NATIONAL BOARD FOR TECHNICAL EDUCATION

Innovation Development and Effectiveness in the Acquisition of Skills (IDEAS) Project

THE WORLD BANK

NATIONAL TECHNICAL CERTIFICATE

AND

ADVANCED NATIONAL TECHNICAL CERTIFICATE

IN

REFRIGERATION AND AIRCONDITIONING WORK

January, 2023

NATIONAL TECHNICAL/ADVANCED NATIONAL TECHNICAL CERTIFICATE IN REFRIGERATION AND AIRCONDITION WORK.

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NATIONAL TECHNICAL CERTIFICATE AND ADVANCED NATIONAL TECHNICAL CERTIFICATE PROGRAMMES

GENERAL INFORMATION

AIM

To give training and impart the necessary skills leading to the production of craftsmen, technicians and other skilled personnel who will be enterprising and self-reliant.

ENTRY QUALIFICATIONS

CRAFT PROGRAMME

Candidates must not be less than 14 years of age and should have successfully completed three years of Junior Secondary education or its equivalent. Special consideration may be given to sponsored candidates with lower academic qualifications who hold trade test certificates and are capable of benefiting from the programme.

ADVANCED CRAFT PROGRAMME

Candidates should possess the National Technical Certificate or its equivalent and should have had a minimum of two years post qualification cognate industrial experience.

THE CURRICULUM

The Curriculum of each programme is broadly divided into three components:

a. General Education, which accounts for 30% of the total hours required for the programme.
b. Trade Theory, Trade Practice and Related Studies which account for 65% and
c. Supervised Industrial Training/Work Experience, which accounts for about 5% of the total hours required for the programme. This component of the course which may be taken in industry or in college production unit is compulsory for the full-time students.

Included in the curriculum is the teacher's activity and learning resources required for the guidance of the teacher.

UNIT COURSE/MODULES

A Course/Module is defined as a body of knowledge and skills capable of being utilized on its own or as a foundation or pre-requisite knowledge for more advanced work in the same or other fields of study. Each trade when successfully completed can be used for employment purposes.

BEHAVIOURAL OBJECTIVES

These are educational objectives, which identify precisely the type of behaviour a student should exhibit at the end of a course/module or programme. Two types of behavioural objectives have been used as the curriculum. They are:

a. General Objectives
b. Specific learning outcomes

General objectives are concise but general statements of the behaviour of the students on completion of a unit of week such as understanding the principles and application in:

a. Orthographic projection in engineering/technical drawing;
b. Loci in Mathematics
c. Basic concepts of politics and government in Political Science
d. Demand and supply in Economics

Specific learning outcomes are concise statements of the specific behaviour expressed in units of discrete practical tasks and related knowledge the students should demonstrate as a result of the educational process to ascertain that the general objectives of course/programme have been achieved. They are more discrete and quantitative expressions of the scope of the tasks contained in a teaching unit.

GENERAL EDUCATION IN TECHNICAL COLLEGES

The General Education component of the curriculum aims at providing the trainee with complete secondary education in critical subjects like English Language, Economics, Physics, Chemistry, Biology, Entrepreneurial Studies and Mathematics to enhance the understanding of machines, tools and materials of their trades and their application and as a foundation for post-secondary technical education for the above average trainee. Hence, it is hoped that trainees who successfully complete their trade and general education may be able to compete with their secondary school counterparts for direct entry into the polytechnics or colleges of education (technical) for ND or NCE courses respectively. The Social Studies component is designed to broaden the trainee's social skills and his understanding of his environment.

For the purpose of certification, only the first three courses in mathematics will be required. The remaining modules are optional and are designed for the above average students.

NATIONAL CERTIFICATION

The NTC and ANTC programmes are run by Technical Colleges accredited by NBTE.
NABTEB conducts the final National examination and awards certificates.

Trainees who successfully complete all the courses/modules specified in the curriculum table and passed the national examinations in the trade will be awarded one of the following certificates:

S/NO	LEVEL	CERTIFICATE
	Technical Programme	
1.	Craft Level	National Technical Certificate
2.	Advanced Craft Level	Advanced National Technical Certificate

GUIDANCE NOTES FOR TEACHERS TEACHING THE CURRICULUM

The number of hours stated in the curriculum table may be increased or decreased to suit individual institutions' timetable provided the entire course content is properly covered and the goals and objectives of each module are achieved at the end of the term.

The maximum duration of any module in the new scheme is 300 hours. This means that for a term of 15 weeks, the course should be offered for 20 hours a week. This can be scheduled in sessions of 4 hours in a day leaving the remaining hours for general education. However, (properly organized and if there are adequate resources), most of these courses can be offered in two sessions a day, one in the morning and the other one in the afternoon. In so doing, some of these programmes may be completed in lesser number of years than at present.

The sessions of 4 hours include the trade theory and practice. It is left to the teacher to decide when the class should e held in the workshop or in a lecture room.

INTEGRATED APPROACH IN THE TEACHER OF TRADETHEORY, TRADE SCIENCE AND TRADE CALCULATION

The traditional approach of teaching trade science and trade calculation as separate and distinct subjects in technical college programmes is not relevant to the new programme as it will amount to a duplication of the teaching of mathematics and physical science subjects in the course. The basic concepts and principles in mathematics and physical science are the same as in the trade calculation and trade science. In the new scheme therefore, qualified persons in these fields will teach mathematics and physical science and the instructors will apply the principles and concepts in solving trade science and calculation problems in the trade theory classes. To this end, efforts have been made to ensure that mathematics and science modules required to be able to solve technical problems were taken as pre-requisite to the trade module.

EVALUATION OF PROGRAMME/MODULE

For the programme to achieve its objectives, any course started at the beginning of a term must terminate at the end of the term.

Instructors should therefore device methods of accurately assessing the trainees to enable them give the student's final grades at the end of the term. A national examination will be taken by all students who have successfully completed their modules. The final award will be based on the aggregate of the scores attained in the course work and the national examination.

COURSE: **REFRIGERATION AND AIRCONDITIONING**
PROGRAMME: **NATIONAL TECHNICAL CERTIFICATE**

SUBJECT CODE	MODULE	YEAR I						YEAR 2						YEAR 3						TOTAL HRS FOR EACH
		Term 1		Term 2		Term 3		Term 1		Term 2		Term3		Term 1		Term 2		Term 3		
		T	P	T	P	T	P	T	P	T	P	T	P	T	P	T	P	T	P	
CEN 11-17	English Lang	2	0	2	0	2	0	3	0	3	0	3	0	3	0	3	0	3	0	288
CBM 11	Enterpreneurship	0	0	0	0	0	0	0	0	0	0	0	0	2	0	2	0	2	0	72
CPH 10-12	Physics	2	0	2	0	2	0	2	2	2	1	2	1	2	1	2	1	2	1	300
CMA 12-15	Mathematics	2	0	2	0	2	0	2	0	2	0	2	0	2	0	2	0	2	0	216
CCH 11-12	Chemistry	2	0	2	0	2	0	2	1	2	1	2	1	2	1	2	1	2	1	288
CEC 11-13	Economics	2	0	2	0	2	0	2	0	2	0	2	0	2	0	2	0	2	0	216
ICT 11-15	Computer Courses	0	0	0	0	0	0	1	2	1	2	1	2	1	2	1	2	0	0	180
CTD 11-13	Tech Drawing	0	3	0	3	0	3	0	3	0	3	0	3	0	2	0	2	0	3	216
CME 11	Gen Metal Work 1	2	5	2	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	168
CME 12	Gen Metal Work 2	1	2	1	2	1	2	0	2	0	2	0	2	0	2	0	0	0	0	204
CAR 11	Basic Principles of Refrigeration and Airconditioning.	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	72
CAR 12	Compressors, Motors and Generators	1	2	1	2	1	2	1	2	1	1	0	2	0	2	1	1	0	2	264
CAR 13	Charging of Refrigerants Oil	1	1	1	0	0	1	0	1	0	1	0	0	0	0	0	0	0	0	72
CAR 14	Heat Exchangers	1	1	1	0	0	1	0	1	0	1	0	0	0	0	0	0	0	0	72
CAR 15	Load Estimating	1	0	1	1	1	0	1	0	0	0	0	0	0	0	0	0	0	0	60
CAR 16	Refrigerant Controls	1	2	1	1	1	2	0	0	0	0	0	0	0	0	0	0	0	0	96
CAR 17	Installation and Insulation of Pipes and Ducts	1	2	1	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	72
CAR 18	Absorption System	1	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	36
CAR 19	Refrigeration Work	1	2	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	60

		22	23	20	15	15	16	14	14	13	12	12	11	14	10	15	7	13	7	2952

ONE YEAR: ANTC IN REFRIGERATION AND AIRCONDITIONING										
S/N	**MODULE CODE**	**MODULE TITLE**	**TERM 1**		**TERM 2**		**TERM 3**		**CONTACT HOURS**
			T	P	T	P	T	P	756
1	CBM 21	Enterpreneurship	2	0	2	0	2	0	72
2	CEN 21-22	English Language & Communication	2	0	2	0	2	0	72
3	CME 21	Mechanical Engineering Sci.	1	1	1	2	1	0	72
4	CMA 21-22	Mathematics	2	0	2	0	2	0	72
5	CTD 21`	Engineering Drawing & Design	0	3	0	3	0	0	72
6	CAR 20	Basic Airconditioning Principles.	2	0	0	2	0	0	48
7	CAR 21	Automobile Airconditioning.	2	0	0	2	0	0	48
8	CAR 22	IndustrialAirconditioning .	2	0	2	0	0	0	48
9	CAR 23	ICE Plant	1	2	0	2	1	0	72
10	CAR 24	Transport Réfrigération	1	2	0	2	1	0	72
11	CAR 25	Cold Store Installation & Maintenance	1	0	0	2	0	0	36
12	CIT 21	Auto CAD 1	1	2	0	0	0	0	36
13	CIT 22	Auto CAD 2	0	0	1	2	0	0	36

PROGRAMME: NATIONAL TECHNICAL CERTIFICATE IN REFRIGERATION AND AIR-CONDITIONING		
Course: BASIC PRINCIPLES OF REFRIGERATION AND AIR CONDITIONING	**Course Code : CAR 11**	**Duration: 72 Hours**
Module Specification: PRACTICAL/KNOWLEDGE REQUIREMENTS		

General Objective: On completion of this module the student will be able to:

1.0 Know the basic principle of refrigeration and air-condition systems
2.0 Know the basic materials, tools, equipment and safety precautions used in refrigeration and air-condition practice
3.0 Know the types of thermometers and their uses and be able to convert from one temperature scale to another
4.0 Know the types of Pressure gauges and application
5.0 Understand the effects of Temperature, Pressure and Volume in Refrigeration and Air-conditioning System
6.0 Understand the Principles of conversion of Electrical energy into Heat energy & Vice Versa
7.0Understand the three States of Matter and its application to refrigeration system
8.0 Understand the Principles of Refrigerant as working fluid in the refrigeration Cycle

Practical Competence: On completion of this module, the student will be able to

1.0 Plot temperature scales on a graph and compare their readings
2.0 Demonstrate the use of pressure gauges in refrigeration system
2.0 Demonstrate Charles, Boyles laws and related gas laws.
3.0 Solve some problems on gas laws
4.0 Identify trainer unit for refrigeration system
5.0 Perform installation of basic refrigeration unit.
6.0 Sketch the schematic diagram of vapor compression system

PROGRAMME: NATIONAL TECHNICAL CERTIFICATE IN REFRIGERATION AND AIRCONDITIONING						
Course: BASIC PRINCIPLES OF REFRIGERATION AND AIR CONDITIONING		**Course Code: CAR 11**		**Contact Hours: 1-1**		
Course Specification: Theoretical Content						
WEEK	**General Objective 1.0: Understand the basic principles of refrigeration and air-conditioning. Year 1, Term 1**					
	Theoretical Content			**Practical Content**		
	Specific Learning Outcome:	**Teachers Activities**	**Resources**	**Specific Learning Outcome**	**Teachers Activities**	**Evaluation**

1-10	1.1 Explain refrigeration and air-conditioning (AC) systems 1.2 Explain types of refrigeration and air conditioning systems 1.3 Define vapor compression system 1.4 Explain the working of the vapor compression system and air-condition system 1.5 Explain schematic diagram of vapor compression system 1.6 Explain schematic diagram of a domestic air-conditioning system 1.7 Explain reversed carnot cycle and heat pumps 1.8 Explain the basic concepts of refrigeration/air-conditioning systems. 1.9 Explain the functions of each component of RAC systems.	Describe activities 1.1 to 1.9.	Recommended textbooks, Lecture notes, white board, marker. Models of refrigeration and air-conditioning systems	1.1 Identify types of refrigeration & AC systems 1.2 Identify component parts of refrigeration and air-conditioning systems. 1.3 Identify the functioning of the component parts. 1.4 Identify the differences and similarities of refrigeration and air-conditioning systems. 1.5 Sketch the schematic diagram of vapor compression system	Demonstrate the activities in 1.1 and 1.5 and ask the students to perform the activities.	• Ask the student on refrigeration and air-conditioning • Solve problem on gas laws.
	GENERAL OBJECTIVE: 2.0Know the basic materials, tools, equipment and safety precautions used in refrigeration and air-conditioning practice. Year 1, Term 1					

