrigeration and Air-Conditioning Processes important in the Engineering and Related Design programme?

Refrigeration and Air-Conditioning Processes provides the student with more advanced skills in cooling processes, plant adjustment and trouble shooting. The student would then be able to work on operational plant under supervision of an artisan.

C. The link between the Learning Outcomes for Refrigeration and Air-Conditioning Processes and the Critical and Developmental Outcomes

Refrigeration and Air-Conditioning Processes as a subject will

- Develop a sound basic knowledge of mechanical and electrical engineering principles
- Develop a respect for the planet, the environment and the people through engineering knowledge
- Develop skills and knowledge that will create employment opportunities and a basis for life-long learning.

D. Factors that contribute to achieving Refrigeration and Air-Conditioning Learning Outcomes

- A learning environment that will stimulate interest in the subject
- Qualified and competent lecturers, practical trainers and assessors who will encourage the students to develop their knowledge and skills
- Lecturers and trainers who promote the concept of logical thinking in engineering and problem solving.

1 DURATION AND TUITION TIME

This is a one-year instructional programme comprising 200 teaching and learning hours. The subject may be offered on a part-time basis provided the student meets all the assessment requirements.

Students with special education needs (LSEN) must be catered for in a way that eliminates barriers to learning.

2 SUBJECT LEVEL FOCUS

- Understanding, application and operation of air-conditioning and refrigeration plants, measurement of operating parameters and implementation of servicing procedures
- Understand the principles, application of and perform heat related, psychometrics and air flow calculations
- diagnosis of plant faults and implementation of corrective interventions
- Explain, analyse and apply three-phase circuits, electrical control panels and circuitry.

3 ASSESSMENT REQUIREMENTS

3.1 Internal assessment (50 percent)

3.1.1 Theoretical component

The theoretical component forms 40 percent of the internal assessment mark.

Internal assessment of the theoretical component in Refrigeration and Air-Conditioning Processes Level 4 takes the form of observation, class questions, group work, individual discussions with students, class, topic and semester tests and internal examinations. Observation can be done on completion of work piece.

Assignments, case studies and tests can be completed at the end of a topic. Tests and internal examinations must form part of the internal assessment.

3.1.2 Practical component

The practical component forms 60 percent of the internal assessment mark.

Practical components include applications and exercises. All practical components must be indicated in a Portfolio of Evidence (PoE).

Internal assessment of the practical component in Refrigeration and Air-Conditioning Processes Level 4 takes the form of assignments, practical exercises and practical examinations in a workshop environment.

Students may complete practical exercises daily. Assignments can be completed at the end of a topic. Practical examinations can form part of internal practical assessment.

- **Some examples of practical assessments include, but are not limited to:**
  - Presentations (lectures, demonstrations, group discussions and observation, role-play, independent activity, synthesis and evaluation)
  - Exhibitions by students
  - Visits undertaken by students based on a structured assignment task
  - Task performance in a “Structured Environment”

- **Definition of the term "Structured Environment"**

For the purposes of assessment, "Structured Environment" refers to an actual or simulated workplace or a computer or workshop environment. Activities in the simulated workplace or environment must be documented in a logbook with a clear listing of the competencies to be assessed. The following information must be contained in the logbook:

- Nature of department or environment in which practical component was achieved
- Learning Outcomes
- Activities in the environment with which to achieve the Learning Outcomes
- Time spent on activities
- Signature of facilitator or supervisor and student

For the logbook to be regarded as valid evidence, it must be signed by an officially assigned supervisor.

- **Evidence in practical assessments**

All evidence pertaining to evaluation of practical work must be reflected in the student's Portfolio of Evidence. The tools and instruments used for the purpose of conducting these assessments must be part of the evidence contained in the PoE.

3.1.3 Processing of internal assessment mark for the year

A year mark out of 100 is calculated by adding the marks of the theoretical component and the practical component of the internal continuous assessment (ICASS).

3.1.4 Moderation of internal assessment mark

Internal assessment is subject to internal and external moderation procedures as set out in the *National Examinations Policy for FET College Programmes*.

3.2 External assessment (50 percent)

A national examination is conducted annually in October or November by means of a paper(s) set and moderated externally. The practical component will also be assessed.

