

DRAFT

**NATIONAL BOARD FOR TECHNICAL EDUCATION
KADUNA**

NATIONAL VOCATIONAL CERTIFICATE

IN

REFRIGERATION AND AIRCONDITIONING

CURRICULUM AND COURSE SPECIFICATIONS

August 2007

NVC IN REFRIGERATION AND AIRCONDITIONING (DRAFT)

REFRIGERATION AND AIR CONDITIONING

Goal and objectives

- (1) To produce skilled Trainee with good knowledge of the use of Refrigeration and Air Conditioning working equipment, materials, processes, procedures and safety practice.
- (2) To equip the trainee with modern trends in Refrigeration and Air-conditioning especially as it affects the use of safe refrigerants and preservation of the environment..
- (3) To equip the trainee with the knowledge and skill that will enable him carry out basic repairs and maintenance on domestic, commercial and transport refrigeration and air conditioning systems.

MODULE1. REFRIGERATION.

- (1) Technical Drawing.
- (2) Measurement in Refrigeration and Air conditioning
- (3) Principles of refrigeration
- (4) Environment, Refrigerants and Oils
- (5) Retrofits and controls
- (6) Insulation and piping
- (7) Heat exchangers

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- (8) Load estimation
- (9) Gas welding
- (10) Automobile A C
- (11) Absorption Refrigeration
- (12) Mathematics
- (13) English Language
- (14) Entrepreneurship
- (15) Industrial Attachment
- (16) Physics
- (17) Chemistry

MODULE 2 AIR CONDITIONING

- (1) Technical Drawing
- (2) Measurement in Refrigeration and Air Conditioning
- (3) Principles of Refrigeration
- (4) Compressors and Motors

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- (5) Sheet metal Work
- (6) Environment, Refrigerants and Oils
- (7) Retrofits and Controls
- (8) Insulation and Piping
- (9) Heat Exchangers
- (10) Load Estimation
- (11) Gas Welding
- (12) Automobile Air Conditioning
- (13) Absorption Air Conditioning
- (14) Basic Air Conditioning Work
- (15) Mathematics
- (16) English Language
- (17) Entrepreneurship
- (18) Industrial Attachment
- (19) Physics

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(20) Chemistry

MODULE 3 COMPRESSORS AND MOTORS

(1) Technical Drawing

(2) Measurement in Refrigeration and Air Conditioning

(3) Principles of Refrigeration

(4) Compressors and Motors

(5) Environment, Refrigerants and Oils

(6) Gas Welding

(7) Arc Welding

(8) Mathematics

(9) English Language

(10) Entrepreneurship

(11) Industrial Attachment

(12) Physics

(13) Chemistry

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PROGRAMME DURATION

The VEI Refrigeration and Air Conditioning programme is designed in flexible modular form into three parts. Each part is connected to the other two parts but yet can be taken independently. The three parts are:

Part I	Vocational Refrigeration
Part II	Vocational Air Conditioning
Part III	Vocational compressor work

Each of the modules will last for one year with the entire programme running for three years.

PROGRAMME EVALUATION

The curriculum is composed of 80% practical work and 20% theoretical work.

For the purposes of valuation and examination, the VEI Refrigeration and Air Conditioning programme valuation will be based on evidence of practical attainment, evidence of industrial attachment, continuous assessment and final terminal examination.

The distribution of the evaluation marks is as follows:

Workshop Practical	40%
Industrial Attachment	20%
Continuous Assessment	20%
Terminal Examination	20%
Total	100%

INDUSTRIAL ATTACHMENT: Each candidate is expected to undergo an Industrial Attachment in a relevant industry at the end of each year's module for the first two years. Part III trainees will undergo their own Industrial Attachment at the end of first term. The Industrial Attachment should last for a minimum period of three (3) months. The Institution is expected to have an MOU with any industries it will send its trainees for industry based experience. In that regard, the candidate will be assessed by the industry based supervisor who must be an expert

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in the trainee's field of choice. The school based supervisor should in turn grade the trainee based on the trainee's log book, written report and oral/practical defence.

CURRICULUM TABLE FOR NATIONAL VOCATIONAL CERTIFICATE PROGRAMME IN REFRIGERATION AND AIRCONDITIONING																											
S/N	SUBJECT CODE	MODULE	YEAR 1 REFRIGERATION						YEAR 2 (AIR CONDITIONING)						YEAR 3(COMPRESSOR MTCE)												
			TERM 1		TERM 2		TERM 3	TERM 1		TERM 2		TERM 3		TERM 1		TERM 2		TERM 3									
			T	P	T	P	T	P	T	P	T	P	T	P	T	P	T	P	T	P							
1	VTD11-33	Technical Drawing	-	3	-	3	-	3	-	3	-	3	-	3	-	3	-	-	-	3	288						
2	VRM11-13	Measurement in R & A	1	3	1	3	1	3	ELECTIVE												ELECTIVE		144				
3	VVR11-13	Principles of Refrigeration	2	4	2	4	2	4													216						
4	VCP13-33	Compressors and Motors	-	-	-	-	1	3	1	3	1	3	1	3	1	3			2	6	336						
5	VSM21-33	Sheet Metal Work							2	3	2	3	1	4	2	3			2	3	300						
6	VER11-13	Environments, Refrigerants and Oils	2	-	2	-	1	3	ELECTIVE																		96
7	VIP11-13	Insulation & Piping	1	2	1	2	1	2	ELECTIVE						-	-					-	-	144				
8	VHE11-23	Heat Exchangers	1	3	1	3	1	3	1	3	1	3	1	3	-	-			-	-	288						
9	VLE21-23	Load Estimation	-	-	-	-	-	-	1	3	1	3	1	3	-	-			-	-	144						
10	VGW11-33	Gas Welding	1	3	1	3	1	3	1	3	1	3	1	3	1	3			1	3	384						
11	VAA21-23	Automobile Air-conditioning	-	-	-	-	-	-	1	3	1	3	1	3	-	-			-	-	144						
12	VAR11-13	Absorption System	2	3	2	3	2	3							-	-			-	-	180						
13	PHY11-33	Physics	2	-	2	-	2	-	2	-	2	-	2	-	2	3			2	3	264						
14	CHM11-33	Chemistry	2	-	2	-	2	-	2	-	2	-	2	-	2	3			2	3	264						
15	VAM21-23	Basic Air-conditioning Work							1	3	1	3	1	3							144						
16	VAW31-33	Metal Arc Welding	-	-	-	-	-	-	-	-	-	-	-	-	2	6			2	2	192						
17	VMA11-33	Mathematics	2	-	2	-	2	-	2	-	2	-	2	-	2	-			2	-	180						
18	VEN11-33	English Language	2	-	2	-	2	-	2	-	2	-	2	-	2	-			2	-	180						
19	VBM12-33	Entrepreneurship	-	-	2	-	2	-	-	-	-	2	-	2	-	-			-	2	144						
20	VIT100-300	Industrial Attachment	-	4	-	-	-	4	-	-	-	-	-	4	-	-											

INDUSTRIAL TRAINING

INDUSTRIAL TRAINING

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21	VRC12-13	Retrofits & Controls	-	-	2	4	2	4	-	-	ELECTIVE			144
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COURSE: Load Estimation

COURSE CODE: VLE 21, 22 and 23

GOAL: This programme is designed to equip the trainee with skill in selecting appropriate Refrigeration and Air Conditioning equipment based on need.

GENERAL OBJECTIVES: On completion of this course, the trainee will be able to:

- 1.0 Estimate the load of a cold store
- 2.0 Estimate load from different sources

DURATION: Three terms i.e. the three terms of year II

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PROGRAMME: NATIONAL VOCATIONAL CERTIFICATE IN REFRIGERATION AND AIRCONDITIONING						
COURSE: LOAD ESTIMATION		COURSE CODE: VLE 21-23		CONTACT HOURS: 144		
GOAL: On completing this programme the trainee will be able to select appropriate Refrigeration and Air-conditioning equipment based on need.						
COURSE SPECIFICATION: Theoretical Contents:				Practical Contents:		
1.0	General Objective 1.0: Estimate the Load Of a Cold Store			General Objective 1.0: Estimate the Load Of a cold store		
WEEK	Specific Learning Objective	Teachers Activities	Learning Resources	Specific Learning Objective	Teachers Activities	Learning Resources
1-24	1.1 Calculate heat leakage through composite walls using: Heat leakage $Q = A \times U \times TD$ where U is the over all heat transfer coefficient given as $1/U = 1/h_o + k/x + 1/h_i$ h_o = outside film coefficient k = thermal conductivity of wall material x = thickness of wall h_i = inside film coefficient, A= total surface area and TD = temperature difference.	-Solve problems using given formulae as in 1.1-1.5	1. Chalkboard 2. Thermometer 3. Meter Rule 4. Vernier Caliper 5. Tables 6. Charts	1. Solve problems using given formulae	- Ask student to solve problems using given formulae.	1. Charts 2. Tables 3. Thermometer 4. Meter Rule 5. Vernier Caliper

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	<p>1.2 Calculate the product load using: $Q=mcTD$ where m=mass of product, c= specific heat capacity, TD= Temp. Difference.</p> <p>1.3 Estimate for service load by adding 10-25% of heat leakage depending on store usage.</p> <p>1.4 Estimate for miscellaneous load by adding the entire load from heat generating equipment, lighting and occupants.</p> <p>1.5 Appreciate the use of safe factor 5-10%</p> <p>1.6 Select appropriate unit for a cold room with manufacturer's catalogue for use.</p>					
	General Objective: 2.0 Estimate Load from Different Sources.			General Objective: Estimate Load from Different Sources.		
WEEK	Specific Learning Objective	Teachers Activities	Learning Resources	Specific Learning Objective	Teachers Activities	Learning Resources
25-36	<p>2.1 Estimate load from external sources.</p> <p>- $Roof=A \times K_r \times TD$</p>	-Estimate load from different external and	<p>1. Charts</p> <p>2. Tables</p> <p>3. Thermometer</p>	<p>1. Estimate load from roof, walls, glazed windows, infiltration,</p>	<p>Ask student to estimate load from different</p>	<p>1. Charts</p> <p>2. Tables</p> <p>3. Thermometer</p>

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<ul style="list-style-type: none"> - Walls=$n \times A \times K_w \times TD$ - Glazed windows - Infiltration - Occupancy <p>Where A=Area K_r= Conduction coefficient of roofing material K_w=Conduction coefficient of the wall n=Number of walls.</p>	internal sources.	4. Meter Rule 5. Chalkboard	occupancy, equipment etc.	sources.	4. Meter Rule
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ASSESSMENT:

20% Theory

80% Practical

NVC IN REFRIGERATION AND AIRCONDITIONING (DRAFT)

COURSE: Heat Exchangers

COURSE CODE: VHE 11, 12, 13, 21, 22 and 23

GOAL: This programme is designed to equip the trainee with the operational principles, services, care, and maintenance of heat exchangers and the technicalities of selecting common types used in Refrigeration and Air-conditioning.