	2.1 Explain the potential health and safety hazards associated with the handling and use of refrigeration materials and equipment, use of safety equipment and protective clothing 2.2 List the basic hand tools used in refrigeration and air-conditioning workshop 2.3 Explain the use of each tool named in 2.1 2.4 List basic equipment used in refrigeration and air-conditioning workshop e.g., manifold gauge, leak detectors e. t. c. 2.5 Introduction to basic tubing e.g., size, type, material, bending, cutting, flaring, swaging e. t. c.	Explain activities 2.1 to 2.5.	Hand cutting tools flaring tools, oxy-acetylene gas, Set Safety equipment of masks goggles swaging tools e. t. c.	2.1 Identify the equipment used in refrigeration and air-conditioning workshop e.g., manifold gauge, leak detecting instruments, etc. 2.2 Perform cutting, flaring bending and joining of tubes using appropriate tools and equipment 2.3 Identify tools and equipment in mitigating environmental hazards	Demonstrate activities 2.1 and 2.3 for the students to learn and ask them to practice Assess the students.	• Ask student on how to use tools in refrigeration and air-conditioning practice • Asses student
	General Objectives 3.0: Know types of thermometers and their uses and be able to convert from one temperature scale to another. Year 1, Term 1					

	3.1. Definethermometer and mention types of thermometers and be able to convert from one temperature scale to another 3.2 Explain the principle of converting electrical energy into heat energy and vice versa 3.3 Explain the effect of pressure, temperature and volume in refrigeration and air-conditioning system 3.4 Explain the three states of matter 3.5 Define heat 3.6 Explain the methods of heat transfer i.e., conduction, convection and radiation 3.7 Explain the effect of addition or subtraction of heat to materials- expansion and contraction 3.8 Explain the working principle of the thermometers 3.9 Explain the application of the different types of thermometers 3.10 Explain of conversion from one temperature scale to another a. Celsius to Fahrenheit scale C = 5/9 (F - 32) b. Fahrenheit to Celsius to F = (9/5C) +32 c. Celsius to Kelvin d. Celsius to Rankine 3.11 Explain temperature scales on a graph. 3.12 Correct use and care of thermometers	▪ Explain the activities of 3.1 to 3.12 ▪ Solve some examples on conversions	▪ types of Thermometers ▪ White board and makers ▪ Rulers ▪ Graph sheets	3.1 identify the types of thermometers and their applications 3.2 Solve some examples on conversions 3.3 Identify the different types of thermometers in common use 3.4 Plot temperature scales on a graph and compare their readings	Guide the student on activities of 3.1 to 3.4	• Ask students to identify the types of thermometers and their applications

General Objective: 4.0 Know the types of Pressure gauges and application. Year 1, Term 2

11-20	4.1 Explain different types of pressure and vacuum gauges 4.2 Explain the operating principles of the different type of pressure gauges 4.3 Stress the care of gauges/other instruments	Describe activities in 4.1 to 4.3	▪ Pressure gauges ▪ White board and markers ▪ Vacuum gauge ▪ Digital pressure gauge	• Identify different types of pressure and vacuum gauges • Demonstrate the operating principles of the different type of pressure vacuum gauges • Demonstrate care of gauges/other instruments	Guide the student to demonstrate the use of types of pressure and vacuum gauges	▪ Ask the students to identify the types of pressure gauges and demonstrate their applications ▪ Assess the students

General Objective: 5.0 Understand the effects of Temperature, Pressure and Volume in Refrigeration and Air-conditioning System. Year 1, Term 2						
	5.1 Define gas laws such as a. Boyle's law b. Charles' law c. Dalton's law of partial pressures, etc. 5.2 Explain basic terms relating to heat, temperature and pressure 5.3 State the relationship between different scales of pressure 5.4 State and explain absolute pressure, gauge pressure and vacuum pressure 5.5 State and explain the pressure temperature relationship for a saturated fluid 5.6 Carry out calculations using gas laws formulae P1VI1/T1 = P2V2/T2	▪ Explain the activities in 5.1 to 5.6 ▪ Use refrigerant comparators and tables ▪ Solve some problems on gas laws ▪ State all the gas laws ▪ Work through given exercises	▪ White board ▪ Markers. ▪ Glass tubes, pressure ▪ Tubing scale rule ▪ Mercury ▪ Thermometer ▪ Glass steam jacket ▪ Manifold gauge ▪ Manometer ▪ Barometer	Demonstrate the uses of all the pressure gauges	▪ Guide the students on how to demonstrate the uses of all the pressure gauges	▪ Ask the students to explain the relationship between Pressure, temperature and volume, use sample apparatus to demonstrate Charles and Boyles laws ▪ Ask the students to identify the different types of pressure gauge and applications
General Objective: 6.0 Understand the Principles of conversion of Electrical energy into Heat energy &vice versa. Year 1, Term 3						

21-35	6.1 Define power, work and their units e.g., watts, kilo watts, etc. 6.2 Explain the relationship between heat, work and power 6.3 Use formulae to calculate: a. work b. power 6.4 Explain the conversion of electrical energy to heat energy	▪ Explain the activities in 6.1 to 6.4 ▪ Give exercises and assist those needing extra help	▪ Whiteboard ▪ Markers ▪ Graph paper ▪ Calorimeter/ multimeter ▪ Heating coil Thermometer	▪ Demonstrate using joules experiment	Demonstrate activities in (1) and ask student to perform the activities	▪ Ask the students to explain the relationship between heat, work and power
General Objective 7.0: Understand the three States of Matter and its application to refrigeration systems						

	7.1 Explain good understanding of sensible heat and latent heat 7.2 Distinguish between phases of matter; solid, liquid and gas 7.3 Explain heat of fusion and vaporization 7.4 Use temperature enthalpy graph to illustrate change of states 7.5 Explain meaning of boiling point of liquids 7.6 Explain a vapour compression refrigeration system to identify where the stages takes place.	▪ Explain activities in 7.1 to 7.6 ▪ Draw and describe temperature graph	▪ Smart board/ white board ▪ Graph paper ▪ Sample component in R & A circuit ▪ Projector/screen board ▪ Videos & pictures ▪ Charts and models	7.1 Demonstrate good understanding of sensible heat and latent heat 7.2 Sketch the schematic diagram of vapour compression system 7.3 Illustrate change of states using water as an example.	Guide the student on the activities 7.1 to 7.3	▪ Ask the students to explain the three phases of matter

General Objective 8.0: Understand the Principles of Refrigerant as working fluid in the refrigeration Cycle						
	8.1 Explain the potential of health and safety hazards associated in handling the refrigerant 8.2 Explain Refrigerant as a working medium in refrigeration Cycle 8.3 State the conditions of Refrigerant at points in the cyclic. 8.4 Explain the type of refrigerant and cylinder color code. 8.5 Explain the uses, properties and applications of refrigerant used in refrigeration system	▪ Describe activities 8.1 to 8.5	▪ Trainer Unit. ▪ A pointer ▪ Workshop components and Materials ▪ Different types of refrigerants ▪ Refrigerant analyzer	8.1 Identify trainer unit for refrigeration 8.2 Demonstrate primary refrigerants and secondary refrigerants 8.3 Differentiatebet ween the different refrigerant using cylinder color codes 8.4 Operate trainer unit for the students to observe	▪ Demonstrate the activities in 8.1 and 8.4 and ask students to perform the activities	**EVALUATION:** ▪ Questions and Answers ▪ Written tests ▪ End of module examination

PROGRAMME: NATIONAL TECHNICAL CERTIFICATE IN REFRIGERATION AND AIR-CONDITIONING		
Course: COMPRESSORS, MOTORS AND GENERATORS	**Course Code: CAR 12**	**Duration: 264 Hours**
\\Module Specification: PRACTICAL/KNOWLEDGE REQUIREMENTS		

General Objective: On completion of this module the student will be able to:

1.0 Understand difference types of compressors
2.0 Understand the working principles of the compressors
3.0 Understand the revolution and capacity of reciprocating compressors
4.0 UnderstandServicing Compressor Valves
5.0 Know the method of adjusting safety devices for compressors
6.0 Understand the working principles of types of capacity control on compressors and be able to adjust them appropriately
7.0 Understand compressor efficiency test
8.0 Understand Maintenance electric motors, generators and starters used in refrigeration and air-conditioning systems

Practical Competence: On completion of this module, the student will be able to

1.1 Sketch the principle of operation of each of the compressors
1.2 Describe the appropriate uses of each type of compressor
1.3 Assemble compressor components open type
1.4 Demonstrate how to adjust low and high pressure cut outs.
1.5 Demonstrate how to adjust thermostat and switch of the systems
1.6 Carry out:
1. Repair and replace faulty components including valve lapping and assemble compressors
2. Connect the suction and high-pressure gauges.
3. Check compressor for shorts ground and open circuits
4. Observe and assess the pumping and suction action of the compressor.

1.7 Identify three-phase and single-phase motor
1.8 Oil and grease the appropriate parts of refrigeration and air-conditioning systems
1.9 Identify types of starters, e.g. direct-on-line starters; star-delta starters, etc.

PROGRAMME: NATIONAL TECHNICAL CERTIFICATE IN REFRIGERATION AND AIR CONDITIONING WORK						
Course: COMPRESSORS, MOTORS AND GENERATORS		**Course Code: CAR 12**		**Contact Hours: 1-2**		
Course Specification: Theoretical Content						
WEEK	**General Objective 1.0: Understand difference types of compressors; Year 1, Term 3**					
	Theoretical Content			**Practical Content**		
	Specific Learning Outcome:	**Teachers Activities**	**Resources**	**Specific Learning Outcome**	**Teachers Activities**	**Evaluation**
1-10	1.1 List the difference between hermetic(sealed), semi-hermetic and open type compressors. 1.2 List the different between the following types of compressors: a. Reciprocating b. Rotary c. Centrifugal d. Screw/scroll e. Make scroll 1.3 Explain the principle of operation of each of the compressors 1.4 Explain the methods of cooling motor windings in a hermitically sealed compressor 1.5 Explain methods of compression in a rotary compressor by stationary blade and rotary vane 1.6 Explain Crack seat, front seat, back seat of the service valves	Explain activities 1.1 to 1.6	▪ Markers ▪ white Board ▪ types of Compressors ▪ Compressor service valves	1.1Sketch the principle of operation of each of the compressors 1.2 Demonstrate the appropriate uses of each type of compressor listed in 1.2 1.3 Identify the material used in the construction of part of the compressors	Guide the student on activities in 1.1 and 1.2 and	Ask students to perform the activities. 1.1 to 1.3
	General Objective: 2.0 Understand the Working Principles of the Compressor. Year 2, Term 2					

11-25	2.1 Explain material used in the construction of compressors part 2.2 Explain the construction operating principles of compressors in common use 2.3 Explain with labeled diagram showing the essential features of compressors 2.4 Explain differentparts of components of compressor 2.5 Explain the function of each component part of the compressor	Explain activities 2.1 to 2.5	▪ Models ▪ Whiteboard ▪ types of compressors ▪ Exploded view diagrams ▪ Video and pictures ▪ Projector	2.1 Identify component parts of compressor 2.2 demonstrate the function of the component part 2.3 Draw a well labeled diagram showing the essential part of compressors	• Demonstrate the activities in 2.1 and 2.3 and ask students to perform the activities. • Dismantle and reassemble types of compressors	Ask the Students to: Explain the functions of the components
	General Objective: 3.0 Understand Calculate the revolution and capacity of reciprocating compressors. Year 1, Term 2					
26-29	3.1 Identify the motor speed, fly wheel, and pully diameters. 3.2 Explain the principles of operation of the compressors 3.3 Calculate the revolution of the compressor Dn = dN where D = diameter of compressor fly wheel n = revolution of the compressor d = diameter of the motor pully N = speed of the motor 3.4 Calculate the capacity of the compressor Capacity = $\pi \underline{D^2N}$ x S x RPM 4 Where $\pi = \underline{22}$ or 3,146	▪ Explain using the pressure – volume diagram, to illustrate the stages in the compressing process, e.g. - expansion, suction, compression and discharge	▪ White board ▪ Marker ▪ Compressor ▪ Models ▪ Video and pictures ▪ Projector ▪ Tachometer	Identify the motor speed, fly wheel, and pully diameters.	Guide the student to identify the motor speed, fly wheel, and pully diameters.	Asses the student

	7 N = number of cylinders D = diameter of compressor RPM = revolution per minute S = length of stroke d = diameter of cylinder					
	General Objective: 4.0 Understand Servicing Compressor Valves. Year 2, Term 1					
37-44	4.1 Explain lapping of compressor valve using appropriate lapping paste. 4.2 Explain True compressor valve by lapping using appropriate lapping paste 4.3 Explain the Reassemble and adjust service valves for correct functioning 4.4 Explain heat-test of the system 4.5 Describe compressor service valves and know their application in refrigeration and air-conditioning system.	• Discuss activities 4.1 to 4.5	▪ Oil ▪ Smooth sand paper ▪ Glass block, etc ▪ Grinding paste ▪ Lapping stick	4.1 identify compressor valves 4.2 Identify compressor valve by lapping using appropriate lapping paste 4.3 perform Reassemble and adjust service valves for correct functioning 4.4 Heat-test the system	Demonstrate the activities of 4.1 to 4.4	-Ask the students to demonstrate stripping of components. -Ask the students to lap valve, reassemble and adjust them correctly
	General Objective: 5.0 know the method of adjusting safety devices for compressors					