External assessment details and procedures are set out in the *Assessment Guidelines: Refrigeration and Air-Conditioning Processes Level 4.*

4 WEIGHTED VALUES OF TOPICS

	TOPICS	WEIGHTED VALUE
1	Explain, analyse and apply refrigeration systems, controls and components	20%
2	Explain and apply psychometric charts, heat and mass flow calculations and airflow	20%
3	Explain operating parameters and servicing of Heating, Ventilation-, Air-conditioning and Refrigeration (HVAC&R) systems	20%
4	Explain, analyse and apply three-phase circuits, electrical control panels and circuitry in air-conditioning, refrigeration and ventilation installations	20%
5	Explain and conduct operational fault finding, remedial and corrective actions	20%
	TOTAL	**100**

5 CALCULATION OF FINAL MARK

Internal assessment mark: Student's mark/100 x 50 = a mark out of 50 (a)

Examination mark: Student's mark/100 x 50 = a mark out of 50 (b)

Final mark: **(a) + (b) = a mark out of 100**

All marks are systematically processed and accurately recorded to be available as hard copy evidence for, amongst others, reporting, moderation and verification purposes.

6 PASS REQUIREMENTS

A student must obtain at least fifty percent in internal continuous assessment and fifty percent in the examination to achieve a pass in this subject.

7 SUBJECT AND LEARNING OUTCOMES

On completion of Refrigeration and Air-Conditioning Processes Level 4, the student should have covered the following topics:

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

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

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

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

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

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

7.1.1 Subject Outcome 1: Explain the differences in operation between the basic and actual vapour compression refrigeration cycles

Learning Outcomes:
The student should be able to:

- 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.

7.1.2 Subject Outcome 2: Compare the various types of vapour compression refrigeration systems

Learning Outcomes:

The student should be able to:

- 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.

7.1.3 Subject Outcome 3: Explain the effect of operating conditions on component performance

Learning Outcomes:

The student should be able to:

- 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.

7.1.4 Subject Outcome 4: Define and analyse air-conditioning

Learning Outcomes:

The student should be able to:

- 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

7.1.5 Subject Outcome 5: Name categories of air-conditioning systems, explain their operation, and list the advantages and disadvantages of each

Learning Outcomes:

The student should be able to:

- 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.

7.1.6 Subject Outcome 6: List, identify and explain the purpose of refrigerant control devices

Learning Outcomes:

The student should be able to:

- 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.

7.1.7 Subject Outcome 7: Explain the operation of refrigerant control devices

Learning Outcomes:

The student should be able to:

- 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.

7.1.8 Subject Outcome 8: List controls and safety devices and explain their purpose and operation in refrigeration plants

Learning Outcomes:

The student should be able to:

- 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.

7.1.9 Subject Outcome 9: List defrost systems and explain their purpose and operation

Learning Outcomes:

The student should be able to:

- 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.

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

7.2.1 Subject Outcome 1: Define *psychometrics,* the properties of air, and plot an air condition on a psychometric chart

Learning Outcomes:

The student should be able to:

- 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.

7.2.2 Subject Outcome 2: Calculate the amount of sensible, latent and total heat using enthalpy formulas

Learning Outcomes:

The student should be able to:

- 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.

7.2.3 Subject Outcome 3: Calculate the amount of moisture added to or removed from air

Learning Outcomes:

The student should be able to:

- 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.

7.2.4 Subject Outcome 4: Calculate the amount of chilled water required for a cooling or heating application

Learning Outcomes:

The student should be able to:

- 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.**7.2.5 Subject Outcome 5:** Calculate the amount of heat required to produce saturated steam

Learning Outcomes:

The student should be able to:

- 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.

7.2.6 Subject Outcome 6: Calculate volumes of square and round ducts

Learning Outcomes:

The student should be able to:

- Calculate the area of square and round ducts.
- Calculated the diameter of a round duct from a given area.
- Calculate, for given areas, the sizes and volumes of square, rectangular and round ducts.

7.2.7 Subject Outcome 7: Calculate elementary airflow

Learning Outcomes:

The student should be able to:

- 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.

7.2.8 Subject Outcome 8: Measure air pressure in a duct

Learning Outcomes:

The student should be able to:

- 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.

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

7.3.1 Subject Outcome 1: Explain terminology for operating parameters of air-conditioning and refrigeration systems

Learning Outcomes:

The student should be able to:

- Explain the terminology for operating parameters: *temperature* (including *saturation temperature* and *temperature difference*), *heat, relative humidity, pressure, vacuum, superheat* and *sub-cooling*.

7.3.2 Subject Outcome 2: Measure and determine operating parameters of refrigeration systems

Learning Outcomes:

The student should be able to:

- 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.