GENERAL OBJECTIVES: On completion of this course, the trainee will be able to:

- 1.0 Understand safety with heat applications
- 2.0 Know the operation of heat exchangers
- 3.0 Select appropriate heat exchangers based on determined system capacity
- 4.0 Construct condensers and evaporators

DURATION: Three terms i.e. the three terms of year II

NVC IN REFRIGERATION AND AIRCONDITIONING (DRAFT)

PROGRAMME: NATIONAL VOCATIONAL CERTIFICATE IN REFRIGERATION AND AIR CONDITIONING						
COURSE: HEAT EXCHANGERS			COURSE CODE: VHE 11 - 23		CONTACT HOURS: 288	
GOAL: This programme is designed to equip the trainee with the operational principles, services, care and maintenance of heat exchangers and technicalities of selecting common types used in Refrigeration and Air-conditioning.						
COURSE SPECIFICATION: Theoretical Contents:				Practical Contents:		
1.0	General Objective 1.0: Understand Safety with Heat Applications			General Objective 1.0: Understand Safety with Heat Applications		
WEEK	Specific Learning Objective	Teachers Activities	Learning Resources	Specific Learning Objective	Teachers Activities	Learning Resources
1-3	1.1 Explain the safety involved in working with heat 1.2 Explain how one can protect oneself when working with heat	-Explain safety in the workshop -Explain the importance of protective materials when working under heat environment	1. Protective clothing 2. Face shield 3. Hand gloves	1.3 Discuss the safety involved in working with heat 1.4 Discuss how one can protect oneself when working with heat	-Discuss safety in the workshop -Discuss the protective materials needed when working under heat environment	1. Protective clothing 2. Face shield 3. Hand gloves
2.0	General Objective 2.0: Know the Operation of Heat Exchangers			General Objective 2.0: Know the Operation of Heat Exchangers		
4-30	2.1 Explain the methods of heat transfer: - Conduction - Convection - Radiation	-Show and draw types of heat exchangers. -Explain the principles of	-Heat exchangers -Chalk board -Charts -Wire brushes	1. Draw types of heat exchangers 2. Demonstrate the principles of operation of each of the heat exchangers.	-Ask students to draw various types of heat exchangers -Guide students in servicing heat	1. Heat exchangers. 2. Charts. 3. Wire brushes

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<p>2.2 Explain the operation of heat exchangers.</p> <p>2.3 Compare a heat engine with Refrigeration or Air conditioning plant.</p> <p>2.4 Describe types of heat exchangers</p> <ul style="list-style-type: none"> - Shell and coil - Shell and tube - Double pipe - Tube in tube etc. <p>2.5 Describe the general service and maintenance of heat exchangers mentioned in 2.4 above</p> <p>2.6 Explain fouling in heat exchangers</p> <p>2.7 Identify factors influencing fouling</p> <p>2.8 Identify ways to prevent fouling</p> <p>2.9 Explain corrosion and factors affecting corrosion</p> <p>2.10 Identify ways to prevent corrosion in heat exchangers</p>	<p>operation of each of the heat exchangers.</p> <p>- Describe, Explain and identify as in 2.5 – 2.10</p>	<p>-Antifouling and anti corrosion additives</p>	<p>3. Maintain and service heat exchangers by cleaning and air blowing</p>	<p>exchangers</p>	<p>4. Anti corrosion additives.</p>
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3.0	General Objective 3.0: Select Appropriate Heat Exchanger Based on Determined System Capacity.			General Objective 3.0: Select Appropriate Heat Exchanger Based on Determined System Capacity		
WEEK	Specific Learning Objective	Teachers Activities	Learning Resources	Specific Learning Objective	Teachers Activities	Learning Resources
31-50	3.1 Select an air cooled condenser for a given system capacity. 3.2 Select a water cooled condenser for a given system capacity. 3.3 Use data books and charts for applicable information.	- Solve condenser selection problems using applicable charts and tables. - Do same for evaporators.	1. Charts 2. Data books 3. Chalkboard	- Solve condenser selection problems using applicable charts and tables. - Do same for evaporators.	- ask students to solve problems on condenser selection for a given system capacity - Ask students to do same for evaporators	1. Charts 2. Data books.
4.0	General Objective 4.0: Construct Condensers and Evaporators.			General Objective 4.0: Construct Condensers and Evaporators.		
WEEK	Specific Learning Objective	Teachers Activities	Learning Resources	Specific Learning Objective	Teachers Activities	Learning Resources
51-72	4.1 Explain the purpose of evaporators and condensers in refrigeration and air-conditioning. 4.2 Explain the importance of fins in heat exchangers. 4.3 Construct simple evaporator and condenser. 4.4 Practice fin-tube combinations.	-explain 4.1 and 4.2 -Demonstrate the construction of simple evaporator and condenser - Demonstrate fin-tube combinations.	1. Tool box 2. HX 3. Sheet metal 4. Easy flow 5. Brazing equipment. 6. Flux 7. OXY-acetylene welding	1. Construct simple condensers and evaporators 2. Practice pipe flaring, swaging, soldering and welding.	Ask students to: -Construct simple condensers and evaporators. - Practice pipe flaring, swaging, soldering and welding and brazing.	1. Data books 2. HX 3. Tool box 4. Brazing equipment etc.

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	<p>3.1 Braze fins, elbows and copper tubes together.</p> <p>3.2 Select the right size of fins for condensers/evaporators by using manufacturer's catalogue.</p> <p>3.3 State the functions of liquid receivers in cooling refrigerants.</p>	<p>- Guide students to select fins for condensers and evaporators.</p> <p>- Demonstrate pipe flaring, swaging soldering, welding and brazing</p>	<p>equipment</p> <p>8. Cutters</p> <p>9. flaring and swaging tools</p>			
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ASSESSMENT:

20% Theory

80% Practical

NVC IN REFRIGERATION AND AIRCONDITIONING (DRAFT)

COURSE: Basic Air Conditioning Work

COURSE CODE: VAM 21, 21 and 23

GOAL: This programme will enable the trainee to understand and apply the principles of air conditioning in equipment maintenance.

GENERAL OBJECTIVES: On completion of this course, the trainee will be able to:

- 1.0 Understand safety rules in air conditioning applications
- 2.0 Know the basic principles of air conditioning
- 3.0 Understand psychrometric processes
- 4.0 Understand the air cycle

DURATION: Three terms i.e. the three terms of year II

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PROGRAMME: NATIONAL VOCATIONAL CERTIFICATE IN REFRIGERATION AND AIRCONDITIONING						
	Course: Basic Air-conditioning Work		Course Code: VAM 21-23		Contact Hours: 144 hours	
GOAL: On completing this programme the trainee will be able to understand and apply the principles of air conditioning in equipment maintenance						
	Theoretical Content			Practical Content		
1.0	General Objective 1.0: Understand safety rules in air conditioning applications			General Objective 1.0: Understand safety rules in air conditioning applications		
Week	Specific Learning Outcomes	Teacher's activities	Resources	Specific Learning Outcomes	Teacher's activities	Resources
1-4	1.1 State the sources of hazards in an air conditioning workshop and how to prevent them 1.2 Name safety equipment and wears essential in an air conditioning workshop 1.3 Understand the use of safety charts 1.4 Understand the handling of some tools in an air conditioning workshop 1.5 Understand first aid application in air conditioning workshop accidents.	- Explain sources of hazards such as fire, explosion, pollution, electrocution etc. and their prevention - Explain the importance of safety equipment and wears such as fire extinguisher, sand bucket, etc. - Explain the importance of safety charts - Explain the importance of first aid.	1. Safety equipment and wears such as fire extinguisher, sand bucket, boots, overalls etc. 2. Safety charts 3. First aid box	1. Demonstrate safe ways of handling some basic tools in the air conditioning workshop 2. Demonstrate safe ways to handle fire, pollution and electrocution sources 3. Demonstrate simple first aid treatment in emergency cases e.g. artificial respiration, cold compress etc.	- Demonstrate 1-3 as shown under practical objectives and have trainees practice same.	1. Safety equipment and wears such as fire extinguisher, sand bucket, boots, overalls etc. 2. Safety charts 3. First aid box

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2.0	General Objective 2.0 Know the basic principles of Air Conditioning			General Objective 2.0 Know the basic principles of Air Conditioning		
Week						
5-16	2.1 Define air-conditioning. 2.2 Explain the importance of air-conditioning in industrial and comfort applications 2.3 Describe the basic principles of air-conditioning system. 2.4 Identify the components of an air-conditioning system and their functions. 2.5 Compare air-conditioning system and refrigeration system.	- Explain the importance of Air Conditioning - identify and describe the components of an air-conditioning system.	1. Chalk board 2. System components	1. Draw and describe the components of an air conditioning system	- Ask the students to describe the basic components of an air conditioning system including the necessary drawing	1. Texts 2. Charts
	General Objective 3.0: Understand Psychrometric Processes			General Objective 3.0: Understand Psychrometric Processes		
16-26	3.1 Describe a sling psychrometer 3.2 Use psychrometric chart to determine the following: Relative humidity, dew point temperature, humidity ratio, enthalpy per unit mass, specific volume etc.. 3.3 Describe air-conditioning	- Plot various air-conditioning processes on psychrometric chart and ask students to practice same. - Demonstrate the use of sling	1. Lesson plan 2. Chalkboard 3. sling Psychrometer 4. Psychrometric chart	1. Use a sling psychrometer or psychrometric chart to determine R.H, Dew point, Humidity ration, Enthalpy per unit mass of air etc.	- Ask the students to plot various air-conditioning processes on psychrometric chart. -Ask the students to demonstrate the use of sling	Psychrometer Psychrometric chart

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	processes like: humidification, dehumidification, heating and dehumidification etc.	Psychrometer			Psychrometer. -Ask students to solve exercises on air-conditioning processes.	
	General Objective 4.0: Understand the air cycle			General Objective 4.0: Understand the air cycle		
27-36	4.1 Identify the following components in the air cycle: - Fan - Supply ducts - Supply outlets - Return outlets - Return ducts - Filter - Grilles - Registers - Heating or cooling coil 4.2 Sketch the air conditioning cycle 4.3 Distinguish between the window, split, packaged, and central air- conditioning units.	- Identify the components mentioned in 4.1. - Sketch air- conditioning cycle. - Distinguish between various types of air conditioning units.	1. Components of air handling unit 2. Charts 3. Live units	1. Draw and explain the components of air cycle. 2. Install central air- condition ducts, grilles and duct insulation. 3. Maintain air handling units.	Ask the students to: - Draw and explain the functions of the components of air handling unit. - Identify the components of units while on excursion. - sketch and describe the air conditioning cycle	1. Samples of the components mentioned 2. Texts 3. Charts 4. Live units

ASSESSMENT:

20% Theory

80% Practical

NVC IN REFRIGERATION AND AIRCONDITIONING (DRAFT)

COURSE: Insulation and Piping

COURSE CODE: VIP11, 12 and 13

GOAL: This programme is designed to provide the trainee with the requisite knowledge on insulation and piping techniques.

GENERAL OBJECTIVES: On completion of this course, the trainee will be able to:

1.0 Understand Insulation

2.0 Understand Piping

3.0 Carry out projects on Piping and Insulation

DURATION: Three terms i.e. the three terms of year 1

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PROGRAMME: NATIONAL VOCATIONAL CERTIFICATE IN REFRIGERATION AND AIRCONDITIONING						
Course: Insulation and Piping		Course Code: VIP 11 -13			Contact Hours: 144	
GOAL: This program is designed to provide the trainee with the requisite knowledge on insulation and piping techniques						
	Theoretical Content			Practical Content		
	General Objective 1.0: Understand Insulation			General Objective 1.0 Understand Insulation		
Week	Specific Learning Outcomes	Teacher's activities	Resources	Specific Learning Objective	Teacher's activities	Resources
1-18	1.1 Identify various types of insulation materials. 1.2 Explain the importance of insulation in Refrigeration and Air-conditioning. 1.3 State the properties of good insulation materials 1.4 Carry out a simple project to show heat loss prevention by lagging/insulation e.g. construction of an oven 1.5 Select local materials for insulation work e.g. wood, saw dust, mud, grass etc.	- Identify various types of insulation materials and explain their importance in refrigeration and air-conditioning work. - State the properties of good insulation materials. - Ask students to identify tools used in insulation work and their particular uses.	1. Insulation materials 2. Glue 3. Chalkboard.	1. Select insulation material for various temperature ranges 2. Fix insulation materials to pipes, walls of ducts using adhesives, insulating tapes, rivets etc. 3. Maintain insulation in air-conditioning and refrigeration	- Ask students to carry out (1) – (3)	1. Insulation materials 2. Scissors 3. Glue 4. Accessories 5. Copper pipes 6. Flaring tools 7. Sand paper etc.