	5.1 Explain the functions of high pressure cut out 5.2 Explain low and high pressure cut outs. 5.3 Explain thermostats, and switches of the systems 5.4 Explain relay, overload protector and contactor 5.5 Explain functions of thermal limiter and superheat switch	Discuss activities 5.1 to 5.5	• Screw Drivers • Test pen • Low and high pressure cut out • Relays • Thermostat • Thermal limiter	5.1 demonstrate how to adjust low and high pressure cut outs. 5.2 Demonstrate how to adjust thermostat and switch of the systems	Demonstrate the activities in 5.1 to 5.2for the students to perform the activities.	▪ Ask the Students to: ▪ identify safety devices ▪ asses student
76-86	**General Objective: 6.0 Understand the working principles of types of capacity control on compressors and be able to adjust them. Year 2, Term 3**					
	6.1 Explain the types of capacity controls 6.2 Explain the principle of operation of each type of capacity control: Pneumatic, variable speed, etc 6.3 Explain fault on capacity control 6.4 Explain adjust or replace capacity control	Explain activities 6.1 to 6.4	▪ Whiteboard ▪ Markers ▪ Projector ▪ Video ▪ Cylinder unloaded ▪ Hot gas bypass ▪ Side valve	6.1 Demonstrate Diagnosing fault on capacity control 6.2 Perform Adjustment or replacement of capacity control	Demonstrate the activities in 6.1 to 6.2 for the students to perform the activities.	▪ Ask the students to: ▪ Explain different methods of capacity controls using illustrative diagrams
	General Objective: 7.0 Understand how to Carry out compressor efficiency test. Year3, Term 1					
87-108	7.1 Explain the purpose and importance of compressor efficiency test 7.2 Explain suction and discharge pressure gauges. 7.3 Explain how to Connect the suction and high-pressure	Discussactivities 7.1 to 7.3	▪ Gauge Set ▪ Refrigeration socket set ▪ Multimeter ▪ Compressor analyzers ▪ Complete	Perform the following activities: 7.1 Run the compressor 7.2 Repair and replace faulty components including valve lapping	Demonstrate the activities in 7.1 to 7.11 and guide the students to carry out all the activities.	Asses students

	gauges.		tool box	7.3 Dismantle and assemble compressors 7.4 Connect the suction and high-pressure gauges. 7.5 Check compressor for shorts ground and open circuits 7.6 Run the compressor 7.7 Observe and assess the pumping and suction action of the compressor. 7.8 Demonstrate how problems of compressor noise can be rectified 7.9 Carry out repairs on low pumping of compressor 7.10 Carry out repairs on short-circuits fault in compressor 7.11 Demonstrate process of replacement of faulty compressor		
General Objective: 8.0 Maintain electric motors, generators and starters used in refrigeration and air-conditioning systems						
	8.1 Define three-phase and single-phase motor 8.2 List types of single-phase motors	Describe activities 8.1 to 8.4 with diagrams where necessary	▪ Single-phase and three-phase motors	▪ Identify three-phase and single-phase motor ▪ Demonstrate how	Demonstrate the activities in specific objective and guide the	Asses the student

	8.3 Explain how to oil and grease the appropriate parts of refrigeration and air-conditioning systems motor 8.4 Explain types of starters, e.g., direct-on-line starters; star-delta starters, etc.		▪ Multi-meter ▪ Screw drivers, etc. ▪ Complete tool box	to oil and grease the appropriate parts of refrigeration and air-conditioning systems motor ▪ Identify types of starters, e.g., direct-on-line starters; star-delta starters, etc. ▪ Trouble-shoot for electrical fault in refrigerator motor ▪ Trouble-shoot for mechanical fault in refrigerator ▪ Identify causes of faults associated with domestic refrigerator ▪ Carry out repairs on overload ▪ Carry out repairs on faulty relay ▪ Carry out repairs on faulty electric cord ▪ Carry out repairs on faulty	students to carry out all the activities	

				capacitor ▪ Describe how problems of compressor noise can be rectified ▪ Carry out repairs on low pumping of compressor ▪ Carry out repairs on short-circuits fault in compressor		

PROGRAMME: NATIONAL TECHNICAL CERTIFICATE IN REFRIGERATION AND AIR-CONDITIONING		
Course: CHARGING OF REFRIGERANTS AND OIL	**Course Code: CAR 13**	**Duration: 72 Hours**
Module Specification: PRACTICAL/KNOWLEDGE REQUIREMENTS		

General Objective: On completion of this module the student will be able to:

1.0 Know types of refrigerants and lubrication oil used in a refrigeration system
2.0 Understand the Charging refrigeration system with refrigerants
3.0 Understand the importance of lubricating oil in a refrigeration system.
4.0 Understand methods of lubrication
5.0 Understand the principle of operation of oil separators

Practical Competence: On completion of this module, the student will be able to

1.0 Identify refrigerant and its applications
2.0 know refrigerants according to colour coding
3.0 Charge lubricant into a system.
4.0 Charge the system with refrigerants
5.0 Locate and repair the point of leakages.

PROGRAMME: NATIONAL TECHNICAL CERTIFICATE IN REGRIGERATION AND AIR-CONDITIONING						
Course: CHARGING OF REFRIGERANTS AND OIL	**Course Code: CAR 13**		**Contact Hours 1-1. Year 1, Term 1**			
Course Specification: Theoretical Content						
WEEK	**General Objective 1.0: Know the types of refrigerants lubrication oil used in a refrigeration system and the specific application of each type**					
	Theoretical Content			**Practical Content**		
	Specific Learning Outcome:	**Teachers Activities**	**Resources**	**Specific Learning Outcome**	**Teacher's Activities**	**Evaluation**
1-12	1.1 Define refrigerant 1.2 List common refrigerants in use 1.3 State the properties of a refrigerant and its applications in refrigeration and air-conditioning systems. 1.4 Explain the differences between primary and secondary refrigerant 1.5 Explain the purpose of refrigerant in refrigeration system and be able to classify the types of refrigerants and their properties 1.6 State specific use of each Refrigerant. 1.7 Explain the importance of lubrication in a refrigeration system and the different types of lubricating systems 1.8State the groups of refrigerant accord to their properties e.g., boiling point	▪ Discuss activities 1.1 to 1.17	▪ Refrigerant cylinders ▪ Videos ▪ Filter dryers ▪ Refrigerant ▪ Identifiers' RAC ▪ Refrigeration demonstration unit	1.1 Identify refrigerant and its applications. 1.2 Use refrigeration and air-conditioning demonstration units to illustrate the effect of: (i) pressure on temperature (ii) cooling water rate on condenser and evaporator temperatures. 1.3 Observe safety precaution in the workshop and in the storage of refrigerants. 1.4 identify refrigerants according to colour coding	Demonstrate the activities in 1.1 to 1.4 for the students to learn	▪ Ask the students to show different types of refrigerants by their containers ▪ Ask the students to: ▪ demonstrate use of vacuum pumps ▪ Ask the students to practice. Assess the students

	1.9 Explain desirable properties of refrigerants, 1.10 Explain how to recover, recycle and reclaim refrigerants from faulty systems 1.11 Explain method of evacuation and drying system 1.12Explain functions and types of dehydrants (drier) 1.13 Explain charging and recoveringthe refrigerant from the system 1.14 State the safety precautions in the storage of refrigerants		▪ Refrigerants ▪ Smart board ▪ Dehydrants ▪ Clamp meter ▪ Recovery and recycling machine ▪ Digital vacumm ▪ Models ▪ Test Equipment			
	General Objective: 2.0 Understand Charging a refrigeration system with refrigerants. Year 1, Term 2					
13-36	Explain how to; 2.1 Connect vacuum pumps; 2.2 run vacuum pump until the suction reads: - 100KN/m^2 (760mm vacuum); a. Disconnect the vacuum pump and charge the system as shown in 2.2 above. b. pressurize the system with refrigerant; c. Run the compressor and allow the compressor to suck in the refrigerant until system is fully charged.	• Discuss activities 2.1 and2.1	▪ Refrigerant charging cylinder; ▪ Vacuum pump; ▪ Gauge set; ▪ Leak detectors; etc.	2.1 Locate and repair the point of leakage if any, by using electronic leak detector halide torch, soap solution, etc. 2.2 Charge the system with refrigerants, following the correct procedure e.g. a. connect the suction and high pressure gauges;	Demonstrate the activities in 2.1 to 2.2 for the students to learn and ask the students to practice.	Assess the students

				b. Connect the refrigerant cylinder to the system; c. Crack seat the valve of the cylinder/pressurize the system with refrigerant d. Run the compressor until the system is fully charged; and observe all necessary precautions		
	General Objective: 3.0 Understand the importance of lubricating oil in a refrigeration system and be able to charge the system with lubricating oil where necessary.					
	3.1 State the importance of lubricating oil in a refrigeration system. 3.2 State properties of lubricating oil used in refrigeration systems. 3.3 Explain how to select lubricating oils, viscosity 150-300	▪ Discussaffinity of refrigerant to lubricating oil which is of great advantage ▪ Discussactivities 3.1 to 3.3	▪ Lubricating Oils ▪ Oil can ▪ Cotton waste	3.1 Demonstrate the charging of lubricant into a system via the suction side	Demonstrate the activities in 3.1 for the students to learn and ask the students to practice.	▪ Ask the students to: ▪ Explain affinity of refrigerant to lubricating oil which is of great advantage ▪ Assess the students

	General Objective: 4.0 Understand methods of lubrication.					
37-60	4.1 State the two methods of lubrication (gravity, splash, forced feed) 4.2 Explain each method stated in 4.1 4.3 Explain oil compatibility with refrigerant	▪ Using diagram, to describe the methods of lubrication ▪ Describe oil compatibility with refrigerant	▪ Whiteboard ▪ Video ▪ Smart board ▪ Different types of lubrication oil.	Demonstrate using diagram, to explain the methods of lubrication	Guide student using diagram, to explain the methods of lubrication	Ask the students using diagram, to explain the methods of lubrication
	General Objective: 5.0 Understand the principle of operation of oil separators					
	5.1 Explain the Principle of operation of oil separators 5.2 Name and draw two types of oil separators 5.3 Explain all safety involve in installing an oil separator	▪ Usediagram to describe oil separators and safety involve	▪ Videos ▪ Charts ▪ Oil separator ▪ White board	▪ Demonstrate principle of operation of oil separators ▪ Demonstrate all safety involve in installing an oil separator	▪ Guide student on operation of oil separators ▪ Guide student to identify all safety involve in installing an oil separator	▪ Ask the students to use diagram to explain oil separators ▪ Assess the student

PROGRAMME: NATIONAL TECHNICAL CERTIFICATE IN REFRIGERATION AND AIR-CONDITIONING		
Course: CAR 14 – HEAT-EXCHANGERS (CONDENSER & EVAPORATOR)	**Course Code: CAR 14**	**Duration: 72 Hours**
Module Specification: PRACTICAL/KNOWLEDGE REQUIREMENTS		

General Objective: On completion of this module the student will be able to:

1.0 Understand the principles of operation of heat exchangers
2.0 Know how to Calculate heat load, size and overall length of pipes required for refrigeration installation
3.0 Know how toConstruct Condensers and evaporators for refrigeration and air-conditioning systems
4.0 Understand the function of the liquid receiver and the service valve, and their applications

Practical Competence: On completion of this module, the student will be able to

1.1 Identify modes of heat transfer
1.2 Carry out experiments to demonstrate heat transfer by conduction, convention and radiation
1.3 Construct simple condenser and evaporator.
1.4 Operate the liquid receiver service valves, i.e.

a. crack
b. front seat
c. back seat

1.5 Pump down condensers and evaporators

PROGRAMME: NATIONAL TECHNICAL CERTIFICATE IN REFRIGERATION & AIRCONDITIONING WORK						
Course: CAR 14 – HEAT EXCHANGERS		**Course Code: CAR 14**		**Contact Hours: 1–1**		
Course Specification: General Objective: 1.0 Understand the principles of operation of heat exchangers and select the common types used in refrigeration and air-conditioning. Year 1, Term 1 & 2						
WEEK	**Theoretical Content**			**Practical Content**		
	Specific Learning Outcome:	**Teachers Activities**	**Resources**	**Specific Learning Outcome**	**Teachers Activities**	**Evaluation**

1-20	1.1 Define heat exchanger and types of heat exchanger 1.2 Explain the purpose of heat exchanger in the refrigeration system 1.3 Explain the methods of heat transfer in each type of heat exchanger 1.4 Define condenser and it types. 1.5 Explain the functions and operating principles of condensers 1.6 Calculate heat load, size and length of pipes required for refrigeration installation 1.7 Explain without heat transfer, air-conditioning and refrigeration systems will not work (in principle, the refrigeration and air conditioning system's job is similar to that of engine cooling system) 1.8 Explain condenser by clearing the tubing and fins	▪ Discuss the methods of heat transfer ▪ Discuss the functions and operating principles of condenser ▪ Discuss 1.1 to 1.3	▪ Heat exchangers ▪ Condensers ▪ Video ▪ Models ▪ Pictures ▪ Evaporator	1.1 Identify condensers in refrigeration system 1.2 Identity evaporators in refrigeration system 1.3 Identify the types of pipes used in evaporators and condensers units of refrigerators 1.4 Distinguish between pipes used in evaporators and condensers units of refrigerator	Demonstrate for the student to Construct simple condenser and evaporator using the process of 1.1 to 1.4	▪ Ask the students to: ▪ Explain the methods of heat transfer and the principles of operation of heat exchangers. ▪ Explain the functions and operating principles of condenser and evaporator