7.3.3 Subject Outcome 3: Compare observations with the design parameters for a plant

Learning Outcomes:

The student should be able to:

- 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.

7.3.4 Subject Outcome 4: Operate the valves in a typical refrigeration system

Learning Outcomes:

The student should be able to:

- 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.

7.3.5 Subject Outcome 5: Service a refrigeration system

Learning Outcomes:

The student should be able to:

- 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.

7.3.6 Subject Outcome 6: Benchmark and set pressure switches in a plant

Range: High pressure, low pressure, oil pressure and condensing pressure control switches.

Learning Outcomes:

The student should be able to:

- 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.

7.3.7 Subject Outcome 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.

Learning Outcomes:

The student should be able to:

- 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.

7.3.8 Subject Outcome 8: Set a refrigeration system in operation

Learning Outcomes:

The student should be able to:

- 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.

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

7.4.1 Subject Outcome 1: Identify symbols, components and loads

Learning Outcomes

The student should be able to:

- 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.

7.4.2 Subject Outcome 2: Sketch and interpret three-phase circuit diagrams

Learning Outcomes:

The student should be able to:

- 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.

7.4.3 Subject Outcome 3: Design and construct three-phase circuit diagrams

Learning Outcomes:

The student should be able to:

- 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.

7.4.4 Subject Outcome 4: Convert an electrical line diagram to a drawing that complies with national standards

Learning Outcomes:

The student should be able to:

- 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.

7.4.5 Subject Outcome 5: Plan to maintain electric motors, circuitry and controls

Learning Outcomes:

The student should be able to:

- 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.

7.4.6 Subject Outcome 6: Prepare to inspect and maintain electrical panels, electric motors, circuitry and controls

Learning Outcomes:

The student should be able to:

- 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.

7.4.7 Subject Outcome 7: Inspect and maintain electrical control panels and circuitry

Range: including ac motors, circuitry and controls

Learning Outcomes:

The student should be able to:

- 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.

7.4.8 Subject Outcome 8: Conduct inspection and maintenance of electrical panel circuitry and motors

Learning Outcomes:

The student should be able to:

- 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.

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

7.5.1 Subject Outcome 1: Conduct fault finding: Identify faults

Learning Outcomes:

The student should be able to:

- 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.

7.5.2 Subject Outcome 2: Conduct fault finding: Diagnose the fault

Learning Outcomes:

The student should be able to:

- 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).

7.5.3 Subject Outcome 3: Demonstrate the use of trouble shooting procedures

Learning Outcomes:

The student should be able to:

- 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

7.5.4 Subject Outcome 4: Correct faults and replace faulty components

Learning Outcomes:

The student should be able to:

- 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.

7.5.5 Subject Outcome 5: Set plant in operation

Learning Outcomes:

The student should be able to:

- 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.

8 RESOURCE NEEDS FOR TEACHING OF REFRIGERATION AND AIR-CONDITIONING - LEVEL 4

8.1 Human resources

The educator for Refrigeration and Air-conditioning Processes Level 4 must be:

- a subject matter expert
- refrigeration trade tested or in possession of a NQF L4 Refrigeration qualification
- in possession of a safe handling license.
- a competent lecturer
- a life-long learner
- conversant with OBE methodologies
- an instructor qualified in the field of study
- skilled in facilitating learning programme development

It is important that educators working in this environment should attend seminars and upgrading workshops in order to be updated and re-skilled with respect to the latest developments in technology.

8.2 Physical resources

- Store room for consumable stocks
- Tool room
- Fully equipped workshop
- Lecture room(s)
- Training area and work area
- Ablution facilities

Storeroom must be equipped with mechanical lifting devices suitable for dealing with the storage of heavy consumables

8.3 Learning materials and other resources

Funds obtained from the learning provider or from funding bodies for the procurement of consumable resources, tools and equipment must be readily available for the effective operation of a workplace involved in a training program. Students must be individually equipped with the necessary tools. Learning materials must conform to approved training and industrial standard requirements and must articulate to Higher Education. Learning materials must cater for both academic and practical aspects of learning. Available material must address the following:

- Texts that fully address the task
- Workshop manuals using projection equipment
- Visual and audio-visual material
- Promotion of research
- Educational tours to relevant learning venues
- Educational and motivational talks from industry
- Models and demonstrations
- Psychometric charts sea level, 700m, 1400m and 1700m
- Mollier diagrams R134A, R410A, R22.