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General Objective 2.0 Understand Piping				General Objective 2.0 Understand Piping		
Theoretical Content				Practical Content		
Week	Specific Learning Outcomes	Teacher's activities	Resources	Specific Learning Objective	Teacher's activities	Resources
19-36	2.1 Identify various types of pipes used in Refrigeration and Air-condition e.g. copper, aluminum and steel. 2.2 Select and describe tools and equipment used for pipe installation 2.3 Identify the sizes of pipes used in the condensers and evaporators of various Air-condition and Refrigeration units e.g. refrigerators, window units, packaged units etc 2.4 List out the activities for piping and insulating.	<ul style="list-style-type: none"> - Identify various pipes used in Refrigeration and Air-conditioning. - Ask students to identify the various tools used in piping - Ask student to identify sizes of pipes used in condensers and evaporators of different units. 	1. Chalkboard 2. Piping tools 3. Various types of pipes 4. Insulation materials	1. Identify different types of pipes and their applications. 2. Demonstrate the piping and insulation of a deep freezer. 3. Interpret installation drawing of pipes and ducts for air-conditioning and refrigeration work.. 4. Describe precautionary measures to be taken while installing pipe and ducts. 5. Bend pipes to specification required using bending machines and springs. 6. Cut pipes to length using pipe cutter. 7. Practice flaring and swaging.	<ul style="list-style-type: none"> - Ask students to identify different types of pipes and their applications. - Guide students in carrying out the piping and insulation of a deep freezer. - Ask students to carry out 3 – 7 under general objectives 2.0 practical. 	1. Piping tools 2. Various types and sizes of pipes 3. Insulation materials 4. Bending Machine. 5. Swaging tools 6. Flaring tools 7. Cutter

ASSESSMENT

20% theory

80% practical

NVC IN REFRIGERATION AND AIRCONDITIONING (DRAFT)

COURSE: Compressors and Motors

COURSE CODE: VCP 13, 21, 22, 23, 31 and 33

GOAL: At the end of this course the trainee will be able to identify different types of compressors and motors, understand their working principles and carry out simple maintenance services.

GENERAL OBJECTIVES: On completion of this course, the trainee will be able to:

- 1.0 Classify Compressors
- 2.0 Know operations of Compressors
- 3.0 Understand the performance and capacity of reciprocating Compressors
- 4.0 Service Compressor valves
- 5.0 Know the methods of adjusting the safety devices of Compressors
- 6.0 Understand the working principles of capacity controls on the compressor
- 7.0 Maintain and repair electric Motors

DURATION: Six terms i.e. the third term of year 1, the three terms of year II, the first and third terms of year III

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PROGRAMME: : NATIONAL VOCATIONAL CERTIFICATE IN REFRIGERATION AND AIRCONDITIONING						
Course: Compressors		Course Code: VCP 13 - 33			Contact Hours: 336	
GOAL: At the end of this course the student will be able to identify different types of compressors and motors, understand their working principles and carry out simple maintenance services.						
Theoretical Content				Practical Content		
General Objective 1.0: Classify compressors				General Objective 1.0: Classify compressors		
Week	Specific Learning Outcomes	Teacher's activities	Resources	Specific Learning Outcomes	Teacher's activities	Resources
1-12	<p>1.1 List and explain the various types of compressors e.g. hermetic, semi-hermetic and open types</p> <p>1.2 Differentiate between the following types of compressors – reciprocating, rotary, and centrifugal and screw.</p> <p>1.3 Explain the applications of the compressors mentioned in 1.2 above</p> <p>1.4 Draw and explain the</p>	<ul style="list-style-type: none"> - Explain the various types of compressor. - Explain the applications of the compressors mentioned above. - Explain compression in a rotary compressor - Explain the importance of accumulator and crank case heater to the compressor 	<p>1. Compressor</p> <p>2. Models</p> <p>3. Crank Case heater</p> <p>4. Accumulator</p>	<p>1. Identify compressors and their applications.</p> <p>2. Draw and explain the principle of operation of each of the compressors.</p>	<ul style="list-style-type: none"> - Ask the student to carry out (1 and (2) as is under specific learning objective. - Ask the student to draw a crank case heater and explain its function - Sketch the position of the accumulator as a part of the evaporator 	<p>1. Compressor</p> <p>2. Models</p>

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	<p>principle of operation of each of the compressors mentioned in 1.2 above.</p> <p>1.5 Explain the cooling of motor winding in hermetically sealed compressors.</p> <p>1.6 Explain the methods of compression in a rotary compressor.</p> <p>1.7 Explain the role of accumulator and crank case heater in preserving the computer.</p>					
	General Objective 2.0: Know operation of compressors			General Objective 2.0: Know operation of compressors		
13-24	<p>2.1 Explain the construction and operating principles of compressors in common use.</p> <p>2.2 Identify the components of the</p>	<ul style="list-style-type: none"> - Explain 2.1 – 2.3 - Demonstrate the dismantling and re-assembling of various compressors - Identify and draw the 	<p>1. Compressors</p> <p>2. Models</p> <p>3. Chalkboard</p>	<p>1. Draw the various components of any compressors.</p> <p>2. Dismantle and reassemble various types of compressors</p>	<ul style="list-style-type: none"> - Ask students to identify and draw components of any compressors 	<p>1. Compressors</p> <p>2. Models</p> <p>3. Chalkboard</p>

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	compressor. 2.3 Explain the functions of each component. 2.4 Dismantle and reassemble various types of compressors.	components of compressors			- Ask the student to reassemble various types of dismantled compressor	
	General Objective 3.0: Understand the Performance and Capacity of Reciprocating compressors			General Objective 3.0: Understand the Performance and Capacity of Reciprocating compressors		
25-36	3.1 Explain the compression cycle of reciprocating compressor. 3.2 Explain single and double acting compressors. 3.3 Calculate the piston displacement of single acting reciprocating compressor as Piston displacement $V_p = \frac{\pi D^2 L \times RPM \times n}{4}$ Where $\pi = 22/7$, D=	- Describe compression cycle of reciprocating compressors. - Describe single and double acting compressors. - Calculate the piston displacement of single acting reciprocating Compressors - Calculate the theoretical and actual refrigeration	1 Reciprocating compressor 2 Chalkboard	1. Calculate the theoretical and actual capacity of a reciprocating compressor. 2. Calculate the piston displacement of single acting reciprocating compressor	- Ask the students to carry out exercises on the capacity and piston displacement of reciprocating compressors.	Compressor 2. Charts 3. Models

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	diameter of piston, RPM = crankshaft revolution per minute, L = length of stroke and n = number of cylinders.	capacity of the compressor.				
General Objective 4.0: Service Compressor Valves			General Objective 4.0: Service Compressor Valves			
37-46	<p>4.1 Retrieve and inspect compressor valves.</p> <p>4.2 Practice valve lapping using appropriate lapping paste.</p> <p>4.3 Reassemble and adjust service valves for correct functioning.</p> <p>4.4 Heat test the system.</p>	<p>- Ask student to demonstrate stripping of valve components.</p> <p>- Ask student to: (i) practice valve lapping (ii) reassemble and adjust the valves correctly.</p>	<p>1. Grinding paste 2. Smooth sand paper 3. Oil etc.</p>	<p>1. Practice valve lapping 2. Reassemble and adjust service valves for correct functioning.</p>	<p>-Ask the students to carry out valve lapping</p> <p>- Demonstrate Re-assembling and adjustment of service valves and have students do the same</p>	<p>Grinding past Smooth sand paper Oil etc.</p>
General Objective 5.0 Know the methods of adjusting the safety devices of compressors			General Objective 5.0 Know the methods of adjusting the safety devices of compressors			
47-58	5.1 Identify and explain the functions of high pressure cut out.					

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	<p>5.2 Set low and high pressure cut outs.</p> <p>5.3 Adjust thermostats and switches of the system.</p> <p>5.4 Locate relay and overload appropriately.</p> <p>5.5 Identify and explain functions of thermal limiter and superheat switch.</p> <p>5.6 Diagnose faults that have to do with electrical circuitry e.g</p> <p>(i) faulty compressor motor, open circuit, short circuit etc</p> <p>(ii) adjust time switch thermostat, time delay relay and starter.</p>	<p>- Ask the student to identify the safety devices as mentioned in 5.1 – 5.5 under specific learning outcomes.</p>	<p>1. Screw drivers</p> <p>2. Test pen</p> <p>3. Various safety devices e.g. thermostats, relays, overloads etc.</p>	<p>1. Identify safety devices.</p> <p>2. State their appropriate applications.</p> <p>3. Draw and label some of them.</p> <p>4. Locate safety devices appropriately</p>	<p>- Ask the student to</p> <p>i) Identify safety devices</p> <p>ii) State the functions of various safety devices</p> <p>iii) Draw and label various safety devices</p> <p>iv) Locate various safety devices appropriately</p>	<p>1. Screw drivers</p> <p>2. Test pen</p> <p>3. Safety devices such as thermostats, relays, overloads etc</p>
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NVC IN REFRIGERATION AND AIRCONDITIONING (DRAFT)

	General Objective 6.0: Understand the working principles of capacity controls on the compressor			General Objective 6.0: Understand the working principles of capacity controls on the compressor		
59-65	<p>6.1 Identify the various types of capacity controls and explain the principle of operation of each.</p> <p>6.2 Diagnose faults in capacity controls</p> <p>6.3 Adjust or replace capacity controls.</p>	- Ask the student to identify, diagnose and adjust as in 6.1 – 6.3.	<p>1. Controls</p> <p>2. Compressor</p> <p>3. Models</p> <p>4. Chalkboard</p>	<p>1. Explain different methods of capacity control using illustrative diagrams</p> <p>2. Diagnose faults in capacity controls</p> <p>3. Demonstrate the adjustment of capacity controls</p>	<p>-Ask the student to explain different methods of capacity controls using illustrative diagrams</p> <p>-Guide students to adjust capacity controls.</p> <p>-Supervise students in diagnosing faults in capacity controls.</p>	<p>1. Various controls</p> <p>2. Models</p> <p>3. Compressor</p>
	General Objective 7.0: Maintain and repair electric motors			General Objective 7.0: Maintain and repair electric motors		
66-72	<p>7.1 Distinguish between 3-phase and single phase motors</p> <p>7.2 Identify types of single phase motors</p> <p>7.3 Identify types of starters e.g. direct on line, star delta etc.</p>	-Explain 7.1-7.4	<p>1. Motors</p> <p>2. Starters</p> <p>3. Models</p> <p>4. Chalkboard</p>	<p>1. Explain and distinguish between single and 3-phase motors</p> <p>2. Identify different types of starters</p> <p>3. Practice rewinding</p>	<p>-Ask the student to carry out exercises 1-3</p>	<p>1. Motors</p> <p>2. Starters</p> <p>3. Models</p>

NVC IN REFRIGERATION AND AIRCONDITIONING (DRAFT)

	7.4 Practice the rewinding of motor coils					
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ASSESSMENT:

20% theory

80% practical

NVC IN REFRIGERATION AND AIRCONDITIONING (DRAFT)

COURSE: Sheet Metal Work

COURSE CODE: VSM 21, 22, 23, 31 and 33

GOAL: This course will equip the trainee with the techniques of fabricating air conditioning ducts using sheet metal.