	1.9 Define types of condensers and their correct uses: a. shell and coil b. shell and tube c. Double pipe d. Convectional 1.10 Explainevaporator 1.11 State different types of evaporators and their application ; ▪ Drier expansion ▪ Flooded 1.12 Expain principal of operation of each type of evaporator SS	▪ Show types of heat exchangers ▪ Describe the principles of operation of each ▪ Describe modes of heat transfer ▪ Describe the function and operation principles of condenser and evaporator	▪ Heat exchangers ▪ Free and forced convection Heat & Mass Transfer Apparatus. ▪ Thermal conductivity apparatus ▪ Models ▪ Charts ▪ Videos	1.5 Identify modes of heat transfer in the laboratory 1.6 Carry out experiments to demonstrate heat transfer by conduction, convention and radiation	Demonstrate for the students to learn and guide them to perform all the activities	▪ Ask the students to: ▪ Show and draw types of heat exchangers ▪ Explain the principles of operation of each ▪ Explain modes of heat transfer
21-48	**General Objective: 2.0 know how to Calculate heat load, size and overall length of pipes required for refrigeration installation. Year 1, Term 2&3. Year 2, Term 1**					
	2.1 Calculate the total load of the condenser/evaporator using the formulae Load = AxUxT.D U = Coefficient of heat transfer T.D. = Temperature Difference A = Area **2.2** Explain accuracy of calculating heating and	▪ solve problems on heat exchangers using the given formula	▪ whiteboard ▪ markers			▪ Ask the students to solve problems on heat exchangers using the given formula

	cooling loads **2.3** Explain the importance of data books and charts for applicable information					
	General Objective: 3.0 Know how to Construct Condensers and evaporators for refrigeration and air-conditioning systems					
	3.1 Explain the purpose of condensers and evaporators in a refrigeration and air-conditioning systems 3.2 Explain materials used for constructing condenser/evaporators, copper, pipes, fins, etc. 3.3 Explain how to Bend copper pipes to shapes 3.4 Explain how to Prepare fins for the condenser/evaporator 3.5 Explain how to Braze fins, elbows, copper pipes together 3.7 Explain how to Select the right size of fins for condenser/evaporators by using manufacturers catalogue	Describe how to: ▪ Service and maintain heat exchangers ▪ Construct simple condensers and evaporator ▪ Identify condenser/evaporator made from copper tubing ▪ Practice pipe flaring, swaging, soldering and welding	▪ Heat exchangers ▪ Refrigeration toolbox ▪ Copper tubes ▪ Sheet metal ▪ Easy flow ▪ Brazing equipment, etc. ▪ Protective clothing ▪ Fin	3 Design simple condenser and evaporator 3.1 Select materials used for constructing condenser/evaporators, copper, pipes, fins, etc. 3.2 Bend copper pipes to shapes 3.3 Prepare fins for the condenser/evaporator 3.4 Braze fins, elbows, copper pipes together 3.6 Select the right size of fins for condenser/evaporators by using manufacturers catalogue	Demonstrate for the student to Construct simple condenser and evaporator using the process of 3.1 to 3.6	Ask the students to: ▪ Service and maintain heat exchangers ▪ Construct simple condensers and evaporator ▪ Find condenser/evaporator made from copper tubing ▪ Practice pipe flaring, swaging, soldering and welding

	General Objective: 4.0 Understand the function of the liquid receiver and the service valve, and where they are used. Year 2, Term 2&3					
49-60	4.1 Explain the purpose of the liquid receiver and service valve 4.2 Explain different types of service valves and their applications (stem, schroderetc) 4.3 Explain the use and functions of other flow equipment e.g., solenoid valve, site glass e. t. c.	Explain activities 4.1 to 4.3	▪ Trainer unit ▪ Markers ▪ Whiteboard ▪ Different types of liquid receivers ▪ Solenoid valves ▪ Site glass ▪ Service valves	4.1Operate the liquid receiver service valve, i.e. ▪ Crack ▪ front seat ▪ back seat 4.2 Pump down the system e.g. front seat the service valve and run the compressor until pressure is a little above atmospheric pressure	Demonstrate activities 4.1 and 4.2 for the student and ask them to practice.	▪ Questions and Answers ▪ Written tests End of module examination

PROGRAMME: NATIONAL TECHNICAL CERTIFICATE IN REFRIGERATION AND AIR-CONDITIONING		
Course: CAR 15 – LOAD ESTIMATING	**Course Code: CAR 15**	**Duration: 60 Hours**
Module Specification: PRACTICAL/KNOWLEDGE REQUIREMENTS		

General Objective: On completion of this module the student will be able to:

1.0:Know how toEstimate the total load of a cold store
2.0: Know how toCalculate heat load and apply it in the selection of appropriate unit and commercial air-conditioning
3.0: Understand the specific heat of different types of insulting materials.

Practical Competence: On completion of this module, the student will be able to

Understand how to, calculate and select the appropriate material for refrigeration and air-conditioning unit.

PROGRAMME: NATIONAL TECHNICAL CERTIFICATE IN REFRIGERATION & AIRCONDITIONING WORK						
Course: CAR 15 – LOAD ESTIMATING	**Course Code: CAR 15**	**Contact Hours 1–1**				
Course Specification: General Objective 1.0: know how to Estimate the total load of a cold store. Year 1, Term 1						
WEEK	**Theoretical Content**			**Practical Content**		
	Specific Learning Outcome:	**Teachers Activities**	**Resources**	**Specific Learning Outcome**	**Teachers Activities**	**Evaluation**
1-12	1.1 Explain the total load of a cold store 1.2 Calculate the heat load and use it in selecting an appropriate unit for domestic and industrial air-conditioning unit 1.3 Calculate: a. Heat leakage using the formulae b. A x K factor x T.D (K is conductivity factor considering	▪ Solve problems using given formulae. ▪ Select appropriate unit for a cold room with manufacturer's catalogue for use.	▪ White board ▪ Markers ▪ Charts and tables			▪ Ask the students to: ▪ Solve problems using given formulae

	Insulation thickness and type of material) Where A = Area c. K = KC = Conductivity factor d. T.D. = Temperature Difference Product load using the formulae mass x specific heat x T.D. e. Service load; Add 10-25% of the heat leakage load depending on the use of the cold store. f. Miscellaneous Load: Add heat equivalent of wattages of bulbs, fans and all electrical appliances inside the cold store g. Add 5-10% safety factor					
	General Objective 2.0: Know heat load and apply it in the selection of appropriate unit and commercial air-conditioning. Year 1, Term 2&3					
13-36	2.1 Calculate Load Source **External** a. Roof = A x q x CL/TD (Cooling heat temperature differences) b. Walls = 4 = A x q x Cl/TD c. Conduction = q = A x U x CL/TD Where q = Heat conductivity A = Area U = Heat transfer	▪ Solve problems using given formulae ▪ Select suitable units based on their load estimation	▪ Markers ▪ Whiteboards ▪ Charts and tables			▪ Questions and Answers ▪ Written TestsEnd of Module examinatio n ▪ Ask the students to: ▪ Solve problems

	CL/TD = Temperature Difference d. Solar Base on Tables and conditions prevailing e. Partitions ceiling and floors q = A x U x T.D. Internal f. Lights (a) Ventilation and Infiltration Air-Sensible Latent (Manufacturers) ATA 2.2 Select suitable unit for a domestic and commercial air conditioning systems based on total heat arrived at in 2.1 above plus the adjustment factor a. People (i) Sensible (ii) Latent b. Appliances (i) Sensible (ii) Latent					using given formulae ▪ Select suitable units based on their load estimation
	General Objective 3.0: Understand the specific heat of different types of insulting materials. Year 2, Term 1					
37-48	3.1 Define insulation and insulation materials 3.2 State different types of insulation materials 3.3Explain specific heat of each insulation materials mention above. 3.4 State the application of each insulation materialsmentions above	Discuss the activities in 3.1 to 3.4.	▪ Insulation materials ▪ Chart ▪ Videos ▪ Models	▪ Identify different types of insulation materials	▪ Guide the student to Identify different types of insulation materials	▪ Asses student

PROGRAMME: NATIONAL TECHNICAL CERTIFICATE IN REFRIGERATION AND AIR-CONDITIONING		
Course: CAR 16 – REFRIGERANT FLOW CONTROLS	**Course Code : CAR 16**	**Duration: 96Hours**
Module Specification: PRACTICAL/KNOWLEDGE REQUIREMENTS		

General Objective: On completion of this module the student will be able to:

1.0 Understand the principles of operation of types of refrigerant controls and their functions

2.0 Understand how to Carry out Installation of controls, their adjustment and repairs where necessary**.**

3.0 Understand the Principles of Operational, Regulatory and Safety Control.

Practical Competence: On completion of this module, the student will be able to

1. Identify the controls within the system
2. Install different controls in any system
3. Detect faults in refrigerant controls
4. Service, repair and test refrigerant control
5. Carry out procedure for installation of controls (bearing in mind safety of persons and equipment)
6. Install the appropriate sizes of refrigerant controls for all systems.
7. Adjust the following controls:
    a. thermostatic expansion valve
    b. automatic expansion valve

8. Diagnose fault in refrigerant controls:
    a. thermostatic expansion valve
    b. low side float valve
    c. high side float valve and effect repairs.

9. Install auxiliary valves such as check valves, hand valves, etc.

PROGRAMME: NATIONAL TECHNICAL CERTIFICATE IN REFRIGERATION AND AIRCONDITIONING WORK						
Course: CAR16REFRIGERANT FLOW CONTROLS		**Course Code: CAR 16**		**Contact Hours: 1-2**		
Course Specification: General Objective 1.0: Understand the principles of operation of types of refrigerant controls and their functions.						
WEEK	**Theoretical Content**			**Practical Content**		
	Specific Learning Outcome	**Teachers Activities**	**Resources**	**Specific Learning Outcome**	**Teacher's Activities**	**Evaluation**
1-12	1.1 Explain the operating principles of different types of refrigerant flow controls and their functions. 1.2. List the classes of the controls and their location in the system 1.3 Explain the following refrigerant controls: a. capillary tube b. thermostatic expansion valve c. low side float valve d. high side float valve e. automatic expansion valve f. hand expansion valve g. float switch h. Thermoelectric expansion valve. 1.4 Explain the functions of the controls listed in 1.2 above 1.5 Explain the construction of the controls	• Discussthe activities in 1.1 to 1.5 • Draw the schematic diagram of each type of refrigerant flow control and discuss	▪ Capillary tube ▪ TEV ▪ Low side float valve ▪ High side float valve AEV, ▪ Thermo electric expansion valve ▪ Float switch ▪ Videos ▪ Charts	1.1 Locate the controls within the system 1.2 Install different controls in any system 1.3 Detect faults in refrigerant controls 1.4 Service, repair and test refrigerant control.	Demonstrate activities 1.1 to 1.4 for the student and ask them to practice	▪ Ask the students to: ▪ Draw and explain each of these controls. ▪ Confirm understanding using appropriate questions ▪ Demonstrate application of controls

	General Objective: 2.0 Carry out Installation of controls, their adjustment and repairs where necessary.					
13-24	2.1 Explain procedures for installation of controls 2.2 Explain the basic principles of installation of refrigerant controls. 2.3 Explain installation auxiliary valves such as check valves, hand valves, etc.	▪ Help students to locate these controls ▪ Describe the functions of the controls ▪ Describe the basic principles of installation of refrigerant controls. ▪ Describe installation auxiliary valves such as check valves, hand valves, etc.	▪ Capillary tube ▪ TEV ▪ Low side float valve ▪ High side float valve AEV, ▪ Thermo electric expansion valve ▪ Float switch ▪ Videos Charts	2.1 Carry out procedure for installation of controls (bearing in mind safety of persons and equipment) 2.2 Install the appropriate sizes of refrigerant controls for all systems. 2.3 Adjust the following controls: a. thermostatic expansion valve b. automatic expansion valve 2.4 Diagnose fault in refrigerant controls: a. thermostatic expansion valve b. low side float valve c. high side float valve and effect repairs. 2.5 Install auxiliary	Demonstrate activities 2.1 to 2.5 explain the functions of each control for the student and ask them to practice	▪ Ask the students to: ▪ locate these controls ▪ Explain the functions of each control

				valves such as check valves, hand valves, etc.		
General Objective: 3.0 Understand the Principles of Operational, Regulatory and Safety Control.						
25-36	3.1 Explain the classification of controls a. Operating e.g. thermostat b. Regulating e.g. metering device c. Safety e.g. fusible plug. 3.2 Explain the functions of the followings a. Thermal limiter b. Superheat switch c. Low pressure cut out d. Water control valve 3.3 State the application of the classes of controls.	▪ Show, draw and describe each of the controls in 3.1 and 3.3	▪ White board ▪ Video ▪ Thermal limiter ▪ Super heat switch ▪ Low pressure cut out ▪ High pressure cut out ▪ Water control valve	▪ Classification of controls a. Operating e.g. thermostat b. Regulating e.g. metering device c. Safety e.g. fusible plug	▪ Guide the student to Classify the controls a. Operating e.g. thermostat b. Regulating e.g. metering device c. Safety e.g. fusible plug	Ask the students to show, draw and explain each of the controls in Operating e.g. thermostat, Regulating e.g. metering device and Safety e.g. fusible plug.

