Refrigeration and Airconditioning Work - National Technical Certificate (NTC) and Advanced National Technical Certificate (ANTC)

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

National Board for Technical Education, Kaduna

NATIONAL TECHNICAL CERTIFICATE AND ADVANCED NATIONAL TECHNICAL CERTIFICATE PROGRAMMES

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Foreword

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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 TRADE THEORY, 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.

Curriculum Table (NTC)

COURSE: MOTOR VEHICLE MECHANICS WORK

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
CAR 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	Prin. Of Refrig.	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	72
CAR 12	Comp. Motor & Gen.	1	2	1	2	1	2	1	2	1	1	0	2	0	2	1	1	0	2	264
CAR 13	Charg. Of Ref. 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	Ref & Aircond.	1	2	1	1	1	2	0	0	0	0	0	0	0	0	0	0	0	0	96
CAR 17	Installation & Insulation	1	2	1	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	72
CAR 18	Absorption Sytem	1	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	36
CAR19	Ref. 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

Curriculum Table (ANTC)

ADVANCED NATIONAL TECH. CERTIFICATE IN REFRIGERATION AND AIR CONDITIONING WORK.

S/N	MODULE CODE	MODULE TITLE	ONE YEAR						
			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 Air-conditioning Princ.	2	0	0	2	0	0	48
7	CAR 21	Automobile aircondi.	2	0	0	2	0	0	48
8	CAR 22	Industrial Aircond.	2	0	2	0	0	0	48
9	CAR 23	ICE Plant	1	2	0	2	1	0	72
10	CAR 24	Transport Refrigeration	1	2	0	2	1	0	72
11	CAR 25	Refrigeration Work	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

General Metal Work I

PROGRAMME: NATIONAL TECHNICAL CERTIFICATE IN REFRIGERATION AND AIR-CONDITIONING		
Course: General metal Work I	Course Code: CME 11	Contact Hours: 1 hours Theory 2 HOURS Practical
Module Specification: PRACTICAL/KNOWLEDGE REQUIREMENTS		

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

1. Understand workshop safety rules and their application in machine shop.
2. Know the physical properties, manufacturing process and application of ferrous and non-ferrous metals in common use
3. Select and use common measuring, marking out, cutting and striking tools.
4. Understand the basic working principles of drilling machine and be able to use it for various types of screws treads rivets, and be able to rivet and cut screws by hand.
5. Understand the application of various types of screw threads and rivets, and be able to rivet and cut screws by hand.
6. Understand the ISO system of tolerances and fits their application in engineering production.
7. Produce simple engineering components on the bench.
8. Understand the essential features and working principles of the center, lathe and carry out basic operations such as turning, step turning facing, taper turning., knurling, chamfering and undercutting.

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

1. Use all tools correctly ensuring the machinery guards and protective eye shields are used at all times.
2. Comply with the general rules for safe practice in the work environment at all this.
3. Use and select hand tools for carrying out various bench fitting and assembly tasks
4. Tools: hacksaws, taps, reamers, drills, dividers, surface gauge
5. Produce threads using taps and dies
6. Correctly grind drill point angles: Drills: Twist and flat drills
7. Select and set drilling machine speeds to carryout a range of operations using the appropriate coolants. Drilling, reaming, counter sinking, counterboring
8. Perform metal joining by a range of processes. Cut through the joints and investigate the depth of penetration of the metals at the interface. Processes: Soldering, brazing, and fusion welding.
9. Mark out on metals and other materials, datum lines, angles, radii/circles and hole positions using a range of tools.

PRACTICAL TASKS

	General Objective 1.0: On completion of the following practical task, the trainee will demonstrate the following abilities:		
Week	**Learning Outcome**	**Teachers Activities**	**Resources**
1-3	1.1 Using and handling hand tools, portable power tools and machine 1.2 Lifting, moving and storing materials or job 1.3 Demonstrate first aid application in cases of minor cuts, electric shock, burns. Assess the students	• Demonstrate safe ways of handling basic hand tools • Show a film on industrial safety • Demonstrate how to treat energy cases like artificial respiration cold compress, etc • Assess the student	• Hand tools files, hacksaw • Television, Video machines • Posters on artificial respiration
	General Objective 2.0: Measuring, Marking, cutting and striking		
Week	**Learning Outcome**	**Teachers Activities**	**Resources**
4-6	2.1 Describe the essential features and use of the following a. micrometer b. vernier calliper c. Venier height gauge d. combination set 2.2 Maintain and care for the instruments listed above 2.3 Perform marking out exercise on plane surfaces including profiles 2.4 File a piece of metal to given specifications using any of the following: Cross filing, draw filing, filing square and flat surfaces 2.5 Test surface for flatness using surface plate and try square and state precautions to be taken to avoid pinning 2.6 Maintain files in good working conditions 2.7 Apply various hammers and mallets e.g ball pein, rubber mallets, etc for engineering purposes 2.8 Select and insert hacksaw blade correctly	• Demonstrate how to use micrometer, venier caliper, vernier height gauge, combination set • Demonstrate the maintenance and care of the instruments listed above • Perform marking out for the students to learn and practise till they become competent • Demonstrate how flat surface can be tested using surface plate and try square • Demonstrate how files are cleaned and state the precautions to be taken against pinning. Students to practice till competent • Demonstate the application of hammers and mallets for engineering purposes • Demonstrate how a hacksaw blade can be	• Micrometer, vernier calipers, vernier height gauge, combination sets • Steel rules, dividers, punches, trammel, scribe angle plate, vee block center square • Flat file, hand file, engineers square, tray square • File card, flat file • Ball pein hammers, mallet • Hacksaw blade, Hack saw frame

	2.9 Cut metal and other engineering materials to given specification using the adjustable hacksaws, junior hacksaws, piercing saw, etc drills and Drilling.	inserted correctly • Demonstrate how to use adjustable • hacksaw, junior hacksaw piercing • Students should be allowed to practice till competent • Assess the student • Guide the students to select appropriate cutting tools and set them up to center height for lathe work (turning or facing)	

	General Objective 3.0 Machine Tools		
Week	**Learning Outcome**	**Teachers Activities**	**Resources**
7-9	3.1 Setting up and operate a drilling machine in given situations **Note** Setting up drilling machine should include a. change of spindle speed b. adjustment of drilling table to required height and angle, holding of work on drilling table to required height and angle, using clamping devise c. Install up the drill bit in chuck 3.2 Sharpen a twist drill correctly to manufactures' specification 3.3 Perform with facility the following operations: a. drilling blind holes b. drilling round stock c. counterboring and counter-sink d. drilling large diameter holes 3.4 List the operation sequence and cut internal (through and blind) and external threads by hand method and state precautions to be taken when taping on the bench 3.5 Rivet metals together in any given situations 3.6 Mark out only given bench work using datum points, datum lines, datum faces, chalk or marking solution center or dot, punch, scribing block or measurement transfer. Assess the students.	• Demonstrate how to set up and operate a drilling machine in given situation • Students to practice till competent • Demonstrate how a twist drill can be sharpened correctly • Demonstrate with the appropriate facility how to perform all the drilling operations • Students to practice till they become competent • Give notes as well as demonstrate the operation sequence in cutting internal (through and blind) and external threads by hand method • Demonstrate how riveting can be done and let the students practice same till they become competent • Demonstrate the marking out procedures on bench working using datum lines datum faces, etc • Students to practice till they become competent • Assess the students.	• Bench drill pillar drill, drill bits • Bench drill, pillar drill, twist drill, flat drill, counter sink drill, counterbore drill, center drill • Drills, taps, tap wrench, die and die stock • Rivets and sets of drill bits • Surface table, surface plate, marking solution, center/dot punches, scribing block

	General Objective 4.0 Lathe and Lathework		
Week	**Learning Outcome**	**Teachers Activities**	**Resources**
10-12	4.1 Sharpen cutting tool for plain turning, shouldering, parting off and facing operations 4.2 Set up rough and turned stock in 3-jaw-chuck 4.3 Select appropriate cutting tool and set them up to center height for turning or facing operations 4.4 Carryout chuck work involving facing, step turning, undercutting radiusing, chamfering, parting off and knuring **Note** Components should be produced to specified tolerance and finish 4.5 Produce simple components involving taper turning using the compound slide	• Guide the students to sharpen cutting tool for plain turning shouldering, parting off and facing operations and allow students to practice till competent • Demonstrate how to set-up rough and turned stock in a 3-jaw-chuck and operate lathe. Allow students to practice till competent • Guide students to produce simple engineering components like open ended spanner, engineers square, tool makers clamp, center square, etc. • Make a simple precision fitting project like hexagonal mild steel bar making push fit through a mild steel plate • Students should be allowed to practice till they become competent • Prepare simple exercises that will guide students to produce components involving taper turning using the compound slide. Assess the students	• Point tools, grinding machine, lathe machine • 3-jaw chuck and lathe machine • Point tools lathe machine • Lathe machine and accessories • Centre lathe and accessories like catch plate, face plate, dog lathe, lathe centers fixed steady and traveling steading • Round nose turning tool, fine finishing tool, form tool, parting off tool, boring tool, bar of good length and 4mm diameter, Live/dead centers catch plates • Standard exercises or prepared
	Assessment profile: Practical to take 60% of the overall assessment		

PROGRAMME: NATIONAL TECHNICAL CERTIFICATE IN REFRIGERATION AND AIR-CONDITIONING			
Course: General Metal Work I		Course Code: CME 11	Contact Hours 7hrs/wk
Course Specification: Knowledge Requirement			
	General Objective 1.0: understand workshop safety rules and application in machine shop		
Week	Specific Learning Outcome	Teachers Activities	Resources
	1.1 State sources of harzards in the workshop and how to prevent them. e.g a. handling and using hand tools, portable power tools and machines; b. steppint on or striking obstructions left on floors or benches; c. lifting, moving and storing materials or jobs; d. using inflammable or corrosive liquids and gases; e. inhaling vapours or fumes; 1.2 Explain the application of factory safety regulations in the machine shop. 1.3 Name safety equipment and wears essential in the machine shop, and state their application in working situations. Note: Example of safety wears and equipment should include overall, eye goggles, gloves, safety boots, helmet, fire extinguishers, etc	• State sources of hazards in the workshop. • Through questions and answer, determine whether the students grasped the topic • Show a film on industrial safety. • Through question and answer determine comprehension. • Demonstrate how to treat emergency cases like artifical respiration, cold compress etc. • List the safety equipment and wears that are essential in the workshop. • Give detail notes and explanation in each topic a-g. • Use questions and answer to determine comprehension. • Assess the students	• Safety posters, common hard tools like files hacksaw • Television, Video machine. • Overall, goggles, gloves, hardshoes, head shield, fire extinguishers.