8.4 Equipment

For every 20 students:

DESCRIPTION	TYPE	QUANTITY
Centre punch	3x3x100	20
Crimpling pliers		20
Hacksaw frame	300mm	20
Flat-nose pliers		20
Gas-pliers		20
Digital multimeter		20
Junior saw frame	150mm	20
Shifting spanner	200mm	20
Measuring tape metal case	3m	20
Outside micrometer	(0-25)	5
Soldering iron		20
Insulated Combination pliers	(180mm)	20
Insulated electricians long-nose pliers		20
Round nose pliers		20
Insulated electricians diagonal cutter		20
Tube spanners set	±5mm-12mm	20
Utility knife		20
Water pump pliers	250mm	20
Flat point screwdriver	3,5x75mm	20
Flat point screwdriver	4x150mm	20
Flat point screwdriver	6x150mm	20
Flat point screwdriver	10x250mm	20
Phillips screwdriver	#1 5x80mm	20
Phillips screwdriver	#2 8x150mm	20
Phillips screwdriver	#3 8x150mm	20
Wire stripper	160mm	20
Wire gauge		5
Toolbox 3-tier		20
V Belt tension tester	Fenner	2
Centrifugal water pump		3
Circlip pliers inside		5
Circlip pliers outside		5
Flat nose pliers		20
Files: Rectangular	Barsted	10
	Medium	10
	Smooth	10
Extractor screw kit	Rigid set no.10 (No 35583)	4

DESCRIPTION	TYPE	QUANTITY
Feeler gauge	Omni 25 blade	5
Hammer: Dead blow	Dia 54mm face	5
Ball peen	500gram	10
Hacksaw Frame	300m	20
Magnetic Base Clock gauge		2
Anemometer		2
Multimeter		20
Manometer		
Clamp-on Tong tester		10
Capacitor tester		5
Insulation tester (Mega)		5
Allen key set	Metric (1,5-20mm)	4
Allen key set	Imperial ($^1/_{16}$ inch – ½ inch)	4
Torx set	Multi-splined (T_{10} – T_{50})	4
Line taps:	$4mm^2$	20
Brush: File	Wire	10
Cleaning	Wire	5
Painting	15mm	20
Painting	25mm	20
Bearing Puller set		1
Ladder: Aluminium 1,5m		1
Ladder: Aluminium 2,5m		1
Oxy-Acetylene gas welding / brazing equipment, full size workshop sets		4
Personal protective equipment (PPE)		20
Nitrogen cylinders 11kg with regulator 4000kPa delivery pressure		4
Drill bits	1 box (1mm – 13mm) steel and masonry	5 boxes
Drill Electric (hand)		4
Refrigeration Gauge manifold sets (R22/R134A)		20
Pyrometer		5
Velometer		5
Anometer		5
Infrared thermometer		5
R410A torque wrench		5
Refrigeration Gauge manifold sets (R410A)		20
Electronic refrigerant leak detectors		5
Tap a line tools		10
Pinch off pliers		10

DESCRIPTION	TYPE	QUANTITY
Piercing pliers		10
Pipe cutters 6mm – 22mm copper tubing		20
Imp cutters		5
Flaring and swaging kit		10
2 stage 5-7 cfm vacuum pumps		5
Vacuum gauges (Micron)		5
Mechanical refrigeration pipe benders ¼''		5
Mechanical refrigeration pipe benders 3/8''		5
Mechanical refrigeration pipe benders 1/2''		5
Mechanical refrigeration pipe benders 3/4''		5
Spring refrigeration pipe benders ¼''		5
Spring refrigeration pipe benders 3/8''		5
Spring refrigeration pipe benders 1/2''		5
Spring refrigeration pipe benders 3/4''		5
Thermometers 2 probe digital -40 to + 20 Celsius		10
Refrigerant charging scales		10
Lock ring pliers		1
Service vale spanners		20
Refrigerant recovery units		5
Fin combs		10
High pressure cleaner		2
Pipe reamers (Refrigerant)		20
Equipment		
Refrigeration Controls: Thermostats		5
Humidistat		5
Pressure stats		5
Selector switches		5
Smoke detectors		5
Overheating stats		5
Electric oil pressure switches		5
Defrost timers		5
Circuit breakers (5A→40A)		15 of each
Contactors	220v	50
High pressure switch		5
Dual pressure switch		5
Low pressure switch		5
Electrical control panel accessories:		
Voltmeters		5
Ammeters		5
Pilot lights		40