PROGRAMME: NATIONAL TECHNICAL CERTIFICATE IN REFRIGERATION AND AIR-CONDITIONING		
Course CAR 17 – INSTALLATION & INSULATION OF PIPES AND DUCTS	**Course Code: CAR 17**	**Duration: 72 Hours**
Module Specification: PRACTICAL/KNOWLEDGE REQUIREMENTS		

General Objective: On completion of this module the student will be able to:

1.0: Undertake installation of pipes and ducts for air-conditioning and refrigeration system
2.0: Understand the Properties of Insulating Material
3.0: know how to Insulate pipes, walls and ducts

Practical Competence: On completion of this module, the student will be able to

1.1 Carry out Installation & insulation of pipes and duct for a particular job
1.2 Know necessary materials from specifications to carry out Installation & insulation of pipes and duct
1.3 Interpret installation drawings of pipes and ducts for air-conditioning
1.4 Perform the following activities

a. Bend pipes to specification required using bending machines and springs.
b. Cut pipes to length using a pipe cutter
c. Flaring and swaging
d. Install the piping system with the aid of piping diagrams.
e. Select insulating materials for temperatures
f. Fix insulation materials to pipes, walls of ducts using adhesives, insulation tapes, etc.
g. Maintain insulation of air conditioning and refrigeration

PROGRAMME: NATIONAL TECHNICAL CERTIFICATE IN REFRIGERATION & AIRCONDITIONING WORK						
Course: CAR 17 – INSTALLATION & INSULATION OF PIPES AND DUCTS			**Course Code: CAR 17**		**Contact Hours: 1-2**	
Course Specification: General Objective 1.0: Undertake installation of pipes and ducts for air-conditioning and refrigeration system						
WEEK	**Theoretical Content**			**Practical Content**		
	Specific Learning Outcome:	**Teachers Activities**	**Resources**	**Specific Learning Outcome**	**Teacher's Activities**	**Evaluation**
	1.1 List types of insulating materials and	▪ Drawings of pipes and ducts for air-conditioning and				

1-12	explain the purpose of insulation to pipes and ducts in refrigeration and air conditioning system. 1.2 State the properties of good insulating materials 1.3 Explain installation drawings of pipes and ducts for air-conditioning 1.4 Explain tools and equipment used for pipe and duct installation. 1.5 List necessary materials for installation with specifications 1.6 Explain the need for cleanliness and safety measures 1.7 Describe pipe-cutting operations	refrigeration system. ▪ Draw the tools and equipment to be used and describe their uses. ▪ Describe precautionary measures to be taken while installing pipes and ducts ▪ Describe types of tools used in pipecutting operations ▪ Describe different methods of pipecutting operations ▪ Describe process of pipe bending using different methods	▪ Sample drawing ▪ markers ▪ Whiteboard ▪ Refrigeration ▪ Tool box ▪ Pipes & Ducting materials ▪ Pipes benders ▪ Pipe fittings flooring ▪ Swaging tools ▪ Insulation material	1.1 Carry out activities for a particular job 1.2 List necessary materials from specifications thereafter carry out simple installation from same specifications (Ensure stores/materials are available before embarking on the work) 1.3 Design simple installation & insulation of pipes and ducts 1.4 Identify types of pipes used in refrigeration and air-conditioning 1.5 Select pipes using diameter as parameter 1.6 Select pipes base on functionality 1.7 Show how to connect different pipes in refrigeration system	Demonstrate activities 1.1 to 1.7 for the student and guide them to perform the activity.	▪ Ask the students to: ▪ Show and interpret drawings of pipes and ducts for air-conditioning and refrigeration system. ▪ Show and draw the tools and equipment to be used and describe their uses. ▪ Describe precautionary measures to be taken while installing pipes and ducts

13-24	**General Objective 2.0: Understand the Properties of Insulating Material**					
	2.1 Explain the purpose of insulation to pipes and ducts used in air conditioning and refrigeration (lagging) 2.2 List types of insulating materials used in air-conditioning and refrigeration. 2.3 State the properties of insulating materials listed in item 2.1 above	▪ Show and describe insulating materials for pipes and ducts. ▪ Describe types of insulating materials used in air-conditioning and refrigeration. ▪ Describe the properties of insulating materials listed in item 2.1 above	▪ Samples of insulating and duct materials	Identify types of insulating materials used in air-conditioning and refrigeration.	Guide the student to identify types of insulating materials used in air-conditioning and refrigeration	▪ Ask the students to: ▪ Show and explain insulating materials for pipes and ducts.
	General Objective 3.0: Understand how to insulate pipes, walls and ducts					

	3.1 Explain the following activities: a. Bend pipes to specification required using bending machines and springs. b. Cut pipes to length using a pipe cutter c. Flaring and swaging d. Install the piping system with the aid of piping diagram. e. Select insulating materials for temperatures f. fix insulation materials to pipes, walls of ducts using adhesives, insulation tapes, etc. g. Maintain insulation to airconditionin g and refrigeration.	Discuss activities in 3.1	▪ types of insulation materials ▪ Scissors ▪ Evostic, adhesive tape, etc ▪ Accessories ▪ Copper pipes ▪ Flaring tools ▪ Sand paper etc ▪ Bending machines ▪ Spring bender ▪ Swagging tools	3.1 Demonstrate the following activities a. Bend pipes to specification required using bending machines and springs. b. Cut pipes to length using a pipe cutter c. Flaring and swaging d. Install the piping system with the aid of piping diagram. e. Select insulating materials for temperatures f. fix insulation materials to pipes, walls of ducts using adhesives, insulation tapes, etc. g. Maintain insulation to airconditioning and refrigeration	Demonstrate for the student to learn and guide them to perform the activities in 3.1	▪ Ask student to explain activities in 3.1 ▪ Questions and Answers ▪ Written tests End of Module examination.

PROGRAMME: NATIONAL TECHNICAL CERTIFICATE IN REFRIGERATION AND AIR-CONDITIONING		
Course: : CAR 18 – ABSORPTION SYSTEM	**Course Code: CAR 18**	**Duration: 36 Hours**
Module Specification: PRACTICAL/KNOWLEDGE REQUIREMENTS		

General Objective: On completion of this module the student will be able to:

1 Understand the working Principles of an absorption System, the components and the three cycles of operation of the Elements
2 Understand how to Diagnose and rectify faults within the absorption system
3 Understand how to Install and maintain absorption system

Practical Competence: On completion of this module, the student will be able to

3.1 Perform troubleshooting and fault-finding practices on absorption unit such as condenser generator.
3.2 Replace the heating element
3.3 Carry out installation and maintenance of absorption unit
3.4 Demonstrate how to clean the generator condenser's absorbent unit

PROGRAMME: NATIONAL TECHNICAL CERTIFICATE IN REFRIGERATION & AIRCONDITIONING WORK		
Course: CAR 18 – ABSORPTION SYSTEM	**Course Code: CAR 18**	**Contact Hours: 1-2**

Course Specification: General Objective 1.0: Understand the working Principles of an absorption System, the components and the three cycles of operation of the Elements

WEEK	Theoretical Content			Practical Content		
	Specific Learning Outcome:	**Teachers Activities**	**Resources**	**Specific Learning Outcome**	**Teacher's Activities**	**Evaluation**
1-9	1.1 Explain the working principles of an absorption system, its components and the cycles of operation of its elements 1.2 List the types of absorption systems and identify the components of an absorption system 1.3 Explain the working principles of an absorption system in refrigeration. 1.4 Explain types of Absorption systems in common use 1.5 Explain components of absorption refrigeration system – generator, condenser, rectifier, evaporator, absorber, control and their functions in the systems. 1.6 Explain the three cycles of operation of the elements: • Water (H2O) • Hydrogen (H) • ammonia. (NH3)	Discuss the activities in 1.1 to 1.11	▪ Whiteboard ▪ Wall Charts ▪ Absorption Unit ▪ Videos ▪ Charts ▪ Models ▪ Ammonia ▪ Hydrogen	1.1 Identify the components of absorption refrigeration system – generator, condenser, rectifier, evaporator, absorber, control and their functions in the systems 1.2 Identify working principles of an absorption system in refrigeration.	Demonstrate the activities in 1.1 to 1.3 for the student to learn and guide them to carry out the activities	▪ Ask the students to: ▪ With the aids of diagrams, explain the working principles of absorption systems ▪ Compare different types of absorber/refrigerant combinations ▪ Compare the efficiencies of absorption and vapour compressor cycles

	1.7 Explain with the aid of schematic drawings of continuous absorption through: a. Generator b. Absorber c. Evaporator d. Condenser e. Solution pump 1.8 Explain efficiency between absorption and vapour compression cycle 1.9 Explain energy consumption of absorption system 1.10 Explain procurement of materials 1.11 Explain estimation of installation costs			1.3 Identify with the aid of schematic drawings of continuous absorption through: a. Generator b. Absorber c. Evaporator d. Condenser e. Solution pump		

10	**General Objective: 2.0 Understand how to Diagnose and rectify faults within the absorption system**					
	2.1 Explain how to locate the position of an absorption unit in a room 2.2 Explain how to install the unit and fix the switch and glass on the tank 2..3 Explain how to service and maintain an absorption unit	Explain activities in 2.1 to 2.3	▪ Absorption Unit ▪ Blowers ▪ Brushes ▪ Heating Element, etc. ▪ Videos ▪ Charts ▪ Models ▪ Kerosine	2.1 Perform troubleshooting and fault-finding practices on absorption unit such as condenser generator. 2.2 Replace the heating element	Demonstrate the activities in 2.1 and 2.2 for the student to learn and guide them to carry out the activities	Ask student to trouble shoot and replace the heating element
11-12	**General Objective: 3.0 Understand how to Install and maintain absorption system**					
	3.1 Explain how to install and maintain absorption system 3.2 Explain how to clean the generator condenser's absorbent unit	Explain activities in 3.1 to 3.2	• Glass • Weak • Kerosine • Iron brush	3.1 Carry out installation and maintenance of absorption unit 3.2 Demonstrate how to clean the generator condenser's absorbent unit	Demonstrate the activities in 3.1 and 3.2 for the student to learn and guide them to carry out the activities	▪ Questions and Answers ▪ Written Tests ▪ End of Module Examination

PROGRAMME: NATIONAL TECHNICAL CERTIFICATE IN REFRIGERATION AND AIR-CONDITIONING		
Course: : CAR 19 – REFRIGERATION WORK	**Course Code: CAR 19**	**Contact Hours: 1 hours Theory HOURS Practical**
Module Specification: PRACTICAL/KNOWLEDGE REQUIREMENTS		

General Objective: On completion of this module the student will be able to:

1. Understand the Working Principles of Refrigeration Equipment in the Food Industry
2. Understand how to Install, commission and maintain a Refrigeration System
3. Understand how to Diagnose faults in Refrigeration Equipment/System and rectify them.