GENERAL OBJECTIVES: On completion of this course, the trainee will be able to:

- 1.0 Understand safety rules in sheet metal works
- 2.0 Apply appropriate tools and techniques to mark out and form projects in sheets of metals
- 3.0 Cut and form joints with sheets of metal
- 4.0 Rivet and drill sheet metal work
- 5.0 Solder and braze sheets of metal
- 6.0 Understand processes used to produce sheet metal projects

DURATION: Five terms i.e. the three terms of year II, first and third terms of year III

NVC IN REFRIGERATION AND AIRCONDITIONING (DRAFT)

PROGRAMME: : NATIONAL VOCATIONAL CERTIFICATE IN REFRIGERATION AND AIRCONDITIONING						
Course: Sheet Metal Work		Course Code: VSM 21 - 33		Contact Hours 180		
GOAL: This programme will equip the trainee with the techniques of fabricating air-conditioning ducts using sheet metals						
Theoretical Content				Practical Content		
General Objective 1.0 Understand safety rules in sheet metal works				General Objective 1.0 Understand safety rules in sheet metal works		
Week	Specific Learning Outcomes	Teacher's activities	Resources	Specific Learning Outcomes	Teacher's activities	Resources
1-3	1.1 Identify sources of risks or hazards in sheet metal works and how to prevent them 1.2 Name the safety equipment and wears necessary for sheet metal works 1.3 Understand the handling of some tools in the sheet metal workshop 1.4 Know the use or importance of safety charts.	- Explain sources of hazards such as wrong workshop arrangement, wrong weight lifting methods etc. - Explain how to prevent the hazards mentioned above - Explain the importance of safety charts - Show a film on industrial safety	1. Safety equipment such as boots, gloves etc. 2. Safety charts 3. T.V.	1. Demonstrate safe ways of handling some basic tools used in sheet metal works 2. Improvise the making of safety charts and warning symbols	- Demonstrate safe handling of some basic tools used in sheet metal works - Ask the trainees to draw some safety charts and make some warning symbols	1. safety charts 2. T.V.
General Objective 2.0 Apply appropriate tools and techniques to mark out and form projects in sheets of metal				General Objective 2.0 Apply appropriate tools and techniques to mark out and form projects in sheets of metal		
Week						
4-14	2.1 Identify tools used in	- Identify the tools	1. Marking and	1. Mark and form	- Ask the student to	1. Marking

NVC IN REFRIGERATION AND AIRCONDITIONING (DRAFT)

	<p>marking and cutting sheet metal. 2.2 Mark out the following projects: - rectangular container Funnels -Cylindrical container. 2.3 Cut sheet metal to the shapes marked in 2.2 above. 2.4 Form sheet metal to the shapes cut in 1.3 above.</p>	<p>used in marking and cutting sheet metal. - Ask the student to mark out certain projects and cut and form their shapes.</p>	<p>cutting tools 2. Chalkboard 3. Riveting Machine 4. Drilling machine</p>	<p>projects in sheet metal work.</p>	<p>identify and sketch some of the tools used for marking and cutting. - Give the student some projects on marking, cutting and forming shapes on sheet metals.</p>	<p>and cutting tools. 2. Bench Vice 3. Riveting Machine 4. Drilling machine</p>
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NVC IN REFRIGERATION AND AIRCONDITIONING (DRAFT)

	General Objective: 3.0 Cut and form joints with sheet metal			General Objective: 3.0 Cut and form joints with sheet metal		
15-24	<p>3.1 Calculate the allowance for joint using the formula grooved seam = 11/2x width of groover.</p> <p>3.2 Make the following joints: Solid corner joint, grooved seam joint, panned down joint, knocked up joint.</p> <p>3.3 Sketch the joint allowance in 3.1 above on the materials and notch the joints.</p>	<ul style="list-style-type: none"> - Explain 3.1 – 2.3 and ask student to do same. 	Same as in 1.0 above	<p>1. Demonstrate the making of different types of joints.</p>	<ul style="list-style-type: none"> - Ask the students to sketch and make different types of joints 	<p>1. Marking tools 2. Cutting tools Etc.</p>
	General Objective 4.0: Rivet and drill sheet metal work			General Objective 4.0: Rivet and drill sheet metal work		
25-36	<p>4.1 Name some rivets used in metal work and state their properties.</p> <p>4.2 Sketch common faults in riveting e.g. overlapping, cracked rivet, uneven ends etc.</p> <p>4.3 Drill and punch holes on joints for riveting, making sure that burrs are removed.</p>	<ul style="list-style-type: none"> - Name the types of rivets used in metal work. - Guide student in carrying out 4.2 – 4.4. 	<p>1. Riveting machine 2. Drilling machine 3. Chalkboard 4. Drill bits 5. Marking tools e.g. scribbers and centre punch</p>	<p>1. Carry out jobs on drilling and riveting</p>	<ul style="list-style-type: none"> - Guide student in carrying out drilling and riveting operations. 	<p>1. Riveting machine and accessories 2. Drilling machine and accessories 3. Punches</p>

NVC IN REFRIGERATION AND AIRCONDITIONING (DRAFT)

	4.4 Rivet joints satisfactorily using correct sets.					
	General Objective: 5.0 Solder and Braze sheet metals			General Objective: 5.0 Solder and Braze sheet metals		
37-42	5.1 Identify the types of solders used in sheet metal work and state their compositions e.g. tin man's, grade,. Self flux and resin-core solders.	-Identify solders and state their compositions	1. Various types of solders 2. Chalkboard	1) Solder and braze various sheet metal projects with maximum safety.	-ask students to solder and braze various sheet metal projects with maximum safety.	1.Riveting machine and Accessories 2. Drilling machine and Accessories 3. Punches
	General Objective 6.0: Understand Processes used to produce sheet metal projects			General Objective 6.0: Understand Processes used to produce sheet metal projects		
43-60	5.1 State the meaning of the following: edge stiffening, beading, work hardening, beating, annealing, hollowing, raising, blocking, planishing, sand blasting, picking lacquering, galvanizing, plating, painting etc. 5.2 Produce finished sheet metal projects involving the processes in 5.1	- State the meaning of the following terms: edge stiffening, beading work, hardening, blocking etc - Demonstrate to the students how to carry out sheet metal projects of different sizes	1. Lesson plan 2. Poster 3. Finished sheet metal projects involving terms listed in 5.1.	1. Produce finished sheet metal projects involving various production processes. 2. Draw, develop and produce templates for production of sheet metal projects.	- . Guide student to execute sheet metal projects involving various production processes. - . Guide student in executing the project mentioned under 5.2.	1. Poster 2. Finished sheet metal projects involving terms listed in 5.1. 3. Drilling Machine and accessories 4. Riveting Machine and accessories

NVC IN REFRIGERATION AND AIRCONDITIONING (DRAFT)

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ASSESSMENT:

20% theory

80% practical

NVC IN REFRIGERATION AND AIRCONDITIONING (DRAFT)

COURSE: Automobile Air Conditioning

COURSE CODE: VAA 21, 22 and 23

GOAL: This programme is designed to equip the trainee with the techniques and applications of air conditioning in automobiles.

GENERAL OBJECTIVES: On completion of this course, the trainee will be able to:

- 1.0 Understand the working principles of a car Air Conditioning system
- 2.0 Diagnose and rectify faults in car air conditioning
- 3.0 Install and test a new car Air Conditioning system
- 4.0 Carry out routine services

DURATION: Three terms i.e. the tree terms of year II

NVC IN REFRIGERATION AND AIRCONDITIONING (DRAFT)

PROGRAMME: : NATIONAL VOCATIONAL CERTIFICATE IN REFRIGERATION AND AIRCONDITIONING						
Course: Automobile Air-conditioning		Course Code: VAA 21 - 23		Contact Hours 144		
GOAL: This programme is designed to equip the trainee with the techniques and applications of air conditioning in automobiles						
Theoretical Content				Practical Content		
General Objective 1.0: Understand the working principles of a car air-conditioning system				General Objective 1.0: Understand the working principles of a car air-conditioning system		
Week	Specific Learning Outcomes	Teacher's activities	Resources	Specific Learning Outcomes	Teacher's activities	Resources
1-12	1.1 Explain the working principles of a car air-conditioning system. 1.2 Identify the components of the system in 1.1 above. 1.3 Describe the functions of each component of the system in 1.1 above.		1. Air-conditioned car. 2. Lesson plan 3. Chalkboard 4. Wall Charts	1. Identify the components of a car air-conditioning system and describe their functions.	- Ask the students to identify describe and sketch the components of a car air-conditioning system.	1. Air conditioned car 2. Charts
General Objective 2.0 : Diagnose and rectify faults in car Air-conditioning				General Objective 2.0: Diagnose and rectify faults in car Air-conditioning		
13-24	2.1 Diagnose faults such as - shortage of gas - blockage of air filter - faulty evaporator/condenser fans	- Guide students in Diagnosing and rectifying faults. - Emphasize the	1. Faulty car air-conditioning system. 2. Gauge sets 3. Lubricating	1. Diagnose different kinds of faults that are encountered in a car air-conditioning system and rectify	- Ask the student to diagnose different kinds of faults and prefer solution to	1. Faulty car air-conditioning system. 2. Charts 3. Gauge sets etc.

NVC IN REFRIGERATION AND AIRCONDITIONING (DRAFT)

	<ul style="list-style-type: none"> - leakage of gas hose/tube etc. <p>2.2 Rectify the faults outlined in 2.1 above.</p> <p>2.3 Charge the unit with lubricating oil.</p> <p>2.4 Emphasize the need for evacuation before charging with refrigerant.</p>	<p>need for purging and evacuation before charging with Refrigerant.</p> <ul style="list-style-type: none"> - Emphasise the need for discouraging purging/ flushing. - Emphasise the need for recovering of refrigerants from faulty system before repairs 	<p>oil etc.</p> <ol style="list-style-type: none"> 4. Vacuum pump 5. Recovery equipment 6. Refrigerant 	<p>them.</p>	<p>them</p>	<ol style="list-style-type: none"> 4. Vacuum pump 5. Recovery equipment 6. Refrigerant
	<p>General Objective 3.0: Install and test a new car air-conditioning equipment</p>			<p>General Objective 3.0: Install and test a new car air-conditioning equipment</p>		
25-28	<p>3.1 Design the layout of the unit within the car.</p> <p>3.2 Install and connect the components – compressor, condenser, receiver and evaporator.</p>	<p>- Help the student to:</p> <ol style="list-style-type: none"> i. carry out layout design ii. install car air-conditioning equipments 	<ol style="list-style-type: none"> 1. Components to be installed 2. Oxy-acetylene set. 3. Overall clothing. 	<ol style="list-style-type: none"> 1. Draw the wiring circuit of a car A/C. 2. Practice the installation of car air-conditioning equipment components 	<ul style="list-style-type: none"> - Ask the student to draw the wiring circuit of a car air-conditioning system - Install the components of car air-conditioning equipment and ask the students to do same. 	<ol style="list-style-type: none"> 1. Cardboard paper 2. Charts. 3. Car air-conditioning 4. OXY-acetylene welding set.