PROGRAMME: NATIONAL TECHNICAL CERTIFICATE IN REFRIGERATION AND AIR-CONDITIONING			
Course: General Metal Work I		Course Code: CME 11	Contact Hours 7hrs/wk
Course Specification: Knowledge Requirement			
	General Objective 1.0: understand workshop safety rules and application in machine shop		
Week	Specific Learning Outcome	Teachers Activities	Resources
	1.4 Outline safety rules and regulations relating to:- a. clothing and health hazards; b. workshop hygiene; c. movement and other behaviour of workers in the workshops; d. materials handling; e. too handling, storage and usage; f. machine operation; g. fire protection. 1.5 Understand appropriate procedures in the events of a workshop accident	• Give detail notes and explanation on appropriate procedures to be taken in the event of workshop accident • Give detail notes and explanations to explain the meaning of the following general physical properties of metals: ductility, malleability, strength, toughness, brittleness, elasticity, plasticity. Assess the students	
	General Objective 2.0 Know the physical properties, manufacturing process and application of ferrous and non-ferrous metals in common use		
Week	Specific Learning Outcome	Teachers Activities	Resources
2	2.1 Examples of procedures may include: a. application of first aid to the victim; b. removal or rectification of the accident; c. reporting the accident to the appropriate authority; d. keeping a record of accidents for management use. Ferrous and Non-Ferrous Metals 2.2 Explain the meaning of the following general physical properties of metals:- ductility, malleability, strength, toughness, brittleness, elasticity, plasticity.	• Give detailed notes and explanations for the topics in 2.0	•

PROGRAMME: NATIONAL TECHNICAL CERTIFICATE IN REFRIGERATION AND AIR-CONDITIONING			
Course: General Metal Work I		Course Code: CME 11	Contact Hours 7hrs/wk
Course Specification: Knowledge Requirement			
	General Objective 2.0 Know the physical properties, manufacturing process and application of ferrous and non-ferrous metals in common use		
Week	Specific Learning Outcome	Teachers Activities	Resources
	2.3 Describe the basic composition and properties of plain carbon steels, cast iron and alloy steel and state their application in the engineering industry. Note: Specific examples of tools and equipment made from the various steel and cast iron should be mentioned. Examples of steels and cast irons should include: plain carbon steels, dead mild steels, mild steel, medium carbon steel, high carbon steel. Cast Irons - gray cast iron malleable cast iron, alloy cast irons (spheroidal and acicular) Alloy Steels - High speed steels, high tensile steels, tungeten, carbide, stainless steels, stellite 2.4 Outline: a. the copla process of manufacture of cast iron; b. the blast furnace process of manufacture of pig iron;	• Give notes and specific examples of tools and equipment made from the various steels and cast iron. • Examples of steels and cast irons should include plain carbon steels dead mild steels, mild steel, medium carbon steel high carbon steel, gray cast iron, malleable cast iron, alloy cast iron high speed steels, high tensile steels tungsten, carbide, stainless steels • Give notes and explanation on the cupola process, the blast furnace and the direct reduction process of manufacture of steel. • This can be preceded by film show and a visit to be manufacturing plant. • Give detail notes and explanations describing the physical properties and applications of the following non-ferrous metals: copper, tin, zinc, aluminium, aluminium alloys, brass, (muntzmetal, cartridge brass gilding metal) etc. bronze, manganese bronze bell metal, aluminium bronze phosphor bronze and lead. Assess the students	• Video and television including cassettes on production processes.

	c. the direct reduction process of manufacture of steel. Note: A visit to a steel manufacturing plant is recommended. 2.5 Describe the physical properties and applications of non-ferrous metals below: copper, tin, zinc, aluminium and aluminium alloys brass (muntz metal, cartridge brass, gilding etc) metal,bronze (manganese bronze tunmetal, bell metal, aluminium bronze, phosphor bronze and lead.		

PROGRAMME: NATIONAL TECHNICAL CERTIFICATE IN REFRIGERATION AND AIR-CONDITIONING			
Course: General Metal Work I		Course Code: CME 11	Contact Hours 7hrs/wk
Course Specification: Knowledge Requirement			
Week	Specific Learning Outcome	Teachers Activities	Resources
	General Objective 3.0 Select and use common measuring, marking out, cutting and striking tools.		
3	3.1 Explain with examples the difference between "line" and "end" measurement. 3.2 Explain the use of datum points, datum lines and datum faces in marking out. 3.3 Describe, the functions and application of the following instruments used in metal-work, steel rule, dividers, calipers (inside, outside and odd-legs), trammel, scriber angle plate, vee-block, centre square. 3.4 Describe the various types of files, stating their grades and applications. Note: Types of files should include: flat, square, round, half round, three square, warding pollar, mill and rasp. 3.5 Classify the common files use in metal work and state their composition of material used for their manufacture. 3.6 Sketch the bench vice, explain its clamping power and demonstrate the technique of holding work in the vise for filing,, tapping and designing operations. 3.7 Describe the functions of the various parts of a bench vice, its holding power while performing various operations on its, such as filing, tapping sawing etc. 3.8 Prepare detail notes that will describe the functions of the various parts of a bench vice, its holding power while performing various operations.	• Prepare notes that will clearly differentiate between"line" and "end" measurement. • Prepare notes and examples that will explain the useof datum points, datum lines, and datum faces in marking out. • Demostrate detail notes and explanations regarding the functions and application of: steel rule, dividers, calipers (inside, outside and oddleg) trammel, scriber, angle plate, vee block, centre square • Prepare notes that will describe the various types of files • stating their grades and applications. By type it means: flat, • square round, half round, three square, warding, mill and • rasp. • Prepare detail notes that will classify the common files used • in the metal work as well as stafing the composition of • materials used for their manufacture. • Assess the students	• Steel rule, divides calipers, trammel, scribe angle plate vee block, centre square. • Micrometer vernier callipers vernier height gauge combination set • Flat file, hard file, round file square, half round, triangular warding, mill file, rasp file. • Flat file, handfile engineers square. • Surface plate try square (engineers square) • File card • Flat file • Bench vice.

	3.9 Show a bench vice and demonstrate the technique of holding work in the vice for filing, tapping and designing operations. 3.10 State the safety precautions to be observed when using a hand hacksaw 3.11 Describe and use the following tools: a. cold chisels (flat, cross, cut half round, diamond-point) b. centre punch and dot punch c. scrappers (flat, triangular, half round) d. power hack saw		

PROGRAMME: NATIONAL TECHNICAL CERTIFICATE IN REFRIGERATION AND AIR-CONDITIONING			
Course: General Metal Work I		**Course Code: CME 11**	**Contact Hours 7hrs/wk**
Course Specification: Knowledge Requirement			
Week	**Specific Learning Outcome**	**Teachers Activities**	**Resources**
	General Objective 3.0 Select and use common measuring, marking out, cutting and striking tools.		
4	3.12 Describe the various parts of a hack saw and their function. 3.13 Describe the common types of hacksaw blades, their range of pitches and their applications.	• Show a bench vice and demonstrate the work in the vice for filing, tapping and designing operations • Prepare detail notes that will describe the functions of the various parts of a bench vice, its holding power while performing various operations • Assess the students • Prepare detail notes and demonstrations that will describe and uses of: cold chisels, centre punch dot punch, scrapers and power hacksaw. • Prepare notes that will describe the various parts of a hacksaw and their functions. • Show sample of hacksaw blades as well as prepare notes that will describe the common types of hacksaw blades, their range of pitches and their applications. • Prepare notes that will show correct way of inserting • blades. • Prepare detail notes and explanation, stating the safety • precautions to be observed when using a hand hacksaw. • Prepare notes that will describe the uses of various hacksaws. Assess the students	• Bench vice. • Ball pein hammers mallets. • Cold chisels, centre punches, dot punch, scrapers power hacksaw blades. • Hacksaw blade • Hacksaw frame • Adjustable hacksaw junior hacksaw piercing saw. • Bench drill • Pillar drill.

PROGRAMME: NATIONAL TECHNICAL CERTIFICATE IN REFRIGERATION AND AIR-CONDITIONING			
Course: General Metal Work I		Course Code: CME 11	Contact Hours 7hrs/wk
Course Specification: Knowledge Requirement			
	General Objective 4.0: Understand the working principles of a drilling machine, use it to drill and ream holes on metals and other engineering materials.		
Week	Specific Learning Outcome	Teachers Activities	Resources
5-6	4.1 Identify the various types of drilling machines. 4.2 Describe, with sketches, the main features of a bench or pillar drilling machine. 4.4 Describe with sketches and state where each of the following types of drills are best suited. e.g. twist drill (taper shank, parallel shank and jobbers drill, and their relative merits), flat drill, countersink drill, counter bore drill, combination centre drill. 4.5 Explain the effects of the following faults in a ground twist drill bit: a. point angle too acute; b. point angle too abtuse; c. cutting edges at uneual angles; d. insufficient lip clearance; e. excessive lip clearance. 4.6 Calculate spindle revolution or cutting speed for specified size of drill using the formulae:- N = 1000S/πd S = πdN/1000 Where S = cutting speed (m/min) N = revolution/minute D = diameter of drill	• Prepare detailed notes and demonstrations that will describe and uses of the following: cold chisels, center punch, dot punch, scrapers, and power saw. • Prepare notes that will describe the various parts of hacksaw and their functions • Show samples of hacksaw blades as well as notes that will describe the common range of pitches of the hacksaw blade ad their applications • Show different types of drilling machines • Make notes and drawings that will identify the various types of drilling m/cs. • Prepare detail notes and drawings that will describe the main features of a bench or pillar drilling machine. • Solve many problems for students to practise. • Prepare notes and drawings that will describe where each of the following drills are best suited • Twist drill (taper shank, parallel shank, jobber drill and their relative merits), flat drill, counterbore drill and combination center drill. • Assess the students.	• List drill, flat drill counter sink drill, counter bore drill combination centre drill. • Ball pein hammers, mallet, cold chisels, dot/center punches, hacksaw and hacksaw blades • Drilling machines and its accessories.

	(mm) π = 3.142 4.8 State the cause and remedy of drilling faults such as:- a. drill breaking; b. drill coloured blue; c. walls of drilled hole left rough; d. chipped cutting lips. 4.9 State the safety precautions to be observed when using a drilling machine. 4.10 Explain the purpose of reaming and describe different types of hand and machine reamers. 4.11 Ream to given specification by hand and machine method.		

PROGRAMME: NATIONAL TECHNICAL CERTIFICATE IN REFRIGERATION AND AIR-CONDITIONING			
Course: General Metal Work I		Course Code: CME 11	Contact Hours 7hrs/wk
Course Specification: Knowledge Requirement			
	General Objective 5.0: Understand the applications of various types of screw threads, rivet and cut screws by hand.		
Week	Specific Learning Outcome	Teachers Activities	Resources
7	5.1 Sketch the thread forms below and state their applications:- a. the ISO metric thread b. the unified thread c. Whitworth and British fine threads d. British Association (BA) thread e. British Standard pipe f. Square thread g. Acme thread h. Buttress thread. 5.2 Sketch and state the functions of:- a. taps (taper tap, second tap, plug) b. tap wrench c. die and die stock. 5.3 Explain the meaning of tapping size or tapping drill and estimate its value in given situations using formulae such as:- T = D - P Where T = tapping diameter D = thread top diameter P = pitch	• Give detailed notes with diagrams that will show the various forms of trade and their uses. • Prepare notes that will state the functions of taps, tap wrench, die and die stock. • Give detailed notes that will explain the meaning of tapping size or tapping drill and estimate its values using the formula: T = D - P Where T = tapping diameter D = thread top diameter and P = Pitch	• Diagrams/charts of thread forms • Parallel reamers taper reamers twist drills.
	5.4 State precautions to be taken when taping on the bench. 5.5 Describe and differentiate types of rivets. e.g. Snap and pan head, mushroom and counter-sunk head, flat head, dod rivet, etc. 5.6 Sketch the rivet set and state its use. 5.7 Calculate the diameter of rivet and riveting allowance in given situations.	• Prepare notes that will state recautions to be taken when tapping on bench. • Give notes and diagrams that will describe and differentiate types of rivets, rivet sets, and its uses and guide to calculate the diameter of rivet and riveting allowance. • Assess the students.	• Rivet sets, drills.