PROGRAMME: NATIONAL TECHNICAL CERTIFICATE IN REFRIGERATION & AIRCONDITIONING WORK						
Course: CAR 19 – REFRIGERATION WORK			**Course Code: CAR 19**	**Contact Hours** 36 – 1hr/wk (1-0)		
Course Specification: Theoretical Content				**Practical Content**		
WEEK	**General Objective: 1.0 Understand the Working Principles of Refrigeration Equipment in the Food Industry**					
	Specific Learning Objectives	**Teachers Activities**	**Learning Resources**	**Specific Learning Objectives**	**Teachers Activities**	**Evaluation**
1-8	1.1 Explain the working principles of each type of refrigerating equipment in the food industry 1.2 Describe the functions of the main component parts 1.3 Explain the working principles of types of refrigerating equipment listed in item 1.1 above. 1.4 Explain the function of the main component/parts, e.g., non-return valve (NRV) magnetic valves, pressure-regulating valve, of the refrigeration system.	Discuss 1.1 to 1.4	▪ Solenoid valve ▪ Tool box ▪ Models ▪ Chart ▪ Whiteboard ▪ Commercial Refrigeration training unit ▪ Ice plant ▪ Magnetic Valve ▪ Non-Return Valve, etc.	1.1 Identify, describe and state the application of the types of refrigeration equipment used in the food industry 1.2 Identify and state the application of the types of refrigeration equipment used in food industry, freezers – sharp, blast, immersion soda fountains, beverage coolers, etc.	Guide the student to perform activities 1.1 and 1.2	Ask the students to use diagrams to illustrate the operations of these components e.g., non-return valves, magnetic valves, etc.
	General Objective: 2.0 Understand how to Install, commission and maintain a Refrigeration System					
	Explain how to; 2.1 Be able to interpret the layout diagrams of the system 2.2 Install and commission the equipment as well as maintain same with ease and confidence 2.3 Trouble shoot, service, repair and test the equipment or component parts thereof using appropriate tools and test equipment	Discuss 2.1 to 2.9	▪ Layout diagram ▪ Whiteboard ▪ Refrigeration Training unit ▪ Log sheets ▪ Excursion ▪ Refrigerant ▪ Gauge set ▪ Complete tool box etc. ▪ Videos	Demonstrate 2.1 to 2.9	Guide the student on how to carry out 2.1 to 2.9	Asses student

	2.4 apply all relevant safety precautions while effecting repairs 2.5 Prepare and interpret log sheet for the system 2.6 Interpret the layout diagram and detailed specifications of the refrigeration equipment 2.7 Install and commission the machine 2.8 Maintain refrigeration equipment with facility 2.9 Clean the condensers and defrost the evaporators Interpret the colour coding for refrigerant used in the refrigeration equipment.		▪ Charts			
	General Objective: 3.0 Understand how to Diagnose faults in Refrigeration Equipment/System and rectify them.					
17-24	Explain how to: 3.1 Trouble shoot faults in a refrigeration equipment/system by: a. testing b. recognizing symptoms such as shortage of refrigerants in the system, air in the system, condenser, water too hot, etc. 3.2 Remove, dismantle, re-assemble and install faulty components in a refrigeration system. 3.3 Diagnose and rectify faults in a refrigeration system	Discuss 3.1 to 3.5	• Tool box • Refrigerant test meter • Multimeter • PPE • Screw drivers • Soldering iron • Videos • Charts • Models • Manifold gauge	Demonstrate 3.1 to 3.5	Guide the student how to carry out 3.1 to 3.5	• Questions and Answer • Written Tests • End of module examination

	3.4 Apply all relevant safety precautions while effecting repairs to faults in a refrigeration system. 3.5 Prepare as well as interpret log sheet for the refrigeration system, temperature and pressure, etc.					

ADVANCED NATIONAL CERTIFICATE IN REFRIGERATION AND AIR-CONDITIONING

PROGRAMME: ADVANCED NATIONAL TECHNICAL CERTIFICATE IN REFRIGERATION AND AIR-CONDITIONING		
Course: : CAR 20 – BASIC AIRCONDITIONING PRINCIPLES	**Course Code: CAR 20**	**Duration: 48 Hours**
Module Specification: PRACTICAL/KNOWLEDGE REQUIREMENTS		

General Objective: On completion of this module the student will be able to:

1. Know the Basic Principles of Air-conditioning
2. Know the major parts of equipment in the air-conditioning circle
3. Understand the applications of air-conditioning systems

PROGRAMME: ADVANCED NATIONAL TECHNICAL CERTIFICATE IN REFRIGERATION & AIRCONDITIONING WORK						
Course: BASIC AIRCONDITIONING PRINCIPLES		**Course Code: CAR 20**			**Contact Hours: 2-0**	
Course Specification: Theoretical Content				**Practical Content**		
WEEK	**General Objective 1.0: Know the Basic Principles of Air-conditioning.**					
	Specific Learning Objectives	**Teachers Activities**	**Learning Resources**	**Specific Learning Objectives**	**Teachers Activities**	**Evaluation**
1-12	1.1. Explain the basic principles of an air conditioning system 1.2. List the of types air conditioning components and explaining functions as well as air condition process 1.3 Distinguish between the types 1.4 Define airconditioning 1.5 Explain Use a psychrometer 1.6 Explain Use psychrometric chart to determine the following: a. Relative humidity b. Dew point temperature c. Humidity ratio d. Enthalpy per Unit mass of air, etc. 1.7 Explain air-conditioning processes e.g. a. Humidification b. Dehumidification c. Heating and dehumidification, etc.	• Explain the activities in 1.1 to 1.3	• MotorizePsychrometers • Air velocitymeasuring instrument ▪ Whiteboard ▪ Psychrometric Charts.	1.1 Use correct instruction like psychrometer and psychrometric chart to determine relative humidity, dew point, humidity ratio, enthalpy, per unit mass of air etc 1.2 Carry out maintenance	• Guide the student to perform activities 1.1 and 1.2	▪ Ask the students to: ▪ Plot airconditioningprocesses on psychrometric chart ▪ Solve exercises. ▪ Asses students
	General Objective 2.0: Know the major parts of equipment in the air-conditioning circle.					
	Explain how to; 2.1 Identify the following components in the air cycle: a. Fan b. Supply ducts c. Supply outlets	▪ Explain the activities in 2.1 to 2.3	▪ Demonstration unit ▪ Transportation	2.10 Identify the following components in the air cycle: i. Fan j. Supply ducts k. Supply outlets	Guide the student to perform activities 2.1 to 2.3	Asses student

	d. Space to be conditioned e. Return outlet f. Return ducts g. Filter h. Heating chamber or cooling coil. 2.2 Sketch air conditioning cycle 2.3 Distinguish between window type, spilt, packaged, central air-condition, etc.			l. Space to be conditioned m. Return outlet n. Return ducts o. Filter p. Heating chamber or cooling coil. 2.11 Sketch air conditioning cycle 2.12 Distinguish between window type, spilt, packaged, central air-condition, etc.		
	General Objective 3.0: Understand the applications of air-conditioning systems					
	3.1 State application of air conditioning systems 3.2 Explain operational sequence of air conditioning systems 3.3 Explain different types of air conditioning systems	Explain the activities in 3.1 to 3.3	▪ Trainer unit ▪ Whiteboard ▪ Markers ▪ Video ▪ Chart	3.1 Identify application of air conditioning sequence systems 3.2 Identify operational of air conditioning systems 3.3 Explain different types of air conditioning systems	▪ Guide the student to perform the activities in 3.1 to 3.3	Asses student

PROGRAMME: ADVANCE NATIONAL TECHNICAL CERTIFICATE IN REFRIGERATION AND AIR-CONDITIONING		
Course: : CAR 21 – AUTOMOBILE AIRCONDITIONING	**Course Code: CAR 21**	**Duration: 48 Hours**
Module Specification: PRACTICAL/KNOWLEDGE REQUIREMENTS		

General Objective: On completion of this module the student will be able to:

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1. Understand the working Principles of a car air-conditioning system
2. Understand how to Diagnose and Rectify Faults in Airconditioning System in Car Makes: Peugeot, Toyota, Passat, Mercedes Benz, etc.
3. Understand how to Install new auto air conditioning unit
4. Understand how to Carry out routine maintenance

PROGRAMME: ADVANCED NATIONAL TECHNICAL CERTIFICATE IN REFRIGERATION & AIRCONDITIONING WORK						
Course: CAR 21 – AUTOMOBILE AIRCONDITIONING			**Course Code: CAR 21**		**Contact Hours: 2-2**	
Course Specification: Theoretical Content				**Practical Content**		
WEEK	**General Objective 1.0: Understand the working Principles of a car air-conditioning system**					
	Specific Learning Objectives	**Teachers Activities**	**Learning Resources**	**Specific Learning Objectives**	**Teachers Activities**	**Evaluation**
	1.1 Explain the working principles of a car air-conditioning system 1.2 List the components of the system as well as explaining their functions 1.3 Explain the necessary precautions to take when working on car AC.	Explain the activities 1.1. to 1.3.				Asses student
1-8	1.4 Principles of automobile Air-conditioning system 1.5 Explain the working principles of a car air-conditioning system 1.6 Explain the components of the unit such as: a. Compressor b. Condenser c. Liquid receiver/sight glass d. Evaporators/fan e. Refrigerant control (TEV) f. Thermostat (thermostatic switch) g. Relay 1.7 Define the function of each component of the system. 1.8 Define the operation of a car air-conditioning system	Explain the activities 1.4. to 1.8.	▪ Air-conditioned car ▪ Whiteboard ▪ Charts ▪ Liquid receiver ▪ Site glass ▪ Video ▪ TEV ▪ Thermostat ▪ Compressor ▪ Tool box	1.4 Demonstrate the working principles of a car air-conditioning system 1.5 Identify the components of the unit such as: h. Compressor i. Condenser j. Liquid receiver/sight glass k. Evaporators/fan l. Refrigerant control (TEV) m. Thermostat (thermostatic switch) n. Relay ▪	▪ Guide the student to perform activities 1.4and 1.5	▪ Ask the students to: ▪ Draw and explain the working principles of a car air-conditioning system ▪ Identify the components of a car air-conditioning system (in a car)

	General Objective: 2.0 Understand how to Diagnose and Rectify Faults in Airconditioning System in Car Makes: Peugeot, Toyota, Passat, Mercedes Benz, etc.					
9-16	2.1 Explain how to Diagnose any fault in an automobile Air-Conditioning system and rectifying same 2.2 Explain the correct tools and equipment to use 2.4 Explain how discharging, purging, evaluating and charging the system 2.5 Explain how to install and testing a new car air condition system in a car 2.6 Explain how carrying out a routine maintenance 2.7 Explain how to Diagnose faults such as: a. shortage of gas b. blockage of air-filter c. faulty evaporator/condenser fans d. faulty compressor e. leakage of gas hose/tube, etc. 2.8Explain how to Rectify faults such as: a. shortage of gas (topping up or complete charge) b. cleaning the filter c. replacing the	Describe the activities 2.1 to 2.8.	▪ Faulty air-conditioned car ▪ Gauge sets ▪ Ratchet sets ▪ R-134a ▪ Lubricating oil ▪ sight glass ▪ leak detector ▪ tool box ▪ charts ▪ video	2.1 Explain how to diagnose any fault in an automobile Air-Conditioning system and rectifying same 2.2 Explain the correct tools and equipment to use 2.3 Explain discharging, purging, evaluating and charging the system 2.4 Explain installing and testing a new air condition system in a car 2.5 Explain how carrying out a routine service 2.6 Diagnose faults such as: a. shortage of gas b. blockage of air-filter c. faulty evaporator/condenser fans d. faulty compressor e. leakage of gas hose/tube, etc. 2.7 Rectify faults such as: a. shortage of gas	Guide the student to perform activities 2.1 to 2.8 Emphasize the need for purging the system and evacuating it after repairs to leaks, replacement of components before charging it with refrigerant	Ask the students to draw and explain the functions of the components of a car air-conditioner

	compressor d. replacement of leaking hose, etc. 2.8 Explain how to Charge the unit with lubricating oil			(topping up or complete charge) b. clearing t he filter c. replacing the compressor d. replacement of leaking hose.\, etc. 2.8 Charge the unit with lubricating oil		
	General Objective: 3.0Understand how to Install new auto air conditioner unit					
17-20	3.1 Explain how to layout of the equipment within the car 3.2 Explain how to install the components. Connect the components together (compressor, condenser, receiver, and evaporator) 3.3 Explain how to wire the circuit 3.4 Explain how to pressure test the system 3.5 Explain how to vacuum the system 3.6 Explain how to charge the system 3.7 Explain how to carry out efficiency test on the system.	Explain the activities 3.1 to 3.7.	▪ All the components to be installed ▪ PPE ▪ Blue gum/Adhesive ▪ Protective clothing	3.1 Describe design the layout of the equipment within the car 3.2 Install the components. Connect the components together (compressor, condenser, receiver, and evaporator) 3.3 Wire the circuit 3.4 Pressure test the system 3.5 Vacuum the system 3.6 Charge the system 3.7 Carry out efficiency test on the system.	Guide the student to perform activities 3.1 to 3.7	▪ Asses student ▪ Ask the students to draw the wiring circuit of a car A/C
	General Objective: 4.0 CARRY OUT ROUTINE MAINTENANCE					
21-24	4.1 Explain the importance of routine service of air-conditioning and	▪ Explain the activities 4.1 to 4.3.	▪ Blowers ▪ Water pressure machine	4.1 Identify the importance of routine	Guide the student to perform	1. Ask the students to design a

	refrigeration systems. 4.2 Explain how to design a routine maintenance chart for use in the maintenance of air-conditioning and refrigeration system 4.3 Explain how to maintain the component of the system, e.g. a. Cleaning of condenser, filters, evaporator, etc. b. checking of joints for leaks c. check oil evaporator fan motor d. check and clear water drain pipe, and e. check the operation of the system		▪ Tool box ▪ Chart	maintenance to air-conditioning and refrigeration systems. 4.2 Design a routine maintenance chart for use in the maintenance of air-conditioning and refrigeration system 4.3 maintain the component of the system, e.g. a. Cleaning of condenser, filters, evaporator, etc. b. checking of joints for leaks c. check oil evaporator fan motor d. check and clear water drain pipe, and e. check the operation of the system	activities 4.1 to 4.3	routine service chart for air-conditioning and refrigeration systems. 2. Questions and Answers 3. Written tests 4. End of Module examination 5. Ask to carry out performance test and stabilize the system.