NVC IN REFRIGERATION AND AIRCONDITIONING (DRAFT)

	General Objective 4.0: Carry out routine service			General Objective 4.0: Carry out routine service		
29-36	<p>4.1 Explain the importance of routine service to air conditioning and refrigeration systems.</p> <p>4.2 Design a routine service chart for use in the service of air conditioning and refrigeration systems.</p> <p>4.3 Service the various components of the system e.g. cleaning, checking for leaks, checking fan motor, water drain pipe etc.</p>	<p>- Explain the importance of routine service to air-conditioning and refrigeration systems</p> <p>- Design a routine service chart for air-conditioning and refrigeration systems</p> <p>- Carry out normal servicing of car Air-conditioning unit and ask students to do the same.</p>	<p>1. Charts 2. Cardboard paper 3. Brushes and detergents</p>	<p>1. Design a routine service chart for air-conditioning and refrigeration systems.</p> <p>2. Carry out normal servicing of car air-conditioner</p>	<p>- Ask the student to design a routine service chart for air-conditioning and refrigeration system.</p> <p>- Ask the student to carry out servicing of car air-conditioner</p>	<p>1. Charts 2. Cardboard paper 3. Brushes and detergents</p>

ASSESSMENT:

20% theory

80% practical

NVC IN REFRIGERATION AND AIRCONDITIONING (DRAFT)

COURSE: Absorption Refrigeration system

COURSE CODE: VAR 11, 12 and 13

GOAL: On completion of this programme the trainee will be able to understand the working principles of Absorption system, diagnose and rectify common faults associated with it

GENERAL OBJECTIVES: On completion of this course, the trainee will be able to:

1.0 Understand the working principles of an Absorption system

2.0 Diagnose and rectify faults within the Absorption system

3.0 Understand Adsorption system

DURATION: Three terms i.e. the first, second and third terms of year 1

NVC IN REFRIGERATION AND AIRCONDITIONING (DRAFT)

PROGRAMME: : NATIONAL VOCATIONAL CERTIFICATE IN REFRIGERATION AND AIRCONDITIONING						
Course: Absorption Refrigeration System		Course Code: VAR 11 - 13		Contact Hours 180		
GOAL: On completion of this programme the trainee will be able to understand the working principles of Absorption system, diagnose and rectify common faults associated with it						
Theoretical Content				Practical Content		
General Objective 1.0: Understand the working principles of an absorption system				General Objective 1.0: Estimate the cost of an Absorption system		
Week	Specific Learning Outcomes	Teacher's activities	Resources	Specific Learning Outcomes	Teacher's activities	Resources
1-12	<p>1.1 Explain the working principles of absorption refrigeration system.</p> <p>1.2 Explain the types of absorption system e.g. intermittent and continuous systems.</p> <p>1.3 Identify the components of the systems in 1.2 above and their functions.</p> <p>1.4 Explain the major advantages and disadvantages of Ammonia/water system:</p>	<p>- Explain the working principles of absorption refrigeration system.</p> <p>- Show the components of the absorption refrigeration system.</p> <p>- Give detailed explanations of cycles of operation of Ammonia – water system</p> <p>- Compare absorption and compression systems to the understanding of students.</p>	<p>1. Chalkboard</p> <p>2. Charts</p> <p>3. Excursion to any know absorption plant</p>	<p>1. Estimate the cost of installing an absorption system based on a schematic drawing</p> <p>2. Draw the P-h diagram of any absorption system.</p>	<p>- Guide trainees to estimate the cost of installing an absorption system</p> <p>-Ask trainees to draw and explain the p-h diagram of any known absorption system.</p>	<p>1. Charts</p> <p>2. Chalkboard</p> <p>3. Excursion to any known functional absorption plant</p>

NVC IN REFRIGERATION AND AIRCONDITIONING (DRAFT)

	1.5 Compare: (a) efficiencies of absorption and compression cycles (b) power consumption (c) procurement of materials (d) estimation of installation costs.	-Ask students to compare absorption and vapour compression system in terms of COP, power consumption and cheapness.				
	General Objective 2.0: Diagnose and rectify faults within the absorption system		General Objective 2.0: Diagnose faults within an absorption system and rectify them			
13-24	2.1 Diagnose faults within the absorption system by checking for leakage, control valve operation, condenser and evaporator performance. 2.2 Replace the heating element of an absorptions system.	Guide the students in diagnosing faults within absorptions systems	1. Absorption plant 2. Charts	1. Examine the generator and condenser for any possible faults and rectify them. 2. Construct an intermittent absorption system that is heated with charcoal.	- Guide student in the diagnosis of faults. Ask students to carry out a project on intermittent absorption system that is powered with locally sourced energy	1.Charts 2. Locally sourced materials e.g charcoal, containers/tanks etc

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	General Objective 3.0: Understand Adsorption system			General Objective 3.0: Understand Adsorption system		
25-36	3.1 Explain adsorption system.	-Explain adsorption system	1. Charts 2. Chalkboard	1. Examine the generator and condenser for any possible faults and rectify them.	- Give a group project that has to do with a charcoal fired adsorption system.	1. Chalkboard 2. Charts.
	3.2 Mention the differences and similarities between absorption and adsorption system.	Mention the differences and similarities of absorption and adsorption system		2. Construct an intermittent adsorption system that is heated with charcoal.		
	3.3 Explore the use of coal in heating generator for intermittent adsorption system.					

ASSESSMENT:

20% theory

80% practical

NVC IN REFRIGERATION AND AIRCONDITIONING (DRAFT)

COURSE: Metal Arc Welding

COURSE CODE: VAW 31and 33

GOAL: This programme will acquaint the trainee with the principles of electric welding and its applications in opening and re-welding compressors after repairs

GENERAL OBJECTIVES: On completion of this course, the trainee will be able to:

- 1.0 understand and apply safety precautions related to metal arc welding
- 2.0 Understand the working principles of welding machines
- 3.0 Make different types of welded joints
- 4.0 Know the properties of various types of ferrous metals
- 5.0 Build up worn metallic shafts using metal arc welding
- 6.0 Cut metals to specifications using metal arc cutting process
- 7.0 Know various welding defects and rectify them

DURATION: Two terms i.e. the first and third terms of year III

NVC IN REFRIGERATION AND AIRCONDITIONING (DRAFT)

PROGRAMME: : NATIONAL VOCATIONAL CERTIFICATE IN REFRIGERATION AND AIRCONDITIONING						
Course: Metal Arc Welding		Course Code: VAW 31 & 33		Contact Hours 192		
GOALS: This programme will acquaint the trainee with the principles of electric welding and its application in opening and rewelding compressors after repairs						
Theoretical Content				Practical Content		
General Objective 1.0: Understand and apply safety precautions related to metal arc welding				General Objective 1.0: Understand and apply safety precautions related to metal arc welding		
Week	Specific Learning Outcomes	Teacher's activities	Resources	Specific Learning Outcomes	Teacher's activities	Resources
1-3	<p>1.1 List and explain the hazards related to metal arc welding e.g. arc eye, burning, radiation, electric shock, toxic fumes etc.</p> <p>1.2 Select, use and care for protective wears required during arc welding – aprons, gloves shield etc.</p> <p>1.3 Explain the necessary safety precautions to be taken when:</p> <ul style="list-style-type: none"> - arc welding in confined space - arc welding empty vessels or drums that had contained inflammable or toxic materials - arc welding near inflammable materials 	<ul style="list-style-type: none"> - Explain the hazards related to metal arc welding. - Discuss how the hazards can be avoided. - List and describe the use and care for protective wears as listed in 1.2 - Show these items to students. 	<p>1. Lesson plan</p> <p>2. Chalkboard</p> <p>3. charts</p> <p>4. Arc welding equipment</p>	<p>1. Apply general safety precaution related to arc welding.</p>	<ul style="list-style-type: none"> - Guide trainee on the application of safety precaution during arc welding. 	<p>1. Protective wears used for arc welding operations.</p>

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	General Objective 2.0: Understand the working principles of welding machines			General Objective 2.0: Understand the working principles of welding machines		
4-8	<p>2.1 Know the working principles of a.c and d.c. welding machines and their differences.</p> <p>2.2 State the functions of the welding accessories: welding load, earth load, electrode holder, chipping hammer, wire brush etc.</p> <p>2.3 Know the advantages and disadvantages of a.c. and d.c. welding machines.</p> <p>2.4 Set and use the a.c. and d.c. welding machines for specific voltage/amperage operation, observing safety precautions.</p> <p>2.5 State the conventional electrode classification system.</p> <p>2.6 State the basic methods of electrode care.</p> <p>2.7 Strike metal arc and maintain the arc.</p>	<p>- Show the student the different features in the construction of the arc welding machine.</p>	<p>1. Arc welding equipment.</p> <p>2. Arc welding accessories.</p> <p>3. A.c. and d.c. welding machines.</p>	<p>1. Demonstrate how to set a.c. and d.c. welding machines for specified voltage/amperage operation, observing safety precautions.</p>	<p>- Ask the student to demonstrate the use of a.c. and d.c. machines in setting specified voltage/amperage operation.</p>	<p>1. a.c. and d.c. welding machines.</p> <p>2. Charts</p> <p>3. Chalkboard</p>

NVC IN REFRIGERATION AND AIRCONDITIONING (DRAFT)

	General Objective 3.0: Make different types of welded joints			General Objective 3.0: Make different types of welded joints		
9-13	<p>3.1 Describe with sketches the application of the following joints in metal fabrication – square butt, single Vee, double Vee, single U fillet, open corner etc.</p> <p>3.2 Know the factors that govern the selection of joints to be used for a project e.g. type of metal, thickness of metal, shape of plate, position of joint.</p> <p>3.3 Interpret the various arc welding symbols and conventions used in engineering working drawings.</p> <p>3.4 Prepare edges for welding the joints as in 3.1 above.</p> <p>3.5 Weld pipes and flanges in various fixed and rotated positions.</p>	<p>-Show with sketches the applications of various joints in metal fabrications. - Explain the factors used in selecting joints - Explain various arc welding symbols - Demonstrate the welding of pipes and flanges in various positions.</p>	<p>1. Charts 2. Chalkboard 3. Arc welding machine 4. Wire brush</p>	<p>1. Use the arc welding machine in fabricating simple engineering projects involving different types of joints. 2. Interpret various arc welding symbols and conventions used in engineering working drawing. 3. Practice welding of pipes and flanges in fixed and rotational positions.</p>	<p>- Guide student to practice fabrications with arc welding machines - Ask students to interpret conventional welding joints - Ask students to practice welding of pipes and flanges in various positions -guide students in preparing surfaces for welding</p>	<p>1. Arc welding machine. 2. Brushes 3. Charts</p>

NVC IN REFRIGERATION AND AIRCONDITIONING (DRAFT)

	General Objective 4.0: Know the properties of various types of ferrous metals			General Objective 4.0: Know the properties of various types of ferrous metals		
14-16	<p>4.1 Identify various types of ferrous metals e.g. cast iron, steel etc.</p> <p>4.2 List the physical properties cast iron.</p> <p>4.3 Know the behavior of the following types of cast iron when welded: grey, white and malleable cast iron.</p> <p>4.4 State the use of and carry out the following procedures: preheating, post heating, fixed and free-end welding.</p> <p>4.5 Prepare cast iron pieces by chamfering and pre—heating etc, weld them satisfactorily, using the following techniques: fusion, studding etc.</p>	<ul style="list-style-type: none"> - Show the types of ferrous metals - Explain 4.2 to 4.4. - Demonstrate 4.5 	<ol style="list-style-type: none"> 1. Different types of ferrous metals 2. Charts 3. Arc welding machine 	<ul style="list-style-type: none"> - Demonstrate pre-heating, post-heating etc. of cast iron. -Practice fusion, studding etc. welding techniques on cast iron pieces 	<ul style="list-style-type: none"> - Guide the student to practice pre-heating, post-heating etc. of cast iron -Ask the trainees to practice fusion, studding etc welding techniques on cast iron pieces. 	<ol style="list-style-type: none"> 1. Charts 2. Arc welding machine 3. Samples of ferrous metals

NVC IN REFRIGERATION AND AIRCONDITIONING (DRAFT)

	General Objective 5.0: Build up worn metallic shafts using metal arc welding			General Objective 5.0: Build up worn metallic shafts using metal arc welding		
17-19	<p>5.1 Identify the composition of a given worn metallic part and its properties.</p> <p>5.2 Build up worn metallic parts to specification using appropriate techniques including controls against distortion.</p>	<p>- Carry out 5.1</p> <p>- Demonstrate how to build up worn metallic parts to specification</p>	<p>1. Samples of worn metallic parts</p> <p>2. Welding Machine</p>	<p>1. Build up worn metallic parts to specification using appropriate techniques.</p>	<p>- Ask the students to practice building up worn metallic parts to specification using appropriate techniques including controls against distortion</p>	<p>1. Samples of worn metallic parts</p> <p>2. Welding Machines and accessories</p>
	General Objective 6.0: Cut metals to specifications using metal arc cutting process			General Objective 6.0: Cut metals to specifications using metal arc cutting process		
20-22	<p>6.1 Know the principles and application of:</p> <ul style="list-style-type: none"> - air arc method - carbon arc method - oxy arc method <p>6.2 Identify and state the compositions and uses of arc cutting electrodes.</p> <p>6.3 Cut metals with arc cutting electrodes</p>	<p>-Explain: air arc method, carbon arc method and oxy arc method</p> <p>- State the composition and uses of arc cutting electrodes</p>	<p>1. Welding Machine and accessories</p>	<p>1. Cut metals to various specifications using metal arc cutting process.</p>	<p>- Demonstrate metal cutting with arc welding equipment and ask student to do same.</p>	<p>Arc welding equipment and accessories</p>

NVC IN REFRIGERATION AND AIRCONDITIONING (DRAFT)

	General Objective 7.0: Know various welding defects and rectify them			General Objective 7.0: Know various welding defects and rectify them		
23-24	7.1 Describe major defects in arc welded joints.	-Describe possible defects in arc welding joints	1. Welding machine and accessories	1. Identify and rectify various welding defects.	- Ask student to identify weld defects and rectify them.	Arc welding equipment
	7.2 Know how weld defects can be avoided.	- Explain how weld defects can be avoided.	2. Sample jobs	2. Produce project involving the application of general safety precaution, welding techniques etc	-Ask students to produce projects involving the application of general safety precaution, welding techniques etc	
	7.3 Apply relevant tests to detect defects in arc welding joints and rectify them.	- Guide trainees to test for weld defects				
	7.4 Produce project involving the application of general safety precaution, welding techniques etc.					