PROGRAMME: NATIONAL TECHNICAL CERTIFICATE IN REFRIGERATION AND AIR-CONDITIONING			
Course: General Metal Work I		Course Code: CME 11	Contact Hours 7hrs/wk
Course Specification: Knowledge Requirement			
	General Objective 6.0:Understand the ISO tolerances and fits and its application in engineering production.		
Week	Specific Learning Outcome	Teachers Activities	Resources
8	6.1 Differentiate between the following:- a. nominal siz b. limits (upper and lower) c. tolerance (unilateral and bilateral) d. fit (clearance, transition interference). 6.2 Explain the importance of tolerance and fit in engineering production and describe briefly the ISO system of limits and fits. 6.3 Determine by calculation the amount of tolerance and types of fit in given situations.	• Give detailed notes that will differentiate between nominal size, limits, tolerance and fits. • Prepare detailed note and diagrams that will explain the important of tolerance and fits in engineering production as well as describing the ISO systems of limits and fits. • Give notes and explanations that will guide in calculating the amount of tolerance and types of fits in given situations. • Assess the students.	• Charts on tolerances, limits and fits.
	General Objective 7.0 Produce simple Engineering Components on the bench. Production		
Week	Specific Learning Outcome	Teachers Activities	Resources
9	7.1 Explain layout procedures from working drawing of simple engineering components or tools such as:- a. open ended spanner b. engineer's try square c. tool maker's clamp d. plate bracket or gusset (involving rounds, angles, holes) e. centre square. 7.2 Explain how to produce any simple engineering component to given specifications including dimensions, tolerance and finish 7.3 Explain how to carry out simple precision fitting project. e.g. hexagonal mild steel bar making push fit through a mild steel plate.	• Teachers to prepare notes and explanations to guide the students in producing simple engineering components as in 7.1 • Assess the students.	• Lesson notes • Diagrams and charts.

PROGRAMME: NATIONAL TECHNICAL CERTIFICATE IN REFRIGERATION AND AIR-CONDITIONING			
Course: General Metal Work I		Course Code: CME 11	Contact Hours 7hrs/wk
Course Specification: Knowledge Requirement			
	General Objective 8.0: Understand the essential features and working principles of the centre lathe and use it to carry out basic operations such as plain turning, stepped turning, facing taper turning, chamfering, and under-cutting		
Week	Specific Learning Outcome	Teachers Activities	Resources
10	8.1 Describe the essential features of a centre lathe and state their functions e.g lathe bed, headstock, tailstock, saddle or carriage, etc. 8.2 Explain the working principles of the centre lathe. 8.3 Identify and state the functions of centre lathe accessories such as: catch or driving plate, face plate, lathe dog or carrier, lathe centres, fixed and travelling steadies. 8.4 Explain the difference between the centre lathe, capstan lathe, in terms, of their main features and functions. 8.5 Name types of cutting fluids used for lathe turning operations and state their composition and purposes. 8.6 Outline safety precautions to be observed when working on the lathe 8.7 Sketch and describe common tools: e.g butt-brazed tool, tipped tool, bit and holder. Note: Tool description should include tool materials e.g plain carbon steel, high speed steel, stellite, cemented carbide, diamond. 8.8 Explain with sketches the functions of tool angles rake, clearance, and state their values for different metals to be machined. 8.9 Differentiate between various tool shapes and state their uses e.g. Round nose rougher, fine finishing, side	• Prepare detailed notes that will describe the essential features of center lathe and their functions. • Give notes and diagrams that will explain the working principles of center lathe and functions of its accessories. • Give explanations that will show the difference between center lathe and capstan lathe in terms of their main features and functions. • Prepare notes that will list types of cutting fluid use for lathe turning operations and their composition and purposes. • Prepare detailed notes and explanation that will outlines safety precautions, common tools and materials used in marking them. • Give detailed notes and diagrams that will explain the functions of too angles (rake, clearance) stating their values for different metals to be machined. • Assess the students • Give notes and diagrams of various tool shapes and their uses. • Prepare detailed notes and explanations to cover 8.10 to 8.15	• Centre lathe and accessories like catch plates, face plates, centers, fixed and traveling steadies. • Charts of center lathe and capstan lathe. • Round nose turning tool, finishing tool, site finishing, knife tool, form tool, parting off tool, and boring tool. • Charts on tool height • Charts and diagrams of different machining operations.

	finishing, knife tool, form tool, parting off tool, boring tool, etc. 8.10 Explain with sketches the effects of wrong setting of cutting tool: e.g vibration and chatter, tool rubbing against or digging into the job. 8.11 Define cutting speed and feed with respect to lathe operation. 8.12 Calculate the cutting speed and feed for given turning operation.		
11-12	8.13 Estimate the rate of metal removal and time required for carrying out specified turning operations 8.14 State precautions to be observed when turning between centres. 8.15 Set up the lathe for and carry out basic turning operations between centres. 8.16 Compute required taper dimensions from given data using taper ratic angle formulae i.e. [d2 - d1]/L Taper Ratio = L OR $\frac{\text{Tan}\theta}{2} = \frac{\text{d2 - d1}}{2}$ where θ = taper angle d1 - small and diameter d2 = large end diameter L = length of taper	• Solve many problems for the students practise. • Assess the students	

General Metal Work II

COURSE:	GENERAL METAL WORK
MODULE:	CME 12 GENERAL METAL WORK II
PRE-REQUISITE:	CME 10
CONTACT HOUR:	5 HOURS/WEEK
GOAL:	The module is designed to introduce the trainee to basic processes in mechanical engineering such as forging, sheet-metal work and welding.

General Objectives

On completion of this module, the trainee should be able to:

1. Understand the basic principles and processes of heat treatment of metal in the workshop.

2. Produce simple engineering components by forging.

3. Understand the basic principles and techniques of gas and metal arc welding and apply them in fabricating simple metal components.

PRACTICAL COMPETENCE: On completion of this module students will be able to:

1. Carry out heat treatment of metal in the workshop
2. Produce simple engineering components by forging
3. Carryout gas/arc welding and apply them in fabricating simple engineering components

PRACTICAL TASKS

	General Objective: On completion of the following practical task, the trainee will demonstrate the following abilities:		
Week	**Specific Learning Outcome**	**Teachers Activities**	**Resources**
1-2	1.1 Carry out the following heat treat processes Hardening, tempering, annealing normalizing, case hardening on given plain carbon steel, engineering component or tool 1.2 Anneal copper, brass and aluminium for various purposes	• Demonstrate heat treatment processes and explain the stages • Demonstrate the annealing process on brass, copper and aluminium for various purposes. • Assess the students.	• Furnace, Forge tongs
3-4 5-8	1.3 Select appropriate forging tools and produced to specification given engineering components by forging processes a. upsetting - drawing down b. setting down - twisting c. forge welding (scarf and spice welds) d. bending, turning closed ring e. forming an eye	• Demonstrate with appropriate forging tools how to produce some engineering components and let the student practice till they become competent • Assess the students	• Anvil, swage block, leg vice, forging hammers, hot set, cold set, sets of hammers, punchers, drifts, fillers, top swage, bottom swage, flatter, open tongs, hallow bit
	General Objective 2.0: Welding Processes		
Week	**Specific Learning Outcome**	**Teachers Activities**	**Resources**
9-12	2.1 Set up and operate gas or metal arc welding equipment in given situations. Note: Equipment operation should include choice of correct nozzles or electrode. Adjustment for correct gas pressure/flame or voltage 2.2 Prepare joints for welding in given situations 2.3 Weld given components by arc or gas welding methods, and state safety precautions to be observed	• Demonstrate the use of both gas and metal welding equipment; and all the students to practice • Demonstrate to the students how to prepare joints for welding purposes • Guide students to weld various components using both gas and arc welding machines and state safety precautions to students to practise till competent	• Oxygen, cylinders, regulations arc, welding set goggles, shield, electrodes, diagrams and charts various welding joints
	Assessment: Practical - 60% of overall assessment		

PROGRAMME: NATIONAL TECHNICAL CERTIFICATE IN REFRIGERATION & AIR-CONDITIONING			
MODULE: GENERAL METAL WORK II		MODULE CODE: CME 12	CONTACT HOURS: 5hrs/wk
MODULE SPECIFICATION: KNOWLEDGE REQUIREMENTS			
	General Objective:1.0 Understand the basic principles and processes of heat treatment of metal in the workshop.		
Week	Specific Learning Outcome	Teacher Activities	Learning Resources
1-4	1.1 Explain briefly the structural behaviour of plain carbon steel as it is heated from room temperature to about 1000C for the purpose of. a. hardening b. tempering c. annealing d. normalising e. case-hardening. 1.2 Explain the meaning of hardening metal work. 1.3 Outline safety precautions relating to heat treatment processes apply them in given situations.	• Prepare detail notes that will explain the structural behaviour of plain carbon steel as it is heated from room temperature to about 1000• Prepare detail notes that will explain the meaning of hardening in metalwork. • Prepare notes that will outline safety precautions relating to heat treatment processes. • Assess the students	• Recommended Text books • Lesson notes, etc
	General Objective 2.0: Understand the techniques of producing simple engineering components by forging.		
Week	Specific Learning Outcome	Teacher Activities	Learning Resources
5-6 7-8	2.1 Explain with outline sketch the main features and working principles of the black smith's forge. 2.2 Describe and state the functions of common forging tools. e.g. anvil, swage block, leg vice, forging hammers, hot and cold sets, set hammer, punches and drifts, hardie, fullers, top and bottom swages flatter, tongs (open mouth, closed mouth, hollow bit, etc.). 2.3 Describe with sketches the following forging operations: a. upsetting b. drawing down c. setting down d. twisting e. forge welding (scarf and splice welds) f. bending g. forming closed ring h. - forming an eye.	• Prepare detail notes and diagrams that will explain the main features and working principles of the black smith's forge. • Prepare notes and diagrams that will describe the functions of common forging tools. • Prepare detail notes that will describe the following forging operations: upsetting, drawing down, setting down, twisting, forge welding, bending, forming closed ring, forming an eye. • Assess the students.	• Recommended Text books • Lesson notes, etc

PROGRAMME: NATIONAL TECHNICAL CERTIFICATE IN REFRIGERATION & AIR-CONDITIONING			
MODULE: GENERAL METAL WORK II		MODULE CODE: CME 12	CONTACT HOURS: 5hrs/wk
MODULE SPECIFICATION: KNOWLEDGE REQUIREMENTS			
	General Objective 3.0: Understand the basic principles and techniques of gas and metal are welding and apply them in fabricating simple metal components.		
Week	Specific Learning Outcome	Teacher Activities	Learning Resources
	3.1 Describe the equipment and explain the basic principles and application of gas and metal arc welding. 3.2 State the safety precautions to be observed and apply them in given welding situations. 3.3 Differentiate between various tool shapes and state their uses. e.g round nose rougher, fine finishing, side finishing, knife tool, form tool, parting off tool, boring tool, etc.	• Prepare detail notes and diagrams that will describe the equipment and explain the basic principles and application of gas and metal arc welding. • Prepare diagrams of joints that the students will practice. • Prepare detail notes that will state the safety precautions to be observed during welding. • Assess the students.	• Oxygen cylinder acetylene cylinder regulations arc welding set goggles, shield electrode. • Diagrams and charts of various welding joints, and techniques.