PROGRAMME: ADVANCE NATIONAL TECHNICAL CERTIFICATE IN REFRIGERATION AND AIR-CONDITIONING		
Course: : CAR 22 – INDUSTRIAL AIRCONDITIONING	**Course Code: CAR 22**	**Duration: 48 Hours**
Module Specification: PRACTICAL/KNOWLEDGE REQUIREMENTS		

General Objective: On completion of this module the student will be able to:

1. Understand the Principle of operation of the direct and indirect systems of Air-conditioning and the Installation of a Central Air-conditioning System
2. Understand how to Diagnose and rectify faults within the Systems
3. Understand Routine Service of the Central air-conditioning System
4. Understand how to Prepare a Log Sheet for a Plant

PROGRAMME: ADVANCED NATIONAL TECHNICAL CERTIFICATE IN REFRIGERATION & AIRCONDITIONING WORK						
Course: CAR 22 – INDUSTRIAL AIRCONDITIONING	**Course Code: CAR 22**			**Contact Hours: 2-2**		
Course Specification: Theoretical Content				**Practical Content**		
WEEK	**General Objective: 1.0 Understand the Principle of operation of the direct and indirect systems of Air-conditioning and the Installation of a Central Air-conditioning System.**					
	Specific Learning Objectives	**Teachers Activities**	**Learning Resources**	**Specific Learning Objectives**	**Teachers Activities**	**Evaluation**
1-8	1.1 Explain the principles of operation of both direct and indirect systems of air-conditioning 1.2 Explain the function of each component of the system 1.6 Explain the layout diagram of air-conditioning systems, e.g., direct and indirect systems diagrams and electrical circuit.	Explain the activities 1.1 to 1.3	▪ Demonstration unit ▪ Models ▪ Video ▪ Electrical panels ▪ Cooling tower ▪ Anemometer ▪ Diffusers	1.1 Identify the different components of a central air-conditioning system and explain their functions 1.2 Read and interpret the layout diagram of an air conditioning system 1.3 Install and commission a central air-conditioning system. 1.4 Identify components in a central air-conditioning plant such as compressor, condenser, air handling unit, fan, coil unit, chiller and other auxiliary components like diffusers, ductings, electrical panel, thermostatic expansion valve, solenoid valve, Anemometer, cooling towers.	Guide the student to perform activities in 1.1 to 1.4	▪ Ask students to distinguish between direct and indirect systems using diagrams ▪ Ask students to Draw and explain the electrical circuit of a central air-conditioning unit (direct and indirect).

	General Objective: 2.0 Understand how to Diagnose and rectify faults within the Systems					
	Explain the following; 2.1 Install and commission a central air conditioning system 2.2 Accurately diagnose faults in the system and effect repairs with confidence 2.3 Effectively maintain the system and adjust the controls 2.4 Diagnose faults in the electrical circuit e.g., in electrical panel 2.5 Effect repairs on all types of faults, e.g., faulty compressor, motor open circuit, short circuit and single phasing. 2.5 Adjust time switches, thermostats, time delay relay and starter 2.6 Diagnose faults within refrigerant circuits, e.g a. low level of refrigerant b. incomplete charging faulty expansion valve c. erratic air-conditioning, etc. d. Rectify the faults listed in 2.4 above	Describe the activities 2.1 to 2.6.	▪ Tool box ▪ Chart ▪ Models	Demonstrate 2.1 to 2.6	Guide the student to perform activities 2.1 to 2.6	▪ Ask the students to demonstrate proper diagnostic procedure ▪ Ask the students to emphasize need for safety precautions ▪ Ensure some level of independence for trainee to induce confidence ▪ Assess the students

	General Objective: 3.0 Understand Routine maintenance of the Central air-conditioning System					
19-20	Explain how to; 3.1 Check oil in the compressor 3.2 Clean cooling towers and grease/oil cooling towers, fan motors, and pumps, air handling unit filters, and cooling coils. 3.3 Adjust fan belts.	Explain the activities 3.1 to 3.3	• Marker board • Demonstration unit of central Aircontioning unit model • Ananometer • Electric fan	Demonstrate; 3.1 Check oil in the compressor 3.2 Clean cooling towers and grease/oil cooling towers, fan motors, and pumps, air handling unit filters, and cooling coils. 3.3 Adjust fan belts.	Guide the student to perform activities 3.1 to 3.3	▪ Ask the students to demonstrate how to maintain log sheets
	General Objective: 4.0 Understand how to Prepare a Log Sheet for a Plant					
21-24	Explain how to; 4.1 Record running pressures, room temperatures, chilled water temperature, compressor oil pressure, etc. 4.2 Interpret log sheet when solving problems, e.g high head pressure on record indicates dirty condenser or shortage of water or air in the system, 4.3 Design log sheet to record all problem in 4.1 and 4.2	Discussthe activities 4.1 to 4.3	▪ Sample charts ▪ White board ▪ Video ▪ Log sheet	Demonstrate; 4.1 Record running pressures, room temperatures, chilled water temperature, compressor oil pressure, etc. 4.2 Interpret log sheet when solving problems, e.g., high head pressure on record indicates dirty condenser or shortage of water or air in the system, 4.3 Design log sheet to record all problem in 4.1 and 4.2	Guide the student to perform activities 4.1 to 4.3	▪ Questions and Answers ▪ Written tests End of module examination.

PROGRAMME: ADVANCED NATIONAL TECHNICAL CERTIFICATE IN REFRIGERATION AND AIR-CONDITIONING		
Course: : CAR 23 – ICE PLANT	**Course Code: CAR 23**	**Duration: 72 Hours**
Module Specification: PRACTICAL/KNOWLEDGE REQUIREMENTS		

General Objective: On completion of this module the student will be able to:

1. Understand the Principle of Operation of Ice making Machines, Install and Maintain them.
2. Understand the processes of ice manufacturing
3. Understand how to Trouble shoot faulty Ice-Making Machines and be able to repair the fault.

PROGRAMME: ADVANCED NATIONAL TECHNICAL CERTIFICATE IN REFRIGERATION & AIRCONDITIONING WORK						
Course: CAR 23 – ICE PLANT	**Course Code: CAR 23**		**Contact Hours 1-2**			
Course Specification: Theoretical Content				**Practical Content**		
WEEK	**General Outcome 1.0: Understand the Principle of Operation of Ice making Machines, Install and Maintain them.**					
	Specific Learning Objectives	**Teachers Activities**	**Learning Resources**	**Specific Learning Objectives**	**Teachers Activities**	**Evaluation**
1-8	1.1 Explain the working principles of ice making machine. 1.2 Explain the constructional features of ice making machine 1.3 State the type and their application of ice making machine 1.4 Explain the process of installation	Explain the activities 1.1 to 1.4	▪ Ice making machine training unit ▪ Tool box ▪ charts	1.1 Identify types of ice plant, tube, flake, plate, and block types 1.2 Effectively trace faults on ice plant 1.3 Repair or derive an ice plant or sub-assemblies 1.4 Select ice making machine for the making of type and size of ice required. 1.5 Installand maintain ice making machine	Guide the student to perform activities 1.1 to 1.5	▪ Asses the student

	General Objective: 2.0 Understand the processes of icemanufacturing					
9-10	Explain how to; 2.1 Identify types of ice tub, flake, fermenter ice, block ice, etc. 2.2 Explain the function of the agitators 2.3 Explain the process of ice production from start to finish (storage)	Explain the activities 2.1 to 2.3	▪ Faulty ice making Machine ▪ Set of spanners ▪ Rachet wrench ▪ Gauge set ▪ Charts ▪ Illustration board	2.1 Identify types of ice tub, flake, fermenter ice, block ice, etc. 2.2 Appreciate air agitation in the process of clear ice production 2.3 Appreciate the process of ice production from the raw material up to the harvest and storage stages	Guide the student to perform activities 2.1 to 2.3	▪ Ask the students to:
	General Objective: 3.0 Trouble shoot faulty Ice-Making Machines and be able to repair the fault.					
11-12	Explain how to; 3.1 Trouble shoot faults in ice-making plant and effect repairs 3.2 Remove from service, repair or replace the following: brine agitator, brine pump, can lift and grids, etc. 3.3 observe all safety measures on ice making machine	Discuss the activities 3.1 to 3.3	▪ Faulty ice making Machine ▪ Tool box ▪ Charts ▪ Gauge set	3.1 Trouble shoot faults in ice-making plant and effect repairs 3.2 Remove from service, repair or replace the following: brine agitator, brine pump, can lift and grids, etc. 3.3 observe all safety measures on ice making machine	Guide the student to perform activities 3.1 to 3.3	▪ Questions and Answers ▪ Written Tests ▪ End of Module examination.

PROGRAMME: ADVANCED NATIONAL TECHNICAL CERTIFICATE IN REFRIGERATION AND AIR-CONDITIONING		
Course: : CAR 24 – TRANSPORT REFRIGERATION	**Course Code: CAR 24**	**Duration: 72 Hours**
Module Specification: PRACTICAL/KNOWLEDGE REQUIREMENTS		

General Objective: On completion of this module the student will be able to:

1. Understand the Principles of Operation of Transport Refrigeration Equipment
2. Understand how to Install Common Brands of Transport Refrigeration Equipment
3. Understand how to Diagnose faults in Common Brands of Transport Refrigeration Equipment and Repair them
4. Understand how to Service Transport Refrigeration Equipment
5. Understand the Principles of Marine Refrigeration
6. Understand how to Diagnose and Rectify faults in Marine Refrigeration System
7. Understand how to Service Marine Refrigeration System

PROGRAMME: ADVANCED NATIONAL TECHNICAL CERTIFICATE IN REFRIGERATION & AIRCONDITIONING WORK						
Course: CAR 24 – TRANSPORT REFRIGERATION	**Course Code: CAR 24**	**Contact Hours 1-2**				
Course Specification: Theoretical Content				**Practical Content**		
WEEK	**General Objective 1.0: Understand the Principles of Operation of Transport Refrigeration Equipment**					
	Specific Learning Objectives	**Teachers Activities**	**Learning Resources**	**Specific Learning Objectives**	**Teachers Activities**	**Evaluation**
1-6	Explain how to; 1.1 Identifying the types and working principles of transport refrigeration equipment as used in aeroplanes, trains, marine vessels, trucks etc. 1.2. Identify the components within the system as well as explaining their functions 1.3 Identify types and working principles of transport refrigeration equipment used in aeroplane, train, marine, vessels, trucks, etc. 1.4 Identify component within the system. 1.5 Function of each component. 1.6 Sketch the essential parts of the equipment.	Explain how to; 1.1 Identify and describe the types and working principles of transport refrigeration equipment as used in aeroplanes, trains, marine vessels trucks etc 1.2. Identify the components within the system as well as explaining their functions 1.3 Identify types and working principles of transport refrigeration equipment used in aeroplane, train, marine, vessels, trucks, etc. 1.4 Identify component within the system. 1.5 Explain the function of each component. 1.6 Sketch the essential parts of the equipment.	▪ Transport refrigeration equipment of aeroplane, train, truck, marine, vessels, etc. ▪ Excursion and field trips	1.1 Identifying and describing the types and working principles of transport refrigeration equipment as used in aeroplanes, trains, marine vessels trucks etc 1.2. Identify the components within the system as well as explaining their functions 1.3 Identify types and working principles of transport refrigeration equipment used in aeroplane, train, marine, vessels, trucks, etc. 1.4 Identify component within the system. 1.5 Sketch the essential parts of the equipment	Guide the student to perform activities 1.1 to 1.5	▪ Ask the students to: ▪ Itemize the major differences between a normal refrigeration system and transport refrigeration system ▪ Identify the components of a transport refrigeration system in aeroplane, train, marine vessels, trucks etc.
	General Objective: 2.0 Install and Commission Common Brands of Transport Refrigeration Equipment.					
7-10	Explain how to; 2.1 Interpret the layout of any	Discuss 2.1 to 2.9	▪ Layout diagram	2.1 Interpret the layout of any transport refrigeration	Guide the student to perform	▪ Ask the students to

	transport refrigeration system 2.2 Install and commission any of the equipment 2.3 Maintain and repair any of the equipment 2.4 Test and certify any of the equipment or a component sub assembly 2.4 Interpret the layout diagram of a transport refrigeration for trucks, aeroplane, trains, etc. 2.5 Install the equipment – connect compressors condenser, diesel engine, etc. 2.6 Wire the circuit 2.7 Pressure tests the system 2.8 Pull vacuum and charge the system 2.9 Commission the system.		▪ Compressors ▪ Condenser ▪ Diesel engine, etc. ▪ Vacuum pump ▪ Gauge set ▪ Tool box	2.2 Install and commission any of the equipment 2.3 Service and repair any of the equipment 2.4 Test and certify any of the equipment or a component sub assembly 2.4 Interpret the layout diagram of a transport refrigeration for trucks, aeroplane, trains, etc. 2.5 Install the equipment – connect compressors condenser, diesel engine, etc. 2.6 Wire the circuit 2.7 Pressure tests the system 2.8 Pull vacuum and charge the system 2.9 Commission the system	activities 2.1 to 2.9	sketch and interpret the layout diagram of a transport refrigeration system
	General Objective: 3.0 Understand how to Diagnose faults in Common Brands of Transport Refrigeration Equipment and Repair them.					
11-12	Explain how to; 3.1 Locate and amend points of leakage using electronic or halide leak detector 3.2 Top up the system using correct refrigerant 3.3 Adjust control in the system, fan belt, speed control, etc. 3.4 Start the diesel engine and repair simple faults.	Discuss activities 3.1 to 3.4	▪ Faulty air-condition ▪ Test equipment ▪ Tool box ▪ Protective clothing etc. ▪ Leak detector ▪ refrigerant	▪ Amend points of leakage using electronic or halide leak detector ▪ Top up the system using correct refrigerant ▪ Adjust control in the system, fan belt, speed control, etc.	Guide the student to perform activities 3.1 to 3.4	Asses students

	General Objective: 4.0 Service Transport Refrigeration Equipment.					
13-15	Explain how to; 4.1 Interchange the power supply where necessary from AC to DC and vice versa. 4.2 Bleed the diesel injector 4.3 Defrost the system i.e., hot gas bye pass 4.4 Clean and top up diesel engine with oil and the radiator with water.	▪ Explain 4.1 to 4.4	▪ Complete diesel engine ▪ A. C Coupling ▪ Model charts	4.1 Interchange the power supply where necessary from AC to DC and vice versa. 4.2 Bleed the diesel injector 4.3 Defrost the system i.e., hot gas. 4.4 Clean and top up diesel engine with oil and the radiator with water.	Guide the student to perform activities 4.1 to 4.4	▪ Ask the students to intercharge the power supply from AC to DC and vice Versa
16-19	**General Objective: 5.0 Understand the Principles of Marine Refrigeration**					
	5.1 Explain the principles of operation of marine refrigeration system 5.2 Explain the function of each component of the system listed in 5.1 above 5.3 Explain installation instruction and be able to install marine refrigeration system in a vessel.	▪ Discuss 5.1 to 5.3	▪ Marine refrigeration training unit. ▪ Smart board ▪ Complete tool box. ▪ Excursion or field trip	On excursion; 5.1 Identify essential parts of the plant equipment, viz: compressor, marine condenser, evaporator ice making unit, drinking water cooler, expansion valve, condenser, water regulating valve, temperature control switches, driers, strainers, motor and controls. 5.2 Install marine refrigeration system in a vessel.	Guide the student to perform activities 5.1 to 5.2 in excursion.	Ask the students to embark on an excursion to witness transport equipment.
	General Objective: 6.0 Understand how to Diagnose and Rectify faults in Marine Refrigeration System.					