ASSESSMENT:

20% theory

80% practical

NVC IN REFRIGERATION AND AIRCONDITIONING (DRAFT)

COURSE: Principles of Refrigeration

COURSE CODE: VVR11, 12 and 13

GOAL: This programme is designed to give the student a good background in both practical and theoretical applications of Refrigeration system and to prepare the student for gainful employment.

GENERAL OBJECTIVES: On completion of this course, the trainee will be able to:

- 1.0 Know the history and application of Refrigeration
- 2.0 Understand the principles of basic (Vapour) Refrigeration cycle
- 3.0 Understand actual Refrigeration cycle
- 4.0 Know Refrigeration maintenance and services

DURATION: Three terms i.e. the first, second and third terms of year 1

NVC IN REFRIGERATION AND AIRCONDITIONING (DRAFT)

PROGRAMME: : NATIONAL VOCATIONAL CERTIFICATE IN REFRIGERATION AND AIRCONDITIONING						
Course: Principles of Refrigeration		Course Code: VVR 11 - 13		Contact Hours 216		
GOAL: This programme is designed to give the student a good background in both Practical and Theoretical applications of Refrigeration System and to prepare the student for gainful employment						
	Theoretical Content			Practical Content		
	General Objective 1.0: Know the History and Application of Refrigeration					
Week	Specific Learning Outcomes	Teacher's activities	Resources	Specific Learning Outcomes	Teacher's activities	Resources
1-7	1.1 Trace the history of Refrigeration. 1.2 List and explain the applications of refrigeration. 1.3 Explain the importance of refrigeration in the control of spoilage agents like bacteria, fungi, enzymes etc.	- Give the history of Refrigeration - The applications of Refrigeration	1. Chalkboard 2. Charts 3. Tables			
	General Objective 2.0: Understand the Principles of Basic Refrigeration Cycle			General Objective 2.0: Understand the Principles of Basic Refrigeration Cycle		
8-24	2.1 List the basic components of a vapor compression refrigeration system and their functions. 2.2 Explain refrigerant as a	- List the basic components of a vapour compression system - Explain the	1. Chalkboard 2. Charts	1. Show the components of a basic refrigeration cycle and state their functions. 2. Describe the processes undergone	- Ask the student to identify refrigeration components and state their functions - Ask the student to	1. Components of a refrigeration system. 2. Tables

NVC IN REFRIGERATION AND AIRCONDITIONING (DRAFT)

	<p>working medium in refrigeration cycle.</p> <p>2.3 State the conditions of refrigerant at various points in the refrigeration cycle.</p> <p>2.4 Explain latent heats of vaporization and condensation at the evaporation and condenser respectively.</p> <p>2.5 Explain refrigeration cycle</p> <p>2.6 Explain refrigerating effect</p> <p>2.7 Operate a trainer unit for the students to observe.</p> <p>2.8 Explain co-efficient of performance (COP) and system capacity.</p> <p>2.9 Explain compressor capacity and volume flow rate of refrigerant vapour.</p>	<p>importance of refrigerant in a refrigeration system</p> <p>-Describe the conditions of refrigerant at the various components of a refrigeration system</p> <p>-Draw a refrigeration cycle and use it to explain refrigerating effect, COP and system capacity</p>		<p>by refrigerant at the various components.</p> <p>3. Operate a trainer unit.</p> <p>4. Calculate COP at any given conditions.</p>	<p>run certain experiments on the trainer unit.</p> <p>- Ask the student to calculate COP based on ideal refrigeration system.</p>	3. Charts
	General Objective 3.0: Understand Actual Refrigeration Cycle			General Objective 3.0: Understand Actual Refrigeration Cycle		
25-30	3.1 Explain the effect and importance of superheat on	- Explain superheat	1. Refrigeration	1. Sketch actual refrigeration cycle on	- Ask students to sketch actual	1. Charts 2. Tables

NVC IN REFRIGERATION AND AIRCONDITIONING (DRAFT)

	<p>the refrigeration cycle.</p> <p>3.2 Explain the effect and importance of sub-cooling on the refrigeration cycle.</p> <p>3.3 Explain how and where superheating can be achieved.</p> <p>3.4 Explain how and where sub-cooling can be achieved.</p> <p>3.5 Explain freezing and methods of achieving freezing.</p> <p>3.6 Calculate the actual COP of a refrigeration system</p> <p>3.7 Explain the use of system tables in finding superheat values, enthalpies etc</p> <p>3.8 Demonstrate the use of steam tables in calculating refrigerating effect and system capacity.</p>	<ul style="list-style-type: none"> - Explain sub-cooling. - Explain how and where superheating and sub-cooling can be achieved. - Demonstrate the calculation of actual COP - Explain the use of steam tables in solving various refrigeration problems. 	<p>unit</p> <p>2. Chalkboard</p> <p>3. Charts</p> <p>4. Tables</p>	<p>a T-S and P-h diagram designating superheating and sub-cooling at upper and lower temperatures and pressures.</p>	<p>refrigeration cycle given the upper and lower temperature, and pressure, conditions.</p> <p>-Ask the students to trace the conditions given above on the mollier diagram giving the corresponding values of specific volume, enthalpy, entropy etc.</p> <p>- Ask students to use steam tables in solving problems.</p>	
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NVC IN REFRIGERATION AND AIRCONDITIONING (DRAFT)

	General Objective 4.0: Know Refrigeration Maintenance and Services			General Objective 4.0: Know Refrigeration Maintenance and Services		
31-36	4.1 Demonstrate common maintenance/repair activities like. <ul style="list-style-type: none"> i Changing of compressors. ii Topping of oil iii Changing of driers iv Evacuation with vacuum pumps v Pumping down vi Gas refilling etc 	- Guide students in carrying out the various maintenance and services operations.	1. Vacuum 2. Refrigerant 3. Oil 4. Mainfold guage 5. Oxy-acetylene	1. Practice various maintenance and services operations.	- Guide students in repairing common refrigeration problems e.g. refrigerators, deep freezers, reach in coolers etc.	1. Vacuum 2. Refrigerant 3. Oil 4. Mainfold guage 5. Welding set etc

ASSESSMENT:

20% theory

80% practical

NVC IN REFRIGERATION AND AIRCONDITIONING (DRAFT)

COURSE: Gas Welding

COURSE CODE: VGW11, 12, 13, 21, 22, 23, 31 and 33

GOAL: On completion of this programme the trainee will be able to appreciate gas welding principles and their application in Refrigeration and Air Conditioning work.

GENERAL OBJECTIVES: On completion of this course, the trainee will be able to:

- 1.0 Understand safety precautions in gas welding
- 2.0 Know gas welding equipment
- 3.0 Know non-ferrous metals

DURATION: Eight terms i.e. the three terms of year 1, the three terms of year II and two terms of year III

NVC IN REFRIGERATION AND AIRCONDITIONING (DRAFT)

PROGRAMME: : NATIONAL VOCATIONAL CERTIFICATE IN REFRIGERATION AND AIRCONDITIONING						
Course: Gas Welding		Course Code: VGW 11 - 33		Contact Hours 504		
GOAL: On completion of this programme the trainee will be able to appreciate gas welding principles and their application in Refrigeration and Air conditioning work						
Theoretical Content				Practical Content		
General Objective 1.0: Understand Safety Precautions in Gas Welding				General Objective 1.0: Understand Safety Precautions in Gas Welding		
Week	Specific Learning Outcomes	Teacher's Activities	Resources	Specific Learning Outcomes	Teacher's activities	Resources
1-8	<p>1.1 Explain the safety measures taken in handling gas cylinders.</p> <p>1.2 Explain the safety measures taken in</p> <ul style="list-style-type: none"> - gas welding operations on containers which have been emptied of chemicals, inflammable or explosive liquids. - Gas welding in confined spaces. <p>1.3 Enumerate and explain the use and care of protective wears for carrying out gas welding operations e.g. goggles,</p>	<p>- Explain and enumerate the general safety precautions as applied to gas welding principles</p>	<p>Charts Chalkboard Protective wears e.g. goggles, gloves, boots etc.</p>	<p>1. Demonstrate the operation of oxy-acetylene gas welding</p> <p>2. Guide the student on the need to wear protective clotting and safety boots, helmet etc</p>	<p>-Inspect the students' compliance to safety guidelines during gas welding operations</p> <p>-Guide the student to light on the welding torch.</p> <p>-Guide the student on the step wise manner of shutting down flame.</p>	

NVC IN REFRIGERATION AND AIRCONDITIONING (DRAFT)

	gloves, boots, welding shields etc.					
	General Objective: 2.0 Know Gas Welding Equipment			General Objective: 2.0 Know Gas Welding Equipment		
9-24	<p>2.1 Identify and describe the features, functions, applications and care of:</p> <ul style="list-style-type: none"> - generators - regulators - blow pipes nozzles - hoses and their colours - gas cylinders and their colours - economizers - check valves. <p>2.2 Differentiate between water-to-carbide generator and carbide-to-carbide generator.</p> <p>2.3 Identify the main parts of the generator e.g. hydraulic back pressure valve purifier, carbide trays etc.</p> <p>2.4 Distinguish between high and low pressure systems of welding.</p> <p>2.5 State the composition of calcium carbide</p> <p>2.6 Generate acetylene using calcium carbide guiding</p>	<ul style="list-style-type: none"> - Show the students items listed in 2.1. - Identify and explain the features and functions and applications listed in 2.1. - Explain the difference between the two types of generators stating advantages and disadvantages. - Explain the main part of generator. - Demonstrate how to generate acetylene using calcium carbide. - Show and explain the types of welding rods to students stating their properties, composition and uses. - Explain types of flame and their uses. 	<ol style="list-style-type: none"> 1. Lesson plan 2. Calcium Carbide 3. Chalkboard 4. Charts 5. Gas Welding sets etc. 	<ol style="list-style-type: none"> 1. Generate acetylene using calcium carbide. 2. Demonstrate the lighting and setting up of the flames named in 2.9. 	<ul style="list-style-type: none"> - Ask the students to demonstrate how to generate acetylene using calcium carbide while guiding against danger of over charging. - Ask student to demonstrate lighting and setting up of different types of flame. 	<ol style="list-style-type: none"> 1. Calcium carbide 2. Charts 3. Gas welding sets etc.