Principles of Refrigeration

PROGRAMME: NATIONAL TECHNICAL CERTIFICATE IN REFRIGERATION AND AIR-CONDITIONING			
Course: PRINCIPLES OF REFRIGERATION		Course Code: CAR 11	Contact Hours 72 per week- 2hrs/wk (1-1)
Course Specification: Theoretical Content			
	General Objective 1.0: Know the Various types of thermometers and their uses. and be able to convert from one temperature scale to another.		
Week	Specific Learning Outcome:	Teachers Activities	Resources
1-3	1.1. Define and know the various types of thermometers and gauges and be able to convert from one temperature scale to another 1.2 Understand the principle of converting electrical energy into heat energy and vice versa 1.3 Understand the effect of pressure, temperature and volume in refrigeration and airconditioning 1.4 Understand the three state of matter 1.5 Understand the principles of refrigeration		

PROGRAMME: NATIONAL TECHNICAL CERTIFICATE IN REFRIGERATION AND AIR-CONDITIONING			
Course: PRINCIPLES OF REFRIGERATION		Course Code: CAR 11	Contact Hours 72 per week- 2hrs/wk (1-1)
Course Specification: Theoretical Content			
	General Objective 1.0: Know the Various types of thermometers and their uses. and be able to convert from one temperature scale to another.		
Week	Specific Learning Outcome:	Teachers Activities	Resources
	1.6 Define heat 1.7 Explain the methods of heat transfer i.e conduction, convection and radiation 1.8 Explain the e effect of addition or subtraction of heat to materials- expansion and contraction 1.9 Identify the different types of thermometers in common use 1.10 Explain the working principle of the various thermometers 1.11 Explain and demonstrate the application of the different types of thermometers 1.12 Knowledge 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 1.13 lot various temperature scales on a graph. 1.14 Correct use and care of thermometers	• Ask students to identify the various types of thermometers • and their applications • Solve some examples on conversions • Practicals • Plot various temperature scales on a graph and compare their readings	• Thermometers • Chalkboard • Rulers • Graph sheets

PROGRAMME: NATIONAL TECHNICAL CERTIFICATE IN REFRIGERATION AND AIR-CONDITIONING			
Course: PRINCIPLES OF REFRIGERATION		**Course Code: CAR 11**	**Contact Hours 72 per week- 2hrs/wk (1-1)**
Course Specification: Theoretical Content			
	General Objective: 2.0 Know the various types of Pressure gauges		
Week	**Specific Learning Outcome:**	**Teachers Activities**	**Resources**
4-6	2.1 Identify different types of pressure and vacuum gauges 2.2 Explain the operating principles of the different type of pressure gauges 2.3 Stress the care of gauges/other instruments	• Ask the students to identify the various types of pressure gauges and demonstrate their applications • Assess the students **PRACTICAL:** • Workshop Induction • How to read thermometers • Demonstrate use of pressure gauges	• Pressure gauges • Chalk Board • Lesson plan
	General Objective: 3.0 Understand the effects of Temperature, Pressure and Volume in Refrigeration and Air-conditioning System		
Week	**Specific Learning Outcome:**	**Teachers Activities**	**Resources**
7-10	3.1 Define gas laws such as a. Boyle's law b. Charles' law c. Dalton's law of patial pressures, etc. 3.2 The meaning of basic terms relating to heat, temperature and pressure 3.3 State the relationship between different scales of pressure 3.4 State and explain absolute pressure, gauge pressure and sub-atmospheric pressure 3.5 State and explain the pressure temperature relationship for a saturated fluid 3.6 Carry out calculations using gas laws formulae P1VI1/T1 = P2V2/T2 3.7 Work through given exercises	• Ask the students to explain the relationship between Pressure, temperature and volume, use sample apparatus to demonstrate Charles and Boyles laws • Use refrigerant comparators and tables • Solve some problems on gas laws • Assess the students	• Chalkboard • Lesson Plan. • Glass tubes, pressure • Tubing scale rule • Mercury • Thermometer • Glass steam jacket

PROGRAMME: NATIONAL TECHNICAL CERTIFICATE IN REFRIGERATION AND AIR-CONDITIONING			
Course: PRINCIPLES OF REFRIGERATION		Course Code: CAR 11	Contact Hours 72 per week- 2hrs/wk (1-1)
Course Specification: Theoretical Content			
	General Objective: 4.0 Understand the Principles of conversion of Electrical energy into Heat energy & Vice Versa		
Week	Specific Learning Outcome:	Teachers Activities	Resources
11-14	4.1 Define power, work and their units e.g. watts, kilo watts, etc 4.2 Explain the relationship between heat, work and power 4.3 Use formulae to calculate: a. work b. power 4.4 Explain the conversion of electrical energy to heat energy Demonstrate joules experiment	• Ask the students to explain the relationship between heat, work and power • Demonstrate using joules experiment • Give exercises and assist those needing extra help.	• Lesson plan • Chalkboard • Graph paper • Calorimeter • Heating coil • Thermometer • Voltmeter • Ammeter • A variable resistor • A stop watch
	General Objective 5.0: Understand the three States of Matter and its application to refrigeration		
Week	Specific Learning Outcome:	Teachers Activities	Resources
15-20	5.1 Demonstrate good understanding of sensible heat and latent heat 5.2 Distinguish between phases of matter; solid, liquid and gas 5.3 Explain heat of fusion and vaporization 5.4 Use temperature enthalpy graph to illustrate change of states 5.5 Illustrate change of states using water as an example. 5.6 The meaning of boiling point of liquids 5.7 The basic components and their functions in a simple vapour compression refrigeration cycle	• Ask the students to explain the three phases of matter • Draw and explain temperature graph	• Lesson plan • Chalkboard • Graph paper • Sample component in R & A circuit

PROGRAMME: NATIONAL TECHNICAL CERTIFICATE IN REFRIGERATION AND AIR-CONDITIONING			
Course: PRINCIPLES OF REFRIGERATION		Course Code: CAR 11	Contact Hours 72 per week- 2hrs/wk (1-1)
Course Specification: Theoretical Content			
	General Objective 6.0: Understand the Principles of Basic Refrigeration Cycle		
Week	Specific Learning Outcome:	Teachers Activities	Resources
	6.1 Identify the potential health and safety hazards associated with the handling and use of refrigeration materials and equipment, use of safety equipment and protective clothing 6.2 Explain Refrigerant as a working medium in refrigeration Cycle 6.3 State the conditions of Refrigerant at various points in the circuit. 6.4 Explain refrigeration and arc conditioning cycle 6.5 Recognition of the refrigerants and secondary refrigerants 6.6 Operate trainer unit for the students to observe	• Ask the students to operate trainer Unit for the students to observe PRACTICALS: • Installation of basic Refrigeration Unit. EVALUATION: • Questions and Answers • Written tests • End of module examination	• Trainer Unit. • Safety equipment of masks goggles • A pointer • Workshop components and Materials

Compressors, Motors and Generators

PROGRAMME: NATIONAL TECHNICAL CERTIFICATE IN REFRIGERATION AND AIR-CONDITIONING WORK			
Course: COMPRESSORS, MOTORS AND GENERATORS		**Course Code: CAR 12**	**Contact Hours: 2hrs/wk (1-1)**
Course Specification: Theoretical Content			
	General Objective 1.0: Classify Compressors and differentiate between the various types in common use		
Week	**Specific Learning Outcome:**	**Teachers Activities**	**Resources**
1-10	1.1 Distinguish between hermetic, semi-hermetic and open type compressors (sealed and open compressors) 1.2 Differentiate between the following types of compressors: a. Reciprocating b. Rotary c. Centrifugal d. Screw 1.3 State the appropriate uses of each type of compressor listed in 1.2 above 1.4 Draw and explain the principle of operation of each of the compressors 1.5 Methods of cooling motor windings in a hermitically sealed compressor 1.6 Methods of compression in a rotary compressor by stationary blade and rotary valve	• Explain the construction and operation of various types of compressors • Assess the students	• Lesson Plan • Chalk • Board • Various types of Compressors
	General Objective: 2.0 Understand the Working Principles of the Compressor		
Week	**Specific Learning Outcome:**	**Teachers Activities**	**Resources**
11-25	2.1 Explain the construction operating principles of compressors in common use 2.2 Draw a labeled diagram showing the essential features of compressors 2.3 Identify the components of the compressor 2.4 Explain the function of each component 2.5 Dismantle and reassemble various types of compressors 2.6 Answer questions from the teacher	• Ask the Students to: • Explain the functions of the components • Practical • Assembling of compressor components	• Lesson plan • Chalkboard • Various types of compressors • Exploded view diagrams

PROGRAMME: NATIONAL TECHNICAL CERTIFICATE IN REFRIGERATION AND AIR-CONDITIONING WORK			
Course: COMPRESSORS, MOTORS AND GENERATORS		**Course Code: CAR 12**	**Contact Hours: 2hrs/wk (1-1)**
Course Specification: Theoretical Content			
	General Objective: 3.0 Calculate the revolution and capacity of reciprocating compressors		
Week	**Specific Learning Outcome:**	**Teachers Activities**	**Resources**
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 $\text{Capacity} = \pi \frac{D^2N}{4} \times S \times RPM$ Where $\pi = \frac{22}{7}$ or 3,146 N = number of cylinders D = diameter of compressor RPM = revolution per minute S = length of stroke d = diameter of cylin	• Ask the students to using the pressure - volume diagram, explain the stages in the compressing process, e.g. - expansion, suction, compression and discharge • Assess the student	• Lesson plan • Chalkboard • Compressor • Models
	General Objective: 4.0 Service Compressor Valves		
Week	**Specific Learning Outcome:**	**Teachers Activities**	**Resources**
37-44	4.1 Retrieve, inspect compressor valves 4.2 True compressor valve by lapping using appropriate lapping paste 4.3 Reassemble and adjust service valves for correct functioning 4.4 Heat-test the system	• Ask the students to demonstrate stripping of components • Ask the students to lap valve, reassemble and adjust them correctly	• Oil • Smooth sand paper • Glass block, etc • Grinding paste

PROGRAMME: NATIONAL TECHNICAL CERTIFICATE IN REFRIGERATION AND AIR-CONDITIONING WORK			
Course: COMPRESSORS, MOTORS AND GENERATORS		Course Code: CAR 12	Contact Hours: 2hrs/wk (1-1)
Course Specification: Theoretical Content			
	General Objective: 5.0 Understand the use of measuring instruments and gauges		
Week	Specific Learning Outcome:	Teachers Activities	Resources
45-60	5.1 Demonstrate good knowledge of: a. tapes, steel rule, vernier clippers, micrometer screw gauge, feeler gauge, feeler gauge, wire gauge etc b. Use and care of temperature and pressure gauges c. Use and care of vacuum gauge and gauge manifolds d. Use and care of oxy-acetylene gauges and manifolds, suction gauges e. Charge systems to given pressure and test with gauges of known accessory f. Evaluate systems and test with suction/vacuum gauges 5.2 Adjust compressor service valves and know their application in refrigeration or air-conditioning system. 5.3 Crack, front seat, back seat the service valves	• Ask the students to: • Explain care of gauges Practical • Charge systems via manifold gauges	• Ratchet set • Gauge set • Test pens etc
	General Objective: 6.0 Know the method of adjusting safety devices for compressors		
Week	Specific Learning Outcome:	Teachers Activities	Resources
61-75	6.1 Identify and explain the functions of high pressure cut out 6.2 Set low and high pressure cut outs. 6.3 Adjust thermostats, and switch of the systems 6.4 Locate relay and overload 6.5 Identify and explain functions of thermal limiter and superheat switch	• Ask the Students to: • identify safety devices	• Screw Drivers • Test pen

PROGRAMME: NATIONAL TECHNICAL CERTIFICATE IN REFRIGERATION AND AIR-CONDITIONING WORK			
Course: COMPRESSORS, MOTORS AND GENERATORS		Course Code: CAR 12	Contact Hours: 2hrs/wk (1-1)
Course Specification: Theoretical Content			
	General Objective: 7.0 Understand the working principles of various types of capacity control on compressors and be able to adjust them		
Week	Specific Learning Outcome:	Teachers Activities	Resources
76-86	7.1 Identify the various types of capacity controls 7.2 Explain the principle of eration of each type of capacity control: 7.3 Pneumatic, variable speed, etc 7.4 Diagnose fault on capacity control 7.5 Adjust or replace capacity control	• Ask the students to: • Explain different methods of capacity controls using illustrative diagrams	• Chalkboard • Lesson Plan
	General Objective: 8.0 Carry out compressor efficiency test		
Week	Specific Learning Outcome:	Teachers Activities	Resources
	8.1 Explain the purpose and importance of compressor efficiency test 8.2 Connect the suction and high pressure gauges. 8.3 Run the compressor 8.4 Observe and assess the pumping and suction action of the compressor.	• Ask the students to: • Run the compressor • Repair and replace faulty components including valve lapping • Dismantle and assemble compressors • Connect the suction and high pressure gauges. • Check compressor for shorts ground and open circuits	• Gauge Set • Refrigeration socket set

PROGRAMME: NATIONAL TECHNICAL CERTIFICATE IN REFRIGERATION AND AIR-CONDITIONING WORK			
Course: COMPRESSORS, MOTORS AND GENERATORS		Course Code: CAR 12	Contact Hours: 2hrs/wk (1-1)
Course Specification: Theoretical Content			
	General Objective: 9.0 Maintain and repair electric motors, generators and starters used in refrigeration and air-conditioning systems		
Week	Specific Learning Outcome:	Teachers Activities	Resources
98-106	9.1 Distinguish between three-phase and single-phase motor 9.2 Types of single-phase motors 9.3 Oil and grease the appropriate parts of refrigeration and air-conditioning systems 9.4 Identify types of starters, e.g. direct-on-line starters; star-delta starters, etc.	• Questions and answers • Written test • End of module examination Practical • Identify, diagnose faults and repair or replace the following relays, solenoid valves, capacitors, thermostats, overload protectors, time switches, contactors • Remove faulty electric motors from service, dismantle and check them for both mechanical and electrical faults	• Single-phase and three-phase motors • Multi-meter • Amprobe • Screw drivers, etc.