20-21	Explain; how to; 6.1 Diagnose faults in the system, i.e., shortage of refrigerant, faulty expansion/regulating valves. 6.2 Effect repairs on all types of faults; faulty compressor motor. 6.3 Explain how to adjust control switches, expansion valves, regulating valves.	Describe 6.1 to 6.3	▪ Vacuum pump ▪ Gauge set ▪ Tool box ▪ Expansion valve ▪ Regulating valve ▪ Leak detector ▪ Refrigerant ▪ Chart ▪ Model	Accompany the students for excursion to identify; 6.1 Diagnose faults in the system, i.e., shortage of refrigerant, faulty expansion/regulating valves. 6.2 Effect repairs on all types of faults; faulty compressor motor. 6.3 Adjust control switches, expansion valves, regulating valves.	Guide the student to perform activities 6.1 to 6.3 in the excursion.	Asses students
22-24	**General Objective 7.0: Understand how to Service Marine Refrigeration System**					
	Explain how to: 7.1 Ensure that all the refrigeration controls are in good condition 7.2 Check the oil level of the compressor 7.3 Clear the condenser with suitable chemical i.e., marine condenser 7.4 Observe all safety precaution as regards the handling of ammonia refrigerant (high pressure and gas leakage), etc.	Discuss 7.1 to 7.4	• Guage manifold • Tool box • Leak detector • Condenser washing chemical • Fin stretcher • Refrigerant • Compressor oil	Accompany the students for excursion; 7.1 Ensure that all the refrigeration controls are in good condion 7.2 Check the oil level of the compressor 7.3 Clear the condenser with suitable chemical i.e., marine condenser 7.4 Observe all safety precaution as regards the handling of ammonia refrigerant (high pressure and gas leakage), etc.	Guide the student to perform activities 7.1 to 7.4 in the excursion.	• Questions and Answers • Written tests • End of module examination.

PROGRAMME: ADVANCED NATIONAL TECHNICAL CERTIFICATE IN REFRIGERATION AND AIR-CONDITIONING		
Course: : CAR 25 – COLD STORE INSTALLATION & MAINTENANCE	**Course Code: CAR 25**	**Duration: 36**
Module Specification: PRACTICAL/KNOWLEDGE REQUIREMENTS		

General Objective: On completion of this module the student will be able to:

1. Understand the working Principles of a Cold Store
2. Understand the design blue-print and installation of the cold store
3. Understand how to Maintain a cold store in good working condition

PROGRAMME: ADVANCED NATIONAL TECHNICAL CERTIFICATE IN REFRIGERATION & AIRCONDITIONING WORK						
Course: CAR 25– COLD STORE INSTALLATION & MAINTENANCE			**Course Code: CAR 25**	**Contact Hours: 1-2**		
Course Specification: Theoretical Content						
WEEK	**General Objective 1.0: Understand the working Principles of a Cold Store**					
	Specific Learning Outcome:	**Teachers Activities**	**Resources**	**Specific Learning Outcome:**	**Student Activities**	**Evaluation**
1-12	1.1 Explaincold room and list the main component 1.2 Explain the function of main component of cold store. 1.3 Explain the main parts and application of cold store	▪ Explain the activities in 1.1 to 1.3	▪ Sample blue print of the cold store ▪ Charts ▪ Whiteboard ▪ Models ▪ Thermostat ▪ Time daily relay ▪ Starter delay	1.1 Identify the function of main component of cold store. 1.2 Demonstrate principles of a cold store. 1.3 Demonstrate the main features and application of cold store	Guide the student to perform activities in 1.1 to 1.3	▪ Asses students

	General Objective:2.0. Understand the design blue-print and installation of the cold store

	2.1 Explain design blue-prints of a cold store 2.2 Explain condensing unit foundation 2.3 Explain concrete using cement, sand, gravel mixture	Explain the activities in 2.1 to 2.3	▪ Sample blue print ▪ Charts ▪ Whiteboard ▪ Models ▪ Thermostat ▪ Time relay ▪ Starter	2.7 Interpret design blue-prints of a cold store a. survey site for proper location of components for efficient operation; b. construct condensing unit foundation processes: c. prepare concrete using cement, sand, gravel mixture d. fix wood concrete form work and pour concrete e. mark center of bolts with white washed sticks before the mixture sets.	Guide the student to perform activities in 2.1.	▪ Ask the students to: ▪ Use diagram to expla working inciples cold sto ▪ Give sectiona drawing a sampl cold roo and explain compon s ▪ Give th electrica wiring diagram a cold room ar explain `

13-24	**General Objective:3.0 Maintain a cold store in good working condition.**					
	2.1 Explain faults within electrical circuits e.g., electrical panel and effect repairs to faults e.g., faulty compressor motor, open circuit, short circuit, single phasing, adjust time switch thermostat, time delay relay and starter. 2.2 Explain faults within refrigeration cyclic and effect repairs 2.3 Explain how to check oil level in compressor and tension belts correctly (open type) 2.4 Explain how to clean and straighten condenser fins	▪ Explain faults in cold store in 2.1 to 2.4	▪ Gauge set ▪ Sucket set ▪ Amprobe ▪ Multi-tester ▪ Screw drivers, etc.	2.1 Diagnose faults within electrical circuits e.g., electrical panel and effect repairs to faults e.g., faulty compressor motor, open circuit, short circuit, single phasing (ii) adjust time switch thermostat, time delay relay and starter. 2.2 Diagnose faults within refrigerant circuit and effect repairs, e.g. a. topping up until there is no bubbles on sight glass at correct temperature b. complete charging of the system so that system cuts in and out at correct temperatures. c. avoid erratic refrigeration so that TEV do not defrost and frost at intervals. 2.3 Check oil level in compressor or and tension belts correctly (open type) Clean and straighten condenser fins	Guide the student to perform activities in 2.1 to 2.3	▪ Assess student

LIST OF TOOLS AND EQUIPMENT

S/NO	TOOLS AND EQUIPMENT	MINIMUM QUANTITY REQUIRED	QUANTITY AVAILABLE	ADDITIONAL QUANTITY REQUIRED
GENERAL TOOLS (HAND)				
1	Set of screw drivers	5 sets		
2	Set of spanners	5 sets		
3	Set of pliers	5 sets		
4	Set of hammers	5 sets		
5	Tool box	5 sets		
GENERAL METAL CUTTING TOOLS				
1	Anvil	3		
2	Rula	3		
3	Flashlight	3		
4	Extension cord/light	4		
5	Portable electric (cord type and cordless type)	2		
6	Hole saw different size			
7	Levels different size			
8	Tap and die	5 Sets		
9	Allen keys	5 sets		
10	Toque wrench	5 sets		
11	Electric drilling (heavy duty)	3		
12	Metal snip	5 set		
SPECIALIZED TOOLS				
1	Flare nut wrenches	5		
2	Wirring and cripping tools	5		
3	Assorted nut drivers	3 sets		
4	Inspection mirrors	5		
5	Fin straitening tools	5		

6	Blowers diff sizes	3		
7	Water pressure machine	1		
8	Seal tools	3		
9	Ring removers	2		
10	Pulley bearing assembly	2		
11	Pressure testing connection	3		
12	Snap ring pliers	3		
13	Cylinder alignment tool	5		
TUBING TOOLS				
1	Tube cutters	5		
2	Inner and outer rimmers	5		
3	Flaring tools	5 sets		
4	Swaging tools (puch and lever type)	10		
5	Tube benders (spring and level type) elbow, T-joints	5		
6	Tube brushes (wire type)	5		
7	Plastic tubing shears	4		
8	Hacksaw (junior and senior)	5		
9	Pinch off tools (different types)	5		
10	Tube piecing valve diff size	5		
11	Pipe fittings diff size (soldered/flared)	5		
SOLDERING/BRAZING EQUIPMENT				
1	Oxy-acetylene welding /soldering equipment	2 sets		
2	Air-acelylene unit	2 sets		
3	Soldering gun	5		
4	Propane gas torch	5		
MEASURING /TESTING EQUIPMENT				
1	Pressure gauge (Mani Ford, Barometer, Manometer) digital	5		
2	Programmed charging meter	3		
3	Electronic thermistor	2		
4	Vacuum gauge	3		

5	Leak detector (halide, electronic, fluorescent, due ultra sound)	2 each		
6	Thermometers (diff type)	3		
7	Sling psychrometer	3		
8	Motorize psychrometer (anemometer)	3		
9	Air velocity measuring instrument	3		
10	Multimeter (amprobic volt-ohns, digital/analog) diff type	3		
11	Calorimeter	3		
12	Refrigerant identifier	2		
13	Time delay relay starter	4		
14	Tachometer	3		
CHARGING/RECOVERY TOOL AND EQUIPMENT				
1	Vacuum pump (Digital)	3		
2	Graduated charging cylinder	3		
3	Oil charging pump	3		
4	Recovery cylinder	2		
5	Refrigerant (diff types)	4 cylinder each		
6	Electronic scale	2		
7	Recovery /recycle station	2		
REGULATORS / SAFETY DEVICES				
1	Thermostatic expansion valve (TEV)	5		
2	Automatic expansion valve (AEV)	5		
3	Low-side float valve	5		
4	High-side float valve	5		
5	Thermo-electric expansion valve	5		
6	Thermal limiter	5		
7	Super heat switch	5		
8	Low pressure valve	5		
9	High pressure valve	5		
10	Water control valve	5		
11	Solenoid valve	5		

REFRIGERATION AND AIR-CONDITION COMPONENT				
1	Compressor (diff types)	5 each		
2	Condenser (diff types)	5 each		
3	Evaporator (diff types)	5 each		
4	Liquid receivers (diff types)	5 each		
5	Sight glass (diff types)	10 each		
TRAINING UNITS				
1	Absorption training unit (model)	5		
2	Vapour compressor training unit	5		
3	Ice making machine training (model)	5		
4	Cold store training units (model)	2		
5	Transportation refrigeration training unit(model)	2		
6	Aeroplan refrigeration training model	1		
7	Train refrigeration training (model)	1		
8	Truct refrigeration training unit (model)	1		
9	Marine refrigeration training unit (model)	1		
10	Vessel refrigeration training unit (model)	1		
12	Automobile Airconditioning training unit (model)	2		
MATERIALS				
1	Copper tubes (diff sizes)	15 roll for each		
2	Flux powder (diff types)	5 tins each		
3	Oxygen/acetylene cylinder set/gases and trolley	5 sets		
4	Lubrication oil (diff types)e.g mineral & Alka benzene oil	2 cartons each		
5	Nitrogen gas	10		
6	Fillers (soldering/brazing)	100 stuck each		
7	Masking tapes	20		
8	Sand papers	20		
9	Armoflex tube (diff sizes)	50		
10	Display diagram (diff types)	many		

11	Sample drawing (diff types)	2		
12	White board	2		
13	Smart board	2		

RECOMMENDED TEXTBOOKS

1. Principles of refrigeration – Roy J. Dossat
2. Refrigeration and air-conditioning technology – Whiteman Johnson Tomczyk
3. Modern refrigeration and air conditioning – Althousc Turnquist Bracciano
4. Textbook of refrigeration and air-conditioning - R. S Khurmi & J. K Gupta
5. Electricity and controls for HVAC/R – Stephen L. &Bermie L. Sparkman
6. The motivate series, refrigeration and air-conditioning Technology – N. Coota

NOTE; Latest edition of the books

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