NVC IN REFRIGERATION AND AIRCONDITIONING (DRAFT)

	<p>against danger of over-charge.</p> <p>2.7 Identify types of welding rods stating their properties, compositions and uses.</p> <p>2.8 Differentiate between welding and cutting torches.</p> <p>2.9 Explain”</p> <ul style="list-style-type: none"> - oxidizing flame - carbonizing flame - neutral flame and how each of them is derived in oxy-acetylene welding processes. 					
General Objective: 3.0 Know Non Ferrous Metals				General Objective:3.0 Know Non Ferrous Metals		
	<p>3.1 Identify non ferrous metals like copper, aluminum, brass and bronze, and state their properties and uses in fabrication.</p> <p>3.2 State the properties, functions and composition of fluxes used for welding non-ferrous metals.</p> <p>3.3 Identify suitable flux for bronze welding and state its composition.</p> <p>3.4 Prepare and weld bronze to</p>	<ul style="list-style-type: none"> - Show students samples of non ferrous metals. - Explain the properties of the non-ferrous metals shown to the students. - Explain 3.2 – 3.6 	<ol style="list-style-type: none"> 1. Lesson plan 2. Charts 3. Appropriate tools and equipment 4. Pieces of Bronze. 	<ol style="list-style-type: none"> 1. Perform various gas welding operations. 2. Weld together different types of non ferrous metals. 3. Identify and rectify 	<ul style="list-style-type: none"> - Ask students to perform welding of different types of non-ferrous metals 	<ol style="list-style-type: none"> 1. Charts 2. Appropriate tools and equipment 3. Pieces of bronze etc.

NVC IN REFRIGERATION AND AIRCONDITIONING (DRAFT)

	specifications. 3.5 State reasons for post-heating bronze weld. 3.6 Explain the principles of brazing			welding defects.		
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ASSESSMENT:

20% theory

80% practical

NVC IN REFRIGERATION AND AIRCONDITIONING (DRAFT)

COURSE: Measurements in Refrigeration & Air Conditioning

COURSE CODE: VRM 11, 12 and 13

GOAL: This programme is designed to teach trainees the various physical quantities in Refrigeration and Air Conditioning practice and the equipment for measuring them.

GENERAL OBJECTIVES: On completion of this course, the trainee will be able to:

- 1.0 Know temperature measurement
- 2.0 Know pressure measurement
- 3.0 Know mass measurement
- 4.0 Know linear measurement
- 5.0 Know measurement of electrical quantities

DURATION: Three terms i.e. the three terms of year 1.

NVC IN REFRIGERATION AND AIRCONDITIONING (DRAFT)

PROGRAMME: : NATIONAL VOCATIONAL CERTIFICATE IN REFRIGERATION AND AIRCONDITIONING						
Course: Measurements in R. & A		Course Code: VRM 11 - 13		Contact Hours 144		
GOAL: This programme is designed to teach students the various Physical Quantities in Refrigeration and Air Conditioning Practice and the Equipments for Measuring them.						
Theoretical Content				Practical Content		
General Objective 1.0: Know Temperature Measurement				General Objective 1.0: Know Temperature Measurement		
Week	Specific Learning Outcomes	Teacher's activities	Resources	Specific Learning Outcomes	Teacher's activities	Resources
1-6	1.1 Define temperature. 1.2 Explain various kinds of temperature scales e.g. Celsius, Fahrenheit, Kelvin and Rankine. 1.3 Demonstrate the inter-convertibility of temperature scales. 1.4 Explain thermometer and its types e.g. Analog (glass stem) and digital (electronic) thermometers. 1.5 Explain care of the thermometers mentioned above.	- Ask students to define temperature. - Explain various kinds of temperature scales. - Show examples of conversion from one temperature scale to another. - Explain 1.4 – 1.5	1. Charts 2. Chalkboard 3. Thermometers 4. Tables	1. Convert from one temperature scale to another e.g. °C to °F, Rankine to Kelvin etc.	- Ask students to convert from one temperature scale to another using the appropriate relationships and formulae.	1. Charts 2. Thermometers 3. Tables

NVC IN REFRIGERATION AND AIRCONDITIONING (DRAFT)

	General Objective: 2.0 Know Pressure Measurement			General Objective:2.0 Know Pressure Measurement		
7-4	<p>2.1 Define pressure.</p> <p>2.2 Explain the various kinds of pressure scales e.g. Bar (b), pound per square inch (Psi), inch mercury (inHg), Pascal (Pa), Kgf/cm² etc.</p> <p>2.3 Demonstrates the inter-convertibility of pressure scales.</p> <p>2.4 Explain the instruments for measuring pressure e.g. barometer, pressure gauge, vacuum gauge, electronic gauge etc.</p> <p>2.5 Explain the care of pressure gauges mentioned above.</p> <p>2.6 Explain the following: atmospheric pressure, gauge</p>	<p>- Explain the meaning of atmospheric pressure, absolute pressure, vacuum pressure and their units of measurement.</p> <p>- Explain the operation of barometers</p> <p>- Explain the operation of barometers</p> <p>- Explain care of pressure gauge</p>	<p>1. Pressure gauges</p> <p>2. Chalkboard</p> <p>3. Barometer</p> <p>4. Vacuum gauge</p> <p>5. Manometer</p>	<p>1. Convert from one pressure scale to the other.</p> <p>2. Identify, sketch and explain the working principles of Barometer, vacuum gauge, compound gauge manometer etc.</p>	<p>- Ask the student to sketch pressure gauge manometer etc and explain their working principles</p>	<p>1. Barometers</p> <p>2. Pressure gauges</p> <p>3. Vacuum gauge</p> <p>4. Compound gauge</p> <p>5. Manometer</p>

NVC IN REFRIGERATION AND AIRCONDITIONING (DRAFT)

	pressure and absolute pressure. 2.7 Read pressure from a manometer using the formula: Absolute Pressure = Gauge pressure + Atmospheric pressure.					
	General Objective: 3.0 Know Mass Measurement			General Objective: 3.0 Know Mass Measurement		
15-22	3.1 Define Mass. 3.2 Differentiate between mass and weight. 3.3 State the various units of mass e.g. kilogram (kg), Pound (lb), ounce (oz), Tonne etc. 3.4 Demonstrate the inter-convertibility of units of mass. 3.5 Explain the instruments for measuring mass e.g. spring balance, chemical balance, electronic balance etc.	- Define mass, weight and state their units of measurement -	1. Weighing 1. 1. balances. 2. Chalkboard 3. Charts 4. Tables	1. Demonstrate the conversion of one mass unit to the other. 2. Sketch and explain the spring balance and its working principles. 3. calibrator an uncalibrated balance using known weights.	- Ask the student to carry out the weighing of certain masses - Ask the students to calibrate uncalibrated weighing balance - Convert one mass unit to the other and ask students to do same.	1. Charts 2. Marker 3. Weights

NVC IN REFRIGERATION AND AIRCONDITIONING (DRAFT)

	3.6 Explain care of the instruments mentioned above.					
	General Objective: 4.0 know Linear Measurement			General Objective: 4.0 know Linear Measurement		
23-30	<p>4.1 Define length.</p> <p>4.2 Explain the various units of length used in R & A e.g. meter (m), foot (ft), yard (yd), furlong and cubit.</p> <p>4.3 Demonstrate the inter-convertibility of units of linear measurements.</p> <p>4.4 Explain the instruments used for linear measurements e.g. tape rule, vernier caliper, micrometer screw gauge, plumb line etc.</p> <p>4.5 Explain care of the instruments mentioned above.</p>	<p>- Define, Explain and Demonstrate the measurement of a certain length using the instruments mentioned in 4.4</p>	<p>Chalkboard</p> <p>2. Tape rule</p> <p>3. Venier Caliper</p> <p>4. Micrometer screw gauge</p> <p>5. Plumb line etc.</p>	<p>Convert from one linear measure to the other e.g. ft to m, mile to km.</p>	<p>- Ask the students to carry out linear measurements using the instruments such as vernier caliper, micrometer screw gauge etc</p>	<p>1. Tape rule</p> <p>2. Venier Caliper</p> <p>3. Micrometer screw gauge</p> <p>4. Plumb line etc</p>

NVC IN REFRIGERATION AND AIRCONDITIONING (DRAFT)

	General Objective: 5.0 know Current Electricity Measurement			General Objective: 5.0 know Current Electricity Measurement		
31-36	5.1 Define electricity. 5.2 Define the following electrical quantities and their units of measurement e.g. power, energy, current, resistance, voltage, potential difference, resistivity and temperature coefficient. 5.3 Explain the measuring instruments used in measuring the electrical quantities mentioned above. 5.4 Carry out calculations on the qualities mentioned in 5.2 above.	- Define and explain electrical quantities such as power, energy current, voltage etc - Carry out calculations on the quantities mentioned above.	1. Ohmmeter 2. Voltmeter 3. Ammeter 4. Avometer	1. Demonstrate the use of electrical measuring devices	1. Demonstrate the use of electrical measuring devices and ask the students to do same.	1. Ohmmeter 2. Voltmeter 3. Ammeter 4. Avometer

ASSESSMENT:

20% theory

80% practical

NVC IN REFRIGERATION AND AIRCONDITIONING (DRAFT)

COURSE: Retrofits and Refrigerant Controls

COURSE CODE: VRC 12 and 13

GOAL: This programme will acquaint the trainee with the latest technology for adapting old equipment to new refrigerants and also equip the trainee to know the operation of refrigerant controls.

GENERAL OBJECTIVES: On completion of this course, the trainee will be able to:

- 1.0 Understand retrofits
- 2.0 Know refrigerant controls
- 3.0 Install controls

DURATION: Two terms i.e. the second and third terms of year 1.

NVC IN REFRIGERATION AND AIRCONDITIONING (DRAFT)

PROGRAMME: NATIONAL VOCATIONAL CERTIFICATE IN REFRIGERATION AND AIR-CONDITIONAING ENGINEERING.						
COURSE: RETROFITS AND REFRIGERANT CONTROL		COURSE CODE VRC 12 -23		CONTACT HOURS: 144		
GOAL: This programme will acquaint the candidate with the latest technology for adapting old equipment to new refrigerants and also equip the candidate to know the operation of refrigerant controls.						
COURSE SPECIFICATION: Theoretical Contents:				Practical Contents:		
General Objectives 1.0: Understand Retrofits				General Objectives 1.0: Understand Retrofits		
WEEK	Specific Learning Objective:	Teacher Activities	Learning Resources	Specific Learning Objective:	Teacher Activities	Learning Resources
1-12	1.1 Explain retrofit 1.2 Explain the Department of Transport (DOT) regulation for transporting cylinders 1.3 Explain recover, recycle and reclaim (RRR) as it affects refrigerants from dead refrigeration plants. 1.4 Explain procedure for recovery, recycling and reclamation of CFCs 1.5 List the CFCs and	-Explain retrofit -Explain DOT regulation for transporting cylinders -Explain RRR as it applies to CFCs -List the HFCs that are replacements to the CFCs and HCFCs	1.CFCs 2.HCFCs 3. HFCs 4.Oils e.g. polyol ester, alkyl benzene etc. 5.Hydrocarbon s	1. Carry out retrofit exercises for CFC equipment using HCF and hydrocarbon refrigerants 2. Carry out recovery and recycling of refrigerants.	-Ask the students to practice retrofitting - Demonstrate recovery process and ask students to do same - Demonstrate recycling of recovered refrigerant and ask students to do same	1.CFCs 2.HCFCs 3.HFCs 4.Filter 5.Hydrocarboarbon 6.Live units 7. Dead units 8. Recovery unit 9. Oils

NVC IN REFRIGERATION AND AIRCONDITIONING (DRAFT)

	<p>HCFCs and their equivalent HFC replacements</p> <p>1.6 Explain the procedure for retrofitting CFC systems</p> <p>1.7 Explain retrofitting procedure using organic compounds like propane and butane as refrigerants.</p>	-Explain retrofit procedure for Hydrocarbons	<p>¶</p> <p>1. Filter dryer</p> <p>2. Live refrigeration or air conditioning system etc.</p> <p>3. Chalkboard</p> <p>4. Tables</p> <p>5. Charts</p>			
General Objective 2.0: Know Refrigerant Controls				General Objective 2.0: Know Refrigerant Controls		
13-15	<p>2.1 Identify and describe the operating principles of refrigerant controls such as, Capillary tube, thermostatic expansion valve TEV, Low side float valve LSFV, High side float valve HSFV, Automatic</p>	-Carry out the exercise in 2.1 to 2.2 and ask the students to do same	<p>(1)Capillary tube</p> <p>(2)TEV</p> <p>(3)LSFV</p> <p>(4)HSFV</p> <p>(5)AEV etc</p>	(1)Sketch the construction of refrigerant controls and explain their operations and applications.	-Ask the students to sketch some refrigerant controls -Ask students to explain the operations of such	<p>(1)Capillary tube</p> <p>(2)TEV</p> <p>(3)AEV</p> <p>Etc.</p>

NVC IN REFRIGERATION AND AIRCONDITIONING (DRAFT)

	expansion valve AEV, Float switch, And thermoelectric expansion valve. 2.2 Sketch the construction of the controls mentioned above.				refrigerant controls.	
	General Objective 3.0: Install Controls			General Objective 3.0: Install Controls		
16-24	3.1 Explain basic principles of installation of refrigerant controls 3.2 Install the appropriate sizes of refrigerant controls for all systems. 3.3 Demonstrate the adjustment of TEV and AEV. 3.4 Demonstrate the installation of check valves, hand valves etc 3.5 Explain the classification of controls in terms of operating, regulating	Help the students to carry out 3.1-3.6	1. Various refrigerant controls e.g. TEV, AEV etc.	(1)Install the appropriate sizes of refrigerant controls for all systems	-Guide the students to install refrigerant controls of appropriate sizes for all systems	1. Various refrigerant controls e.g. TEV, AEV etc.