Charging of Refrigerants and Oil

PROGRAMME: NATIONAL TECHNICAL CERTIFICATE IN REGRIGERATION AND AIR-CONDITIONING			
Course: CHARGING OF REFRIGERANTS AND OIL		Course Code: CAR 13	Contact Hours 72 - 2hr/week (1-1)
Course Specification: Theoretical Content			
	General Objective 1.0: Know the various types of refrigerants used in a refrigeration system and the specific application of each type.		
Week	Specific Learning Outcome:	Teachers Activities	Resources
1-12	1.1 Know the purpose of refrigerant in a refrigeration system and be able to classify the various types of refrigerants and their properties 1.2 State specific use of each refrigerant 1.3 Know the colour coding of refrigerant cylinders 1.4 Understand the importance of lubrication in a refrigeration system and the different types of lubricating systems	• Ask the students to show different types of refrigerants by their containers	• Refrigerant cylinders
	1.5 Explain the purposes of a refrigerant in a refrigeration system. 1.6 Classify various types of refrigerants such as R12, R22, R502, R717 according to their properties e.g. freezing point, boiling point, colour codes. 1.7 The desirable properties of refrigerants, 1.8 State the specific uses of each type of refrigerant listed in 1.2 1.9 Refrigerant cylinders and colour coding of gas cylinders 1.10 Reclaiming of refrigerants from dead systems 1.11 Need and method of evacuation and drying a system 1.12 Functions and types of dehydrants 1.13 To change and back off refrigerant from the system	• Ask the students to: • demonstrate use of vacuum pumps • identify dehydrants and explain their functions • State the specific uses of each type of refrigerant listed in 1.2	• Refrigerants • Dehydrants • Test equipment

PROGRAMME: NATIONAL TECHNICAL CERTIFICATE IN REGRIGERATION AND AIR-CONDITIONING			
Course: CHARGING OF REFRIGERANTS AND OIL		Course Code: CAR 13	Contact Hours 72 - 2hr/week (1-1)
Course Specification: Theoretical Content			
	General Objective: 2.0 Charge a refrigeration system with refrigerants		
Week	Specific Learning Outcome:	Teachers Activities	Resources
13-24	2.1 Locate and repair the point of leakage if any, by using electronic leak detector halve 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; b. Connect the refrigerant cylinder to the system; c. Crack the valve of the cylinder/pressurize the system with refrigerant d. Run the compressor until the system is fully charged; and e. Observe all necessary precautions. 2.3 Identify and amend leaks, e.g. (a) connect vacuum pumps; a. run vacuum pump until the suction reads:- 100KN/m^2 (760mm vacuum); b. disconnect the vacuum pump and charge the system as shown in 2.2 above. c. pressurize the system with refrigerant; d. run the compressor and allow the compressor to suck in the refrigerant until system is fully charged.	• Ask the Students to: • Re-emphasize safety precautions when handling refrigerants • Demonstrate methods of detecting and locating leaks and service checks • Explain how to mend leaks (discharge systems and recharge) • How to stabilize systems	• Refrigerant charging cylinder; • Vacuum pump; • Gauge set; • Leak detectors; etc. Refrigerant charging cylinder; • Vacuum pump; • Gauge set; • Leak detectors; etc.

PROGRAMME: NATIONAL TECHNICAL CERTIFICATE IN REGRIGERATION AND AIR-CONDITIONING			
Course: CHARGING OF REFRIGERANTS AND OIL		Course Code: CAR 13	Contact Hours 72 - 2hr/week (1-1)
Course Specification: Theoretical Content			
	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.		
Week	Specific Learning Outcome:	Teachers Activities	Resources
	3.1 Explain the importance of lubricating oil in a refrigeration system. 3.2 State and describe properties of lubricating oil used in refrigeration systems. 3.3 Select the lubricating oils, viscosity 150-300	• Ask the students to: • Explain affinity of refrigerant to lubricating oil which is of great advantage • Demonstrate the charging of lubricant into a system via the suction side	• Lubricating Oil • Oil can • Cotton waste
	General Objective: 4.0 Understand various methods of lubrication		
Week	Specific Learning Outcome:	Teachers Activities	Resources
29-30	4.1 State the two methods of lubrication (gravity, splash, forced feed) 4.2 Explain each method stated in 4.1	• Ask the students using diagram, to explain the methods of lubrication	• Lesson plan • Chalkboard
	General Objective: 5.0 Understand the principle of operation of oil separators		
Week	Specific Learning Outcome:	Teachers Activities	Resources
30-31	5.1 Explain the Principle of operation of oil separators 5.2 Name and draw two types of oil separators	• Ask the students to use diagram to explain oil separators • Assess the student	• Lesson Plan • Chalkboard • Oil separator
31-36	At the end of this course, the trainee should be able to: a. Reclaim refrigerant from a dead system and evacuate dry and recharge the system b. (2) Locate and repair leaks in the system. **PRACTICALS** **Efficiency Test** • Explain the importance of efficiency test after charging the refrigeration system with refrigerant and lubricating oil • Describe types of efficiency test • Perform efficiency test of a refrigeration unit • Run the unit unloaded (cabinet) until the thermostat cuts in and out.	**EVALUATION** • Questions and Answers • Written Tests • End of Module examination	

Heat Exchangers

PROGRAMME: NATIONAL TECHNICAL CERTIFICATE IN REFRIGERATION & AIR-CONDITIONING WORK			
Course: CAR 14 - HEAT EXCHANGERS		**Course Code: CAR 14**	**Contact Hours: 2hr/week (1 - 1)**
Course Specification: Theoretical Content			
	General Objective: 1.0 Understand the principles of operation of heat exchangers and select the common types used in refrigeration and air-conditioning.		
Week	**Specific Learning Outcome:**	**Teachers Activities**	**Resources**
1-20	1.1 Explain the methods of heat transfer and the principles of operation of heat exchangers 1.2Calculate heat load, size and length of pipes required for refrigeration installation 1.3 Explain the functions and operating principles of condensers 1.4 Understand the function of required receiver and the service valve	• 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	• Heat exchangers • Condensers
	1.1 Explain the principles of operation of heat exchangers 1.2 Explain the methods of heat transfer by a. conduction b. convection c. radiation 1.3 Appreciate that 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) 1.4 Maintain heat exchanger by clearing the tubing and fins 1.5 Describe types of heat exchangers and their correct uses: a. shell and coil b. shell and tube c. double pipe d. convectional	• Ask the students to: • Show and draw types of heat exchangers • Explain the principles of operation of each	• Heat exchangers

PROGRAMME: NATIONAL TECHNICAL CERTIFICATE IN REFRIGERATION & AIR-CONDITIONING WORK			
Course: CAR 14 - HEAT EXCHANGERS		**Course Code: CAR 14**	**Contact Hours: 2hr/week (1 - 1)**
Course Specification: Theoretical Content			
	General Objective: 2.0 Calculate heat load, size and overall length of pipes required for refrigeration installation.		
Week	**Specific Learning Outcome:**	**Teachers Activities**	**Resources**
20-34	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 Appreciate accuracy of calculating heating and cooling loads 2.3 Understand the importance of data books and charts for applicable information	• Ask the students to solve problems on heat exchangers using the given formula	• Chalkboard • Lesson plan
	General Objective: 3.0 Construct Condensers and evaporators for refrigeration and air-conditioning systems		
Week	**Specific Learning Outcome:**	**Teachers Activities**	**Resources**
	3.1 Explain the purpose of condensers and evaporators in a refrigeration and air-conditioning systems 3.2 Design simple condenser and evaporator 3.3 Select materials used for constructing condenser/evaporators, copper, pipes, fins, etc. 3.4 Bend copper pipes to shapes 3.5 Prepare fins for the condenser/evaporator 3.6 Braze fins, elbows, copper pipes together 3.7 Select the right size of fins for condenser/evaporators by using manufacturers catalogue	Ask the students to: • Service and maintain heat exchangers • Construct simple condensers and evapoorator • find 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

PROGRAMME: NATIONAL TECHNICAL CERTIFICATE IN REFRIGERATION & AIR-CONDITIONING WORK			
Course: CAR 14 - HEAT EXCHANGERS		Course Code: CAR 14	Contact Hours: 2hr/week (1 - 1)
Course Specification: Theoretical Content			
	General Objective: 4.0 Understand the function of the liquid receiver and the service valve, and where they are used.		
Week	Specific Learning Outcome:	Teachers Activities	Resources
46-58	4.1 Explain the purpose of the liquid receiver and service valve 4.2 Operate the liquid receiver service valve, i.e. a. crack b. front seat c. back seat 4.3 Pump down the system e.g. front seat the service valve and run the compressor until pressure is a little above atmospheric pressure. 4.4 Know different types of service valves and their applications (stem, schroder etc) 4.5 Appreciate use and functions of other flow equipment	EVALUATION: • Questions and Answers • Written tests • End of module examination	• Trainer unit • Lesson plan • Chalkboard

Load Estimation

PROGRAMME: NATIONAL TECHNICAL CERTIFICATE IN REFRIGERATION & AIR-CONDITIONING WORK			
Course: CAR 15 - LOAD ESTIMATION		Course Code: CAR 15	Contact Hours 2hr/week (2 - 0)
Course Specification: Theoretical Content			
	General Objective 1.0: Estimate the total load of a cold store		
Week	Specific Learning Outcome:	Teachers Activities	Resources
1-24	1.1 Estimate 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 c. Insulation thickness and type of material) d. Where A = Area e. K = KC = Conductivity factor f. T.D. = Temperature Difference g. Product load using the formulae mass x specific heat x T.D. h. Service load; Add 10-25% of the heat leakage load depending on the use of the cold store. i. Miscellaneous Load: Add heat equivalent of wattages of bulbs, fans and all electrical appliances inside the cold store j. Add 5-10% safety factor 1.4 Select appropriate unit for a cold room with manufacturer's catalogue for use.	• Ask the students to: • Solve problems using given formulae.	• Lesson plan • Chalkboards • Charts and tables