DESCRIPTION	TYPE	QUANTITY
Isolator		20
Double pole switches (single throw)		15
Double pole switches (double throw)		15
Overload protection devices (3A→13A)		15 of each
Relays		50
Rotary switch		20
Single phase earth leakage		5
Single phase electric motor accessories:		
Capacitors	Applicable to 375w	5
Current relays	Applicable to 375w	5
Potential relays	Applicable to 375w	5
Solid-state relays		5
Overload relays		5
Single phase motors:		
Shaded pole motor	375w	2
Permanent split motor	375w	2
Split phase motor	375w	2
Capacitor start motor	375w	2
Capacitor start-capacitor run motor	375w	2
Multi speed fan motors	375w	2
Single phase humidifiers		5
Single pole switches (single throw)		15
Single pole switches (double throw)		15
Timers	220v	5
Amour flex		2m per size
Pipe brackets		2
Trucking / plastic		2m 20x 50mm 2m 50x 100mm
Domestic fridge freezer		4
Operational single phase refrigeration units with semi hermetic compressors in 1.5 x 1.5 cold room installation, pressure switch and thermostatic control -10 to 5 Degrees C installation temperatures.	220V	10
Operational mid wall split single phase air-conditioning unit		5
Operational mid wall split three phase air-conditioning unit		5
Water treatment system		1
Ducted DX air-conditioning 3 phase system with variable volume diffusers.		1
Computerised BMS System		1

DESCRIPTION	TYPE	QUANTITY
Humidification system		

8.5 Consumable resources

Per every 20 students

DESCRIPTION	TYPE	QUANTITY
Cables / conductors:		
	1,0mm^2 (solid)	20 rolls
	1,0mm^2 (stranded)	20 rolls
	1,5mm^2 (solid)	20 rolls
	1,5mm^2 (stranded)	20 rolls
	2,5mm^2 solid	20 rolls
	2,5mm^2 stranded	20 rolls
	4mm^2 solid	10 rolls
	4mm^2 stranded	10 rolls
	6mm^2 solid	8 rolls
	6mm^2 stranded	8 rolls
	10mm^2 solid	5 rolls
	10mm^2 stranded	5 rolls
	16mm^2 solid	5 rolls
	16mm^2 stranded	5 rolls
	PVC steel wire armoured	12m
	Cable 16mm^2 (4 wire)	12m
	PVC steel wire armoured	12m
	Cable 16mm^2 (3 wire)	12m
Earth tags	for 16mm^2	20
Ferrules	4mm^2	100
Fuses	Glass (0,1→30A)	10 of each
Gland kit:	for SWA cables (16mm^2)	20
	for unarmoured cables (16mm^2)	20
Lugs:	Round lugs: M_3	100
	M_4	100
	M_5	100
	M_6	100
	M_8	100
	M_{10}	100
	Spade lugs: M_3	100
	M_4	100
	M_5	100
	M_6	100
	M_8	100

DESCRIPTION	TYPE	QUANTITY
	M_{10}	100
	Push on lugs: (4,8 x 0,8)	100
	Push on lugs: (6,3 x 0,8)	100
Mutton cloth	400 grams	30
Plug tops		20
Terminal screw connectors	$4mm^2$	20
Terminals		100
Flare nuts:	¼ inch nuts	40
	$^3/_8$ inch nuts	40
	½ inch nuts	40
	$^5/_8$ inch nuts	40
Flared Tee Fitting, male flare x male flare	¼ inch	20
Flared Union Coupling, male flare x male flare	¼ inch	20
Manometer		5
Copper tubing:		
¼ inch		5 Rolls
3/8 inch		5 Rolls
½ inch		5 Rolls
5/8 inch		5 Rolls
Hacksaw blades:	300mm (blade capacity)	100
	Junior hacksaw blades	100
Loctite	50 grams	3
Mutton cloth	400grams	30
Oil: Mineral oil		20ℓ (litres)
Ester oil		20ℓ (litres)
Sand paper (emery board)	Grade P100 (50mmx50m)	2
Soap (hand)		
Schrader valves	¼ inch	20
Silver solder rod	3003u Flux	50 rods
Refillable refrigerant service cylinders (11Kg)		5
R134A		28Kg
R22		28Kg
R141B		28Kg
R410A		28Kg
Copper tech brazing rods		200g
Silver solder flux		2 x 100ml
69 kg Cylinder trolley		2
PVC pipe 19 and 25mm		2m
PVC Glue		2 X 100ml

DESCRIPTION	TYPE	QUANTITY
Water treatment chemicals		1ℓ