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and safety. 3.6 explain the functions of the following: -Thermal limiter -Superheat switch -Low pressure cut. -Water control valve.					
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ASSESSMENT:

20% theory

80% practical

NVC IN REFRIGERATION AND AIRCONDITIONING (DRAFT)

COURSE: Environment, Refrigerants and Oils

COURSE CODE: VER 11, 12 and 13

GOAL: On completion of this programme the candidate will be able to appreciate the impact of refrigerants on the environment, identify various refrigerants and charging procedures for refrigerants and oils.

GENERAL OBJECTIVES: On completion of this course, the trainee will be able to:

- 1.0 Understand Refrigerants
- 2.0 Charge Refrigerants
- 3.0 Understand Oils in Refrigeration

DURATION: Three terms i.e. the three terms of year 1.

PROGRAMME: NATIONAL VOCATIONAL CERTIFICATE IN REFRIGERATION AND AIR-CONDITION						
COURSE:ENVIRONMENT, REFRIGERANTS AND OILS		NVC IN REFRIGERATION AND AIRCONDITIONING (DRAFT) COURSE CODE VER 11-13			CONTACT HOURS: 180	
GOAL: On completion of this programme the candidate will be able to appreciate the impact of Refrigerants on the Environment; Identify Various Refrigerants and Charging procedures for Refrigerants and Oils						
1.0	General Objectives 1.0: Understand Refrigerants			General Objectives: 1.0: Understand Refrigerants		
WEEK	Specific Learning Objective:	Teacher Activities	Learning Resources	Specific Learning Objective:	Teacher Activities	Learning Resources
1-9	1.1 Explain the purpose of refrigerant in a refrigeration system 1.2 Classify refrigerants as organic and inorganic 1.3 Classify organic refrigerants as chlorofluorocarbons (CFCs), Hydrochlorofluorocarbons (HCFCs), Hydro fluorocarbons (HCFs), Azeotropes and Zoetropes 1.4 Classify the inorganic refrigerants such as NH ₃ , SO ₂ 1.5 Mention and explain the safe properties of ideal refrigerants 1.6 Classify refrigerants in terms of flammability and toxicity 1.7 Identify refrigerants by colour coding of refrigerant cylinders. 18 Read the saturation properties of some refrigerants on tables and charts. 1.9 State the specific application of each of the refrigerants mentioned in 1.3 and 1.4 above.	-Explain the function of refrigerant -Classify refrigerants under the heading mentioned in 1.2, 1.3, and 1.4 -Explain the properties of ideal refrigerants -Ask students to read and interpret the saturation properties of refrigerants from charts and tables -State the specific applications of some refrigerants.	1.Chalk board 2.Refrigerants 3.Charts 4. Tables.	1. List in tabular or graphical form the flammability and toxicity or certain refrigerants 2. Identify refrigerants by colour coding of the refrigerant cylinder 3. Design a service card which identifies a recently repaired / serviced refrigeration and air conditioning plant in terms of : refrigerant used, date of service, type of oil used, mass of refrigerant charged, charging pressure, due date for future service, name of service technician etc.	-Ask students to carry out (1) (2) and (3) as stated under practical specific learning objective	1 Refrigerants 2 Charts 3 Tables

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2.0	General Objectives 2.0: Charge Refrigerants.			General Objectives 2.0: Charge Refrigerants.		
10-18	<p>2.1 Reclaim refrigerant from dead systems</p> <p>2.2 Explain the types of cylinders used for handling refrigerants</p> <p>2.3 Explain the need and methods of evacuation and drying of refrigeration systems.</p> <p>2.4 Itemise the importance and kinds of dehydrates.</p> <p>2.5 Explain the methods of leak detection and practice repair of leakage in a system.</p>	<p>-Ask the student to reclaim refrigerant from dead units</p> <p>-Explain 2.2-2.5</p> <p>-Guide the student to evacuate and charge a unit</p>	<ol style="list-style-type: none"> 1. Gauge sets 2. Oil 3. Filter drier 4. Refrigerant 5. Vacuum pump etc. 	<ol style="list-style-type: none"> 1. Practice Evacuation, and charging of refrigerant into a system 	<p>Ask students to:</p> <ul style="list-style-type: none"> - Practice evacuation of a refrigeration system. Through vacuum pump and manifold gauge up to 100km/m² - Practice charging of refrigerant into the evacuated refrigeration system mentioned in above as follows: Crack the valve of the refrigerant cylinder to flush the manifold gauge hose which is slacked at the manifold gauge and, tighten the slacked hose back, run the compressor while monitoring the 	<ol style="list-style-type: none"> 1. Vacuum pump 2. Manifold gauge 3. refrigerant 4. Oil 5. filter drier etc.

NVC IN REFRIGERATION AND AIRCONDITIONING (DRAFT)

					weighing balance upon which the refrigerant cylinder is placed, make sure the required mass of refrigerant has been charged.	
3.0	General Objective 3.0: Understand Oils			General Objective 3.0: Understand Oils		
19-27	<p>3.1 Explain the importance of lubrication in refrigeration system</p> <p>3.2 Mention the types of refrigeration oil such as mineral oil, alkyl benzene and polyol ester and their appropriate refrigerants</p> <p>3.3 State the properties of lubricating oil used in refrigeration systems</p> <p>3.4 Select lubricating oils, viscosity 150-300</p> <p>3.5 Explain the</p>	<p>-Explain the importance of lubrication</p> <p>-Mention types of refrigerant oils and their properties</p> <p>-Explain the methods of lubrication</p> <p>-Explain the principle of operation of separators.</p>	<p>1. Refrigerant oils</p> <p>2. Oil separators</p>	<p>1. Practice oil charging into the compressor</p> <p>2. Draw two types of oil separators</p>	<p>-Ask the students to:</p> <p>- Practice oil charging into the compressor</p> <p>- Draw two types of oil separators</p>	<p>1. Refrigerant oils</p> <p>2. Oil separator.</p>

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	<p>methods of lubrication (gravity, splash, forced feed,)</p> <p>36 Explain the principle of operation of oil separators</p> <p>3.7 Name and draw two types of oil separators.</p>					
4.0	General Objectives 4.0: Understand the impact of Refrigerants on the ozone layer			General Objectives 4.0: Understand the impact of Refrigerants on the ozone layer		
28-36	<p>4.1 Explain the ozone layer, its depletion and the Montreal protocol to forestall its depletion.</p> <p>4.2 Identify the ozone depleting substances (ODSs) like the CFCs and Bromides</p> <p>4.3 List the ozone depleting potential (ODP) of the substances mentioned above</p>	<p>-Explain, identify, list and mention as in 4.1-4.6</p> <p>-Ask students to do same</p>	<p>- Chalkboard</p> <p>- Charts</p> <p>- Film or T.V.</p>	<p>1 List in tabular or graphical form the ODP of some refrigerants</p>	<p>-Ask the students to list in tabular or graphical form the ODP of some refrigerants</p>	<p>Charts</p>

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	4.4 Mention the health hazards associated with ozone depletion 4.5 List the green house gases and their effects on the environment 4.6 Identify the ozone friendly refrigerants as a replacement to the ODSs					
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ASSESSMENT:

20% theory

80% practical

NVC IN REFRIGERATION AND AIRCONDITIONING (DRAFT)

LIST OF BOOKS

1. Refrigeration and Air-conditioning by K.M. Gutkowski
2. Principles of Refrigeration (fourth edition) by Roy J. Dossat
3. Modern Refrigeration and Air Conditioning by Althouse,Turnquist and Bracciano
4. Workshop Technology –Parts 1, 2 and 3 by Chapman

NVC IN REFRIGERATION AND AIRCONDITIONING (DRAFT)

LIST OF TOOLS AND EQUIPMENT

MATERIALS STORE

Refrigerants e.g. R-134a, R-123, R-717 (Ammonia) etc.
Filter driers-1/2 flare – 7/8 flare (open type)
Replaceable core filter drier
Silica gel
Duct tapes rolls
Adhesives e.g. evostic
Assorted insulating materials: cork, fiber glass, urethane foam etc.
Pipes (Copper, Aluminum and steel) and fittings
Brazing rods
Lead, solder and fluxes
Emery cloth
Methylated spirit
Gasket materials
Lubricating oils (assorted)
Oxygen cylinder
Acetylene cylinder

TOOLS

1. Torque wrench
2. Shifting spanner
3. Allen-keys
4. Bending springs
5. Pipe bender
6. Pipe cutter
7. Ball pen hammers

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8. Flaring Kit
9. Swaging tools
10. Set of spanners
11. Stock and dies
12. Stilton wrench
13. Knife
14. Screw driver (flat and Philips)
15. Pop-rivet gun-tornado guns
16. Metal shears
17. Hand drills
18. Power brush
19. Mallets
20. Rawl plug
21. Scrappers
22. Wire brush
23. Pliers
24. Pinch off tools
25. Ratchet spanner set
26. Tester screw drivers
27. Socket Spanner Set

GENERAL INSTRUMENTS, MACHINERY AND EQUIPMENT

1. Manifold gauge
2. Am-probe
3. Electronic leak detector
4. Halide torch
5. Dial thermometer
6. Wall thermometer
7. Graduate charging cylinder

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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
23. Blower
24. Arc welding equipment (complete set)
25. Oxy-acetylene welding set (complete set)

NVC IN REFRIGERATION AND AIRCONDITIONING (DRAFT)

LIST OF PARTICIPANTS

S/N	NAME	ADDRESS
1.	Mr. Rabiuh Mohammed	Government Technical College, Malali, Kaduna
2.	Mr. Barth Obioha	Ortech Engineering, Kaduna
3.	Engr. Isiaka Lawal	Drake and Scull Nig. Ltd, Kaduna
4.	Engr. Dr. Nuru A Yakubu, OON	Executive Secretary, NBTE Kaduna
5.	Dr. M S Abubakar	Director of Programmes NBTE, Kaduna
6.	Mal. Lawan Abdulkarim	Ag. HOD Technical Collges Division, NBTE, Kaduna
7.	Engr. A D K Muhammad	D O VEI/IEI, NBTE Kaduna
8.	Engr. E.I.E Onyeocha	National Board for Technical Education, Kaduna
9.	Mal. Hassan Aliyu	National Board for Technical Education, Kaduna