PROGRAMME: NATIONAL TECHNICAL CERTIFICATE IN REFRIGERATION & AIR-CONDITIONING WORK			
Course: CAR 15 - LOAD ESTIMATION		Course Code: CAR 15	Contact Hours 2hr/week (2 - 0)
Course Specification: Theoretical Content			
	General Objective 2.0: Calculate heat load and apply it in the selection of appropriate unit and commercial air-conditioning		
Week	Specific Learning Outcome:	Teachers Activities	Resources
22-55	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 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 **EVALUATION:** a. Questions and Answers b. Written Tests c. End of Module examination	• Ask the students to: • Solve problems using given formulae • Select suitable units based on their load estimation	• Lesson plan • Chalkboards • Charts and tables

Refrigerant and air-conditioning Controls

PROGRAMME: NATIONAL TECHNICAL CERTIFICATE IN REFRIGERATION AND AIR-CONDITIONING WORK			
Course: REFRIGERANT AND AIR-CONDITIONING CONTROLS		Course Code: CAR 16	Contact Hours: 3hr/wk (1-2)
Course Specification: Theoretical Content			
	General Objective 1.0: Understand the principles of operation of various types of refrigerant controls and their functions.		
Week	Specific Learning Outcome	Teachers Activities	Resources
	1.1 Identify and describe the operating principles of different types of refrigerant and air-conditioning controls and their functions. 1.2. Explain the classes of the controls and their location in the system PRACTICALS: a. Locate the controls within the system b. Install different controls in any system c. Detect faults in refrigerant controls, service, repair and test them		
1-12	1.1 Explain the principles of operation of types of refrigerant controls. 1.2 Identify 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. 1.3 Describe the functions of the controls listed in 1.2 above 1.4 Locate the controls within the system 1.5 Sketch the construction of the controls	• Ask the students to: • Show, draw and explain each of these controls. • Confirm understanding using appropriate questions • Demonstrate application of various controls	• Capillary tube • TEV • Low side float valve • High side float valve • AEV, etc

PROGRAMME: NATIONAL TECHNICAL CERTIFICATE IN REFRIGERATION AND AIR-CONDITIONING WORK			
Course: REFRIGERANT AND AIR-CONDITIONING CONTROLS		Course Code: CAR 16	Contact Hours: 3hr/wk (1-2)
Course Specification: Theoretical Content			
	General Objective: 2.0 Carry out Installation of controls, their adjustment and repairs where necessary.		
Week	Specific Learning Outcome	Teachers Activities	Resources
13-24	2.1 Demonstrate good knowledge of correct procedures for installation and making good (bearing in mind safety of persons and equipment) 2.2 Know the functions of the different controls 2.3 Explain the basic principles of installation of refrigerant controls. 2.4 Install the appropriate sizes of refrigerant controls for all systems. 2.5 Adjust the following controls: a. thermostatic expansion valve b. automatic expansion valve 2.6 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 valves such as check valves, hand valves, etc.	• Help students to locate these controls • Request and explain the functions of each controls • Ask the students to: • Identify the controls • Explain the functions of the controls	• Chalkboard • Lesson plan
	General Objective: 3.0 Understand the Principles of Operational, Regulatory and Safety Control.		
Week	Specific Learning Outcome	Teachers Activities	Resources
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 d. Water control valve	• Ask the students to show, draw and explain each of the controls	• Chalkboard • Lesson plan

Installation and Insulation of pipes and ducts

PROGRAMME: NATIONAL TECHNICAL CERTIFICATE IN REFRIGERATION & AIR-CONDITIONING WORK			
Course: CAR 17 - INSTALLATION & INSULATION OF PIPES AND DUCTS		Course Code: CAR 17	Contact Hours: 2hr/week (1-1)
Course Specification: Theoretical Content			
	General Objective 1.0: Undertake installation of pipes and ducts for air-conditioning and refrigeration system		
Week	Specific Learning Outcome:	Teachers Activities	Resources
1-12	1.1 Interprete installation drawings of pipes and ducts for air-conditioning and select appropriate tools and equipment for some 1.2 Identify various types of insulating materials and explain the purpose of insulation to pipes and ducts in refrigeration and air conditioning system. 1.3 State the properties of good insulating materials		
	1.4 Interpret installation drawings of pipes and ducts for air-conditioning 1.5 Select and describe tools and equipment used for pipe and duct installation. 1.6 List out activities for a particular job 1.7 List necessary materials from specifications thereafter carry out simple installation from same specifications 1.8 Ensure stores/materials are available before embarking on the work 1.9 Recognise the need for cleanliness	• 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	• Sample drawing • Lesson Plan • Chalkboard • Refrigeration • Tool box

PROGRAMME: NATIONAL TECHNICAL CERTIFICATE IN REFRIGERATION & AIR-CONDITIONING WORK			
Course: CAR 17 - INSTALLATION & INSULATION OF PIPES AND DUCTS		Course Code: CAR 17	Contact Hours: 2hr/week (1-1)
Course Specification: Theoretical Content			
	General Objective 2.0: Understand the Properties of Insulating Material		
Week	Specific Learning Outcome:	Teachers Activities	Resources
13-24	2.1 Explain the purpose of insulation to pipes and ducts used in air-conditioning and refrigeration (lagging) 2.2 Identify various types of insulating materials used in air-conditioning and refrigeration. 2.3 State the properties of insulating materials listed in item 2.1 above	• Ask the students to: • Show and explain insulating materials for pipes and ducts.	• Samples of insulating materials
	General Objective 3.0: Insulate pipes, walls and ducts		
Week	Specific Learning Outcome:	Teachers Activities	Resources
25-36	PRACTICALS 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 various temperatures f. fix insulation materials to pipes, walls of ducts using adhesives, insulation tapes, etc. g. Maintain insulation to air-conditioning and refrigeration.	EVALUATION: • Questions and Answers • Written tests • End of Module examination.	• Various types of insulation materials • Scissors • Evostic, adhesive tape, etc • Accessories • Copper pipes • Flaring tools • Sand paper etc

Absorption System

PROGRAMME: NATIONAL TECHNICAL CERTIFICATE IN REFRIGERATION & AIR-CONDITIONING WORK			
Course: CAR 18 - ABSORPTION SYSTEM		Course Code: CAR 18	Contact Hours 2hrs/week (1-1)
Course Specification: Theoretical Content			
	General Objective 1.0: Understand the working Principles of an absorption System, the components and the three cycles of operation of the Elements		
Week	Specific Learning Outcome:	Teachers Activities	Resources
	1.1 Know the working principles of an absorption system, its components and the cycles of operation of its elements 1.2 Know the types of absorption systems and identify the components of an absorption system		
1-9	1.3 Explain the working principles of an absorption system in refrigeration. 1.4 Types of Absorption systems in common use 1.5 Identify the 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: a. water b. hydrogen c. ammonia. 1.7 Schematic drawings of continuous absorption through: a. Generator b. Absorber c. Evaporator d. Condenser e. Solution pump 1.8 Comparison of efficiency between absorption and compression cycle 1.9 Power consumption 1.10 Procurement of Materials 1.11 Estimation of installation costs	• Ask the students to: • Using diagrams, explain the working principles of absorption systems • Compare different types of absorber/refrigerant combinations • Compare the efficiencies of absorption and vapour compressor cycles	• Wall Charts • Absorption Unit

PROGRAMME: NATIONAL TECHNICAL CERTIFICATE IN REFRIGERATION & AIR-CONDITIONING WORK			
Course: CAR 18 - ABSORPTION SYSTEM		**Course Code: CAR 18**	**Contact Hours 2hrs/week (1-1)**
Course Specification: Theoretical Content			
	General Objective: 2.0 Diagnose and rectify faults within the absorption system		
Week	**Specific Learning Outcome:**	**Teachers Activities**	**Resources**
10	2.1 Locate the position of an absorption unit in a room 2.2 Install the unit and fix the wich and glass on the tank 2.3 Service and maintain an absorption unit		
	PRACTICALS **Faults in absorption System** a. Diagnose faults within the absorption system by checking the working performance of the unit such as condenser generator. b. Replace the heating element.	• Diagnose probable faults associated with absorption system	• Absorption Unit • Blowers • Brushes • Element, etc.
	General Objective: 3.0 Install and maintain absorption system		
Week	**Specific Learning Outcome:**	**Teachers Activities**	**Resources**
11-12	**Installation and Maintenance of Absorption System** c. Locate position of the absorption unit in the room d. Install the unit e. Fix the wick and glass on the tank f. Clean the generator condenser's absorbent unit g. Install and maintain absorption system.	**EVALUATION:** • Questions and Answers • Written Tests • End of Module Examination.	

Cold Store Installation and Maintenance

PROGRAMME: NATIONAL TECHNICAL CERTIFICATE IN REFRIGERATION & AIR-CONDITIONING WORK			
Course: CAR 19 - COLD STORE INSTALLATION & MAINTENANCE		Course Code: CAR 19	Contact Hours 2hr/wk (1-1)
Course Specification: Theoretical Content			
	General Objective 1.0: Understand the working Principles of a Cold Store and be able to apply them in (i) interpreting the design layout of a cold store; and (ii) installing and commissioning of cold store to given specifications: Maintain a cold store in good working condition		
Week	Specific Learning Outcome:	Teachers Activities	Resources
1-12	1.1 Explain the working principles of a cold store. 1.2 Read and interpret design blue-prints of a cold store a. survey site for proper location of components for efficient operation; b. construct condensing unit foundation c. Processes: d. prepare concrete using cement, sand, gravel mix e. fix wood concrete forms and pour concrete f. mark center of bolts with white washed sticks before the mixture sets. PRACTICALS a. Erect components e.g. condensing unit evaporator, etc. b. Connect components up with line e.g. compressor, condenser and evaporator c. Wire the system components in accordance with manufacturer's wiring diagrams e.g. gear switch starter, time switch, solenoid, valves, thermostats and pressure cut-outs. d. Pressure test the system with electronics leak detectors; halide, etc. e. Charge the system f. Carry out efficiency test by running the system to check the correct performance of the automatic cotrols.	• Ask the students to: • Use diagrams to explain working/principles of cold store • Give sectional drawing of a sample cold room and explain the components • Give the electrical wiring diagram of a cold room and explain it.	• Sample blue print • Lesson plan • Chalkboard

PROGRAMME: NATIONAL TECHNICAL CERTIFICATE IN REFRIGERATION & AIR-CONDITIONING WORK			
Course: CAR 19 - COLD STORE INSTALLATION & MAINTENANCE		Course Code: CAR 19	Contact Hours 2hr/wk (1-1)
Course Specification: Theoretical Content			
	General Objective: 2.0 Maintain a cold store in good working condition.		
Week	Specific Learning Outcome:	Teachers Activities	Resources
13-24	2.1 Diagnose faults within elec trical 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) 2.4 Clean and straighten condenser fins	• Assess the students	• Gauge set • Sucket set • Amprobe • Multi-tester • Screw drivers, etc.

Basic Air-Conditioning Principles

PROGRAMME: ADVANCED NATIONAL TECHNICAL CERTIFICATE IN REFRIGERATION & AIR-CONDITIONING WORK			
Course: BASIC AIR-CONDITIONING PRINCIPLES		Course Code: CAR 20	Contact Hours 2hr/week (1-0)
Course Specification: Theoretical Content			
	General Objective 1.0: Know the Basic Principles of Airconditioning.		
Week	Specific Learning Outcome:	Teachers Activities	Resources
1-12	1.1.Describing the basic principles of an air-conditioning system 1.2. Identify the various air-conditioning components and explaining functions as well as air condition process 1.3 Distinguish between the various types **Practical Capabilities** 1.4 Be able to use correct instruction like psychrometer and psychrometric dart to determine relative humidity, dew point, humidity ratio, enthalpy, per unit mass of air etc 1.5 Carry out maintenance		
	1.6 Define air-conditioning 1.7 Use a psychrometer 1.8 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. 1.9 Know air-conditioning processes e.g. a. Humidification b. Dehumidification c. Heating and dehumidification, etc.	• Ask the students to: • Plot various air-conditioning processes on psychrometric chart • Solve exercises.	• Lesson Plan • Chalkboard • Psychrometers • Psychrometric • Charts.

PROGRAMME: ADVANCED NATIONAL TECHNICAL CERTIFICATE IN REFRIGERATION & AIR-CONDITIONING WORK			
Course: BASIC AIR-CONDITIONING PRINCIPLES		Course Code: CAR 20	Contact Hours 2hr/week (1-0)
Course Specification: Theoretical Content			
	General Objective 2.0: Know the major parts of equipment in the air-conditioning circle.		
Week	Specific Learning Outcome:	Teachers Activities	Resources
	2.1 Identify the following components in the air cycle: a. Fan b. Supply ducts c. Supply outlets 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.	• Ask the students to: • Draw and explain functions of these components • Draw and explain each unit • Identify the components of units while on excursion • **EVALUATION:** • Questions and Answers • Written tests • End of module examination • SIWES.	• Demonstration unit • Transportation

Automobile Air-conditioning

PROGRAMME: ADVANCED NATIONAL TECHNICAL CERTIFICATE IN REFRIGERATION & AIR-CONDITIONING WORK			
Course: CAR 21 - AUTOMOBILE AIR-CONDITIONING		Course Code: CAR 21	Contact Hours 3hrs/week (1-2)
Course Specification: Theoretical Content			
	General Objective 1.0: Understand the working Principles of a car air-conditioning system		
Week	Specific Learning Outcome:	Teachers Activities	Resources
1-8	1.1 Explaining the working principles of a car air-conditioning system 1.2 Identify the various components of the system as well as explaining their functions 1.3 Know the necessary precautions to take when working on car AC.		
	Principles of automobile Air-conditioning system 1.1 Explain the working principles of a car air-conditioning system 1.2 Identify the various 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 1.3 Describe the function of each component of the system. 1.4 Describe the operation of a car air-conditioning system	• 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)	• Air conditioned car • Lesson plan • Chalkboard • Wall Charts

PROGRAMME: ADVANCED NATIONAL TECHNICAL CERTIFICATE IN REFRIGERATION & AIR-CONDITIONING WORK			
Course: CAR 21 - AUTOMOBILE AIR-CONDITIONING		Course Code: CAR 21	Contact Hours 3hrs/week (1-2)
Course Specification: Theoretical Content			
	General Objective: 2.0 Diagnose And Rectify Faults In Air-conditioning System In Various Car Makes: Peugeot, Toyata, Passat, Mercedes Benz, etc.		
Week	Specific Learning Outcome:	Teachers Activities	Resources
9-16	2.1 Diagnose any fault in an automobile Air-Conditioning system and rectifying same 2.2 Knowing the correct tools and equipment to use 2.3 Discharging, purging, evaluating and charging the system 2.4 Installing and testing a new air condition system in a car 2.5 Carrying out a routine service		
	2.1.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. 2.2.Rectify faults such as: a. shortage of gas (topping up or complete charge) b. clearing t he filter c. replacing the compressor d. replacement of leaking hose.\, etc. 2.3.Charge the unit with lubricating oil 1.12 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 various components of a car air-conditioner	• Faulty air-conditioned car • Gauge sets • Ratchet sets • R-12 • Lubricating oil • Driver-sight glass, etc.

PROGRAMME: ADVANCED NATIONAL TECHNICAL CERTIFICATE IN REFRIGERATION & AIR-CONDITIONING WORK			
Course: CAR 21 - AUTOMOBILE AIR-CONDITIONING		Course Code: CAR 21	Contact Hours 3hrs/week (1-2)
Course Specification: Theoretical Content			
	General Objective: 3.0 Install new auto air conditioner		
Week	Specific Learning Outcome:	Teachers Activities	Resources
17-20	3.1 Design the layout of the equipment within the car 3.2 I 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.	• Ask the students to draw the wiring circuit of a car A/C	• All the components to be installed • Oxy-acetylene set • Protective clothing
	General Objective: 4.0 CARRY OUT ROUTINE SERVICE		
Week	Specific Learning Outcome:	Teachers Activities	Resources
21-24	4.1 Explain the importance of routine service to air-conditioning and refrigeration systems. 4.2 Design a routine service chart for use in the service of air-conditioning and refrigeration system 4.3 Service the various component of the system, e.g. a. cleaning of condenser, filters, evaporator, etc. b. checking of joints for leaks c. check oil evaporation fan motor d. check and clear water drain pipe, and e. check the operation of the system EVALUATION: 1. Questions and Answers 2. Written tests 3. End of Module examination. 4. Carry out performance test and stabilize the system if need be	• Ask the students to design a routine service chart for air-conditioning and refrigeration systems.	

Industrial air-conditioning

PROGRAMME: ADVANCED NATIONAL TECHNICAL CERTIFICATE IN REFRIGERATION & AIR-CONDITIONING WORK			
Course: CAR 22 - INDUSTRIAL AIR-CONDITIONING		Course Code: CAR 22	Contact Hours 3hr/wk (1-2)
Course Specification: Theoretical Content			
	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.		
Week	Specific Learning Outcome:	Teachers Activities	Resources
1-8	1.1 Describe the principles of operation of both direct and indirect systems of air-conditioning 1.2 Identify the different components of a central air-conditioning system and explain their functions 1.3 Read and interpret the layout diagram of an air conditioning system		
	1.4 Explain the principles of operation of direct and indirect systems of air-conditioning 1.5 Identify various 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. 1.6 Explain the function of each components of the system listed in 1.2 above 1.7 Interpret the layout diagram of air-conditioning systems, e.g. direct and indirect systems diagrams and electrical circuit. 1.8 Install and commission a central air-conditioning system.	• Help students to identify the various components of both direct and indirect systems. • Ask students to distinguish between direct and indirect systems using diagrams • Draw and explain the electrical circuit of a central air-conditioning unit (direct and indirect).	• Demonstration unit • Lesson plan

PROGRAMME: ADVANCED NATIONAL TECHNICAL CERTIFICATE IN REFRIGERATION & AIR-CONDITIONING WORK			
Course: CAR 22 - INDUSTRIAL AIR-CONDITIONING		Course Code: CAR 22	Contact Hours 3hr/wk (1-2)
Course Specification: Theoretical Content			
	General Objective: 2.0 Diagnose and rectify faults within the Systems		
Week	Specific Learning Outcome:	Teachers Activities	Resources
	2.1 Be able to install and commissioning a central air conditioning 2.2 Accurately diagnose faults in the system and effect repairs with confidence 2.3 Effectively maintain the system and adjust the various 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 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	• 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	• Faulty Compressor • Faulty Electrical Circuit • Time Switch • Thermostat • Starter, etc.
	General Objective: 3.0 Understand Routine Service of the Central air-conditioning System		
Week	Specific Learning Outcome:	Teachers Activities	Resources
19-20	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.	• Ask the students to demonstrate how to maintain log sheets	• Log Sheet

PROGRAMME: ADVANCED NATIONAL TECHNICAL CERTIFICATE IN REFRIGERATION & AIR-CONDITIONING WORK			
Course: CAR 22 - INDUSTRIAL AIR-CONDITIONING		Course Code: CAR 22	Contact Hours 3hr/wk (1-2)
Course Specification: Theoretical Content			
	General Objective: 4.0 Prepare a Log Sheet for a Plant		
Week	Specific Learning Outcome:	Teachers Activities	Resources
21-24	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,.	EVALUATION: • Questions and Answers • Written tests • End of module examination.	• Log sheet

Ice Plant

PROGRAMME: ADVANCED NATIONAL TECHNICAL CERTIFICATE IN REFRIGERATION & AIR-CONDITIONING WORK			
Course: CAR 23 - ICE PLANT		**Course Code: CAR 23**	**Contact Hours 24 - 2hrs/wk (1-1)**
Course Specification: Theoretical Content			
	General Outcome 1.0: Understand the Principle of Operation of Ice making Machines, Install and Maintain them.		
Week	**Specific Learning Outcome:**	**Teachers Activities**	**Resources**
1-8	1.1 Identify the various types of ice plants as well as describe their constructional features 1.2 Select the type of ice plant for making the type and size of ice needed **Practical Capabilities** 1.3. Effectively trace faults on ice plant 1.4 Repair or derive an ice plant or sub assemblies	• Ask the students to: • Explain the working principles of ice making machine. • Install and maintain ice making machine	
	1.5 Identify various types of ice plant tub, flake, plate, and block types 1.6 Describe the constructional features of ice making machine 1.7 Explain the working principles of ice making machine 1.8 Select ice making machine for the making of type and size of ice required.		• Ice making machine • Chalkboards • Lesson plan
	General Objective: 2.0 Understand the processes of ice manufacturing		
Week	**Specific Learning Outcome:**	**Teachers Activities**	**Resources**
9-10	2.1 Identify various types of ice tub, flake, fermented 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.	• Ask the students to: • Explain the function of the agitators • Explain the process of ice production from start to finish (storage)	• Faulty ice making • Machine • Set of spanners • Rachet wrench • Gauge set, etc.

PROGRAMME: ADVANCED NATIONAL TECHNICAL CERTIFICATE IN REFRIGERATION & AIR-CONDITIONING WORK			
Course: CAR 23 - ICE PLANT		Course Code: CAR 23	Contact Hours 24 - 2hrs/wk (1-1)
Course Specification: Theoretical Content			
	General Objective: 3.0 Trouble shoot faulty Ice-Making Machines and be able to repair the fault.		
Week	Specific Learning Outcome:	Teachers Activities	Resources
11-12	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.	EVALUATION: • Questions and Answers • Written Tests • End of Module examination.	

Refrigerant Work

PROGRAMME: ADVANCED NATIONAL TECHNICAL CERTIFICATE IN REFRIGERATION & AIR-CONDITIONING WORK			
Course: CAR 24 - TRANSPORT REFRIGERATION		Course Code: CAR 24	Contact Hours 48 - 2hr/wk (1-1)
Course Specification: Theoretical Content			
	General Objective 1.0: Understand the Principles of Operation of Transport Refrigeration Equipment		
Week	Specific Learning Outcome:	Teachers Activities	Resources
1-6	1.1 Identifying and describing the various types and working principles of transport refrigeration equipment as used in aeroplanes, trains, marine vessels trucks etc 1.2. Identify the various 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 various component within the system. 1.5 Explain the function of each component. 1.6 Sketch the essential parts of the equipment.	• Ask the students to: • Intemise the major differences between a normal refrigeration system and transport refrigeration system • Identify the various components of a transport refrigeration system in aeroplane, train, marine vessels, trucks etc.	• Lesson plan • Chalkboard • Transport refrigeration equipment of aeroplane, train, truck, marine, vessels, etc.

PROGRAMME: ADVANCED NATIONAL TECHNICAL CERTIFICATE IN REFRIGERATION & AIR-CONDITIONING WORK			
Course: CAR 24 - TRANSPORT REFRIGERATION		Course Code: CAR 24	Contact Hours 48 - 2hr/wk (1-1)
Course Specification: Theoretical Content			
	General Objective: 2.0 Install and Commission Common Brands of Transport Refrigeration Equipment.		
Week	Specific Learning Outcome:	Teachers Activities	Resources
	2.1 Interpret the layout of any transport refrigeration 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		
7-10	2.4 Interpret the layout diagram of a transport refrigeration for trucks, aeroplane, trains, etc. 2.6 Install the equipment - connect compressors condenser, diesel engine, etc. 2.7 Wire the circuit 2.8 Pressure test the system 2.9 Pull vacuum and charge the system 2.10 Commission the system.	• Ask the students to sketch and interpret the layout diagram of a transport refrigeration system • Ask the students to sketch and interpret the layout diagram of a transport refrigeration system	• Lesson Plan • Chalkboard • Layout diagram • Compressors • Condenser • Diesel engine, etc. • Vacuum pump • Gauge set o Hand tools e.g. sucket set, Ratchet set, etc.
	General Objective: 3.0 Diagnose faults in Common Brands of Transport Refrigeration Equipment and Repair them.		
Week	Specific Learning Outcome:	Teachers Activities	Resources
11-12	3.1 Locate and amend points of leakage using electronic or halide leak detector 3.2 Top up the system using correct 3.3 Adjust various control in the system, fan belt, speed control, etc. Start the diesel engine and repair simple faults.		• Faulty air conditioned port • Test equipment • Tool box • Protective clothing etc.

PROGRAMME: ADVANCED NATIONAL TECHNICAL CERTIFICATE IN REFRIGERATION & AIR-CONDITIONING WORK			
Course: CAR 24 - TRANSPORT REFRIGERATION		Course Code: CAR 24	Contact Hours 48 - 2hr/wk (1-1)
Course Specification: Theoretical Content			
	General Objective: 4.0 Service Transport Refrigeration Equipment.		
Week	Specific Learning Outcome:	Teachers Activities	Resources
13-15	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.	• Ask the students to intercharge the power supply from AC to DC and vice Versa	
	General Objective: 5.0 Understand the Principles of Marine Refrigeration		
Week	Specific Learning Outcome:	Teachers Activities	Resources
16-19	5.1 Explain the principles of operation of marine refrigeration system 5.2 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, drier, strainers, motor and controls. 5.3 Explain the function of each component of th system listed in 5.2 above 5.4 Interpret the installation instruction and be able to install marine refrigeration system in a vessel.	• Ask the students to embark on an excursion to witness transport equipment.	• Lesson Plan • Chalkboard • Marine equipment
	General Objective: 6.0 Diagnose and Rectify faults in Marine Refrigeration System.		
Week	Specific Learning Outcome:	Teachers Activities	Resources
20-21	6.1 Diagnose faults in the system, i.e. shortage of regrigerant, 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.		• Lesson Plan • Chalkboard • Vacuum pump • Gauge set • Hand tools e.g. sucket set, ratchet set, etc.

PROGRAMME: ADVANCED NATIONAL TECHNICAL CERTIFICATE IN REFRIGERATION & AIR-CONDITIONING WORK			
Course: CAR 24 - TRANSPORT REFRIGERATION		Course Code: CAR 24	Contact Hours 48 - 2hr/wk (1-1)
Course Specification: Theoretical Content			
	General Objective 7.0: Service Marine Refrigeration System		
Week	Specific Learning Outcome:	Teachers Activities	Resources
22-24	7.1 Ensure that all the refrigeration controls are in good order 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.	EVALUATION: • Questions and Answers • Written tests • End of module examination.	

PROGRAMME: ADVANCED NATIONAL TECHNICAL CERTIFICATE IN REFRIGERATION & AIR-CONDITIONING WORK			
Course: CAR 25 - REFRIGERATION WORK		**Course Code: CAR 25**	**Contact Hours** 36 - 1hr/wk (1-0)
Course Specification: Theoretical Content			
	General Objective: 1.0 Understand the Working Principles of Refrigeration Equipment in the Food Industry		
Week	**Specific Learning Outcome:**	**Teachers Activities**	**Resources**
1-8	1. Identify, describe and state the application of the various types of refrigeration equipment used in the food industry 2. Explain the working principles of each type and 3. describe the functions of the main components		
	1.1 Identify and state the application of the various types of refrigeration equipment used in food industry, freezers - sharp, blast, immersion soda fountains, beverage coolers, etc. 1.2 Explain the working principles of various types of refrigerating equipment listed in item 1.1 above. 1.3 Describe the function of the main component/parts, e.g. non-return valve (NRV) magnetic vlaves, pressure-regulating valve, of the refrigeration system.	• Ask the students to use diagrams to illustrate the operations of these components e.g. Non-return valves, magnetic valves, etc.	• Lesson plan • Chalkboard • Commercial • Refrigeration training unit • Ice plant • Magnetic Valve • Non Return Valve, etc.

PROGRAMME: ADVANCED NATIONAL TECHNICAL CERTIFICATE IN REFRIGERATION & AIR-CONDITIONING WORK			
Course: CAR 25 - REFRIGERATION WORK		Course Code: CAR 25	Contact Hours 36 - 1hr/wk (1-0)
Course Specification: Theoretical Content			
	General Objective: 2.0 Install, commission and maintain a Refrigeration System		
Week	Specific Learning Outcome:	Teachers Activities	Resources
	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 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 2.1 Clean the condensers and defrost the evaporators 5. Interpret the colour coding for various gases used in the refrigeration equipment.	• Teacher to demonstrate and students to practice	• Layout diagram • Lesson plan • Chalkboard • Refrigeration • Training unit • Log sheets • Excursion • R.12, R.22, etc • Gauge set • Sucket set, etc.

PROGRAMME: ADVANCED NATIONAL TECHNICAL CERTIFICATE IN REFRIGERATION & AIR-CONDITIONING WORK			
Course: CAR 25 - REFRIGERATION WORK		Course Code: CAR 25	Contact Hours 36 - 1hr/wk (1-0)
Course Specification: Theoretical Content			
	General Objective: 3.0 Diagnose faults in Refrigeration Equipment/System and rectify them.		
Week	Specific Learning Outcome:	Teachers Activities	Resources
17-24	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 refrigerant system 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.	EVALUATION: • Questions and Answers • Written Tests • End of module examination.	

Guidelines for Textbook Writers

NATIONAL/ADVANCE TECHNICAL CERTIFICATE IN REFRIGERATION AND AIR-CONDITIONING WORK

The following guidelines are suggestions from the Engineering Committees to the writers of the textbooks for the new curricula. They are intended to supplement the detailed syllabuses which have been produced, and which define the content and level of the courses.

Authors should bear in mind that the curriculum has been designed to give the students a broad understanding of applications in industry and commerce, and this is reflected in the curriculum objectives.

- One book should be produced for each syllabus
- Page size should be A4
- The front size should be 12 points for normal text and 14 point where emphasis is needed.
- Line spacing should be set to 1.5 lines
- Headings and subheadings should be emboldened
- Photographs, diagrams and charts should used extensively throughout the book, and these items must be up-to-date
- In all cases the material must be related to industry and commerce, using real life examples wherever possible so that the book is not just a theory book. It must help the students to see the subject in the context of the ´real word'
- The philosophy of the courses is one of an integrated approach to theory and practice, and as such the books should reflect this by not making an artificial divide between theory and practice.
- Examples should drawn from Nigeria wherever possible, so that the information is set in a country text.
- Each chapter should end with student self-assessment questions (SAG) so that students can check their own master of the subject.
- Accurate instructions should be given for any practical work having first conducted the practical to check that the instructions do indeed work.

• The books must have a proper index or table of contents, a list of references and an introduction based on the overall course philosophy an aims of the syllabus.

• Symbols and units must be listed and a unified approach used throughout the book.

• In case of queries regarding the contents o the books and the depth of information, the author must contact the relevant curriculum committee via the National Board for Technical Education.

• The final draft version of the books should be submitted to Nigerian members of the curriculum working groups for their comments regarding the content in relation to the desired syllabus.

List of Books and Reference

1. Workshop Process, Practices and Materials by Bruce J. Black - 2nd Ed.
2. Workshop Technology - Parts 1, 2, and 3 by Chapman.
3. Refrigeration and Air-conditioning by K.M. Gutkowski

List of Equipment

Module: Transport Refrigeration

All tools and materials in auto-air-conditioning with the under listed items.

Materials:

1. R-12 - Freon 12, 502
2. R.22 - Freon 22
3. NH 3 - Ammonia
4. Filter - Driers - ½ Flare - 7/8 Flare (Open type)

4a. Replacable core type

5. Silica Gel
6. V-Belts (assorted)
7. AF Spanners
8. Diesel Injector

Machinery & Equipment

1. Diesel generators
2. Heavy Duty Batteries
3. A/C Rectifier
4. Thermoking Refrigeratiion Unit
5. Vacuum Pump
6. Electronics leak detector
7. Tehcnometer
8. Magnetic clutches (different sizes)
9. Ammonia gas masks.

Tools

1. Torque Wrench
2. Shifting spanner
3. Allen-keys (large sizes)

Installation, Insulation of Pipes and Ducts

Tools

1. Bending springs

2. Pipe bender
3. Pipe cutter
4. Flaring kit
5. Swedging tools
6. Set of spanners
7. Ball pein hammers
8. Stock and dies
9. Stilson wrench
10. Knife
11. Screw driver (flat and Philips)
12. Pop-rivet gun-tornado guns
13. Metal shears
14. Hand drills
15. Power brush
16. Mallets
17. Rawl plug
18. Scrapeprs
19. Wire brush

Materials:

1. Duct tapes rolls
2. Adhesives e.g Evostic
3. Assorted insulating materials: cork, fibre glass, etc.
4. Copper pipe and fittings
5. Brazing rods
6. Lead, solder and fluxes
7. Emery cloth
8. Methylated spirit
9. Emery tape

Machinery/Equipment

1. Blow lamp
2. Oxygen/acetylene sets

Ice Plant

Tools

1. AF Spanners

2. Ratchet spanner
3. Set of screw drivers
4. Pliers
5. Pipe wrench
6. Big tube cutter
7. Hollow punches

Materials

1. Freon 12
2. Freon 22
3. Ammonia
4. Freon 502
5. Lubricating oil
6. Driers
7. Gasket materials

Instruments, machinery and equipment

1. Manifold gauge
2. Amprobe
3. Electronic leak detector
4. Halide
5. Dial thermometer
6. Wall thermometer
7. Graduated charging cylinder
8. Thermostatic expansion valve
9. Automatic expansion valve
10. Hand expansion valve
11. Check valve
12. Solenoid valve
13. Non-return valve
14. Pressure regulating valve
15. Magnetic valve
16. Ice plant (medium size)
17. Tiem switches
18. thermostats
19. Low pressure controls
20. High pressure controls
21. Gas masks for ammonia
22. Air compressors

Tools (Ref. Equipment for the food industry)

1. AF Spanners
2. Ratchet spanner set
3. Set of screw drivers
4. Tester screw driver
5. Fin combs
6. Pilers
7. Flaring tools
8. Pinch off tools
9. Tube cutters
10. Swedging tools
11. Allen keys
12. Stilson wrench
13. Socket spanner set

Instruments, Machinery and equipment

1. Manifold gauges with charging lines
2. Amprobe
3. Electronic leak detector
4. Halide leak detector
5. Dial thermometer
6. Wall thermometer
7. Graduated charging units
8. hermetic compressors analyzer
9. Capacitor analyzer
10. Tester screwdrivers
11. Open type condensing unit (Model)
12. Display cabinets (Model)
13. Ice maker
14. Thermostatic expansion valve
15. Automatic expansion valve
16. Hand expansion valve
17. Check valve
18. Solenoid valve
19. Non-return valves
20. Pressure regulating valve
21. Magnetic valves
22. Time switches
23. Thermostats

24. Low pressure controls
25. High pressure controls
26. Liquid valve
27. Filter drier (flange type)
28. Oxy/acetylene, welding set.

Materials:

1. Freon 12
2. Freon 22
3. Ammonia
4. Freon 502
5. Refrigeration oil (viscosity 150-300)
6. Silica gel
7. Drier cores
8. Methylated spirits
9. Oxygen cylinder
10. Acetylene cylinder

List of Participants

REFRIGERATION AND AIR-CONDITIONING

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