FEDERAL MINISTRY OF EDUCATION

National Technical Certificate (NTC) Curriculum in

FABRICATION AND WELDING

February, 2025

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

Funded by IDEAS project

NATIONAL BOARD FOR TECHNICAL EDUCATION

Plot B, Bida Road, P.M.B. 2239, Kaduna, Nigeria

NATIONAL TECHNICAL CERTIFICATE

CURRICULUM AND MOUDULE SPECIFICATIONS

IN

FABRICATION AND WELDING

FEBRUARY, 2025

GENERAL INFORMATION

GOAL AND OBJECTIVES OF NATIONAL TECHNICAL CERTIFICATE (NTC) IN FABRICATION AND WELDING

GOAL

The trade is aimed at producing skilled craftsmen in fabrication and welding works.

OBJECTIVES

At the end of the trade, the trainee should be able to:

- Know safety precaution in fabrication and welding
- Interpret working drawing
- Use tools and equipment competently for fabrication and welding operation
- Fabricate sheet metals, light pipes, angle irons and rods to various shapes
- Carry out welding operation using gas welding process
- Carry out welding operation using arc welding process

ENTRY QUALIFICATIONS for NATIONAL TECHNICAL CERTIFICATE (NTC) IN FABRICATION AND WELDING

Craft Programme

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

Unit Course/Modules

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

Behavioural Objectives

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

a. General Objectives
b. Specific learning outcomes

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

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

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

General Education In Technical Colleges

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

The NTC and ANTC trades are run by Technical Colleges accredited by NBTE.

NABTEB conducts the final National examination and awards certificates.

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

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

Guidance Notesfor Teachers

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

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

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

RESOURCES of Programme/Module

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

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

Method of Assessment

The students shall be assessed using Continuous Assessment (CA) i.e., Test, Assignment, Examination and Practical

CONTENTS

CURRICULUM TABLE

NTCFABRICATION AND WELDING

			YEAR 1						*YEAR 2*						*YEAR 3*						
S/NO	**Subject Code**	**Module**	**Term 1**		**Term 2**		**Term 3**		*Term 1*		**Term 2**		**Term 3**		**Term 1**		**Term 2**		**Term 3**		**Total Hours For each**
			T	P	T	P	T	P	T	P	T	P	T	P	T	P	T	P	T	P	
1	CMA 12-15	Mathematics	2	-	2	-	2	-	2	-	2	-	2	-	2	-	2	-	2	-	216
2	CEN 11-17	English	2	-	2	-	2	-	2	-	2	-	2	-	2	-	2	-	2	-	216
3	CPH 10-12	Physics	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	324
4	CCH 11-12	Chemistry	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	324
5	CEC 11-13	Economics	2	-	2	-	2	-	2	-	2	-	2	-	2	-	2	-	2	-	216
6	CBM 11	Entrepreneurship	-	-	-	-	-	-	2	-	2	-	2	-	-	-	-	-	-	-	72
7	CTD 11-13	Drawing	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	324
8	ICT 11-15	Computer Studies	1	2	1	2	1	2	1	2	1	2	1	2	-	-	-	-	-	-	216
9	MEC 11	General Metal Work 1	1	3	1	3	1	3	-	-	-	-	-	-	-	-	-	-	-	-	144
10	MEC 12	General Metal Work II	-	-	-	-	-	-	1	3	1	3	1	3	-	-	-	-	-	-	144
11	CFW 1 11	Sheet Metal Work I	2	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	72

12	CFW 121	Sheet Metal Work II	-	-	2	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	72
13	CFW 212	Oxy-Acetylene Gas Welding and Cutting I	-	-	-	-	-	-	2	4	-	-	-	-	-	-	-	-	-	-	72
14	CFW 222	Oxy-Acetylene Gas Welding and Cutting II	-	-	-	-	-	-	-	-	2	4	-	-	-	-	-	-	-	-	72
15	CFW 232	Oxy-Acetylene Gas Welding and Cutting III	-	-	-	-	-	-	-	-	-	-	2	4	-	-	-	-	-	-	72
16	CFW 233	Metal Arc Welding I	-	-	-	-	-	-	-	-	-	-	2	4	-	-	-	-	-	-	72
17	CFW 313	Metal Arc Welding II	-	-	-	-	-	-	-	-	-	-	-	-	2	4	-	-	-	-	72
18	CFW 323	Metal Arc Welding III	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	4	-	-	72
14	CFW 314	Structural Steel Work	-	-	-	-	-	-	-	-	-	-	-	-	2	4	-	-	-	-	72
15	CFW 324	Structural Steel Work	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	4	-	-	72
16	CFW 334	Structural Steel Work	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	4	72
17	CFW 317	Aluminum Work I	-	-	-	-	-	-	-	-	-	-	-	-	2	4	-	-	-	-	72
18	CFW 318	Aluminum Work II	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	4	-	-	72
		GRAND TOTAL	13	15	13	15	11	11	15	15	15	15	17	19	15	18	15	18	11	10	3,132

Key: T- Theory **P - Practical**

PROGRAMME: NATIONAL TECHNICAL CERTIFICATE IN FABRICATION AND WELDING	**Subject Code: CFW 111/121**	**Total Hours:5HRS**
Subject: SHEET METAL WORK I		**Theoretical: 2 hours/week**
Year: TWO Term: 1 & 2	**Pre-requisite: MEC 11 & 12**	**Practical: 4 hours/week**
Goal: This course is designed to provide the trainee with knowledge and skill in sheet metalwork.		
General Objectives: : On completion of this module the student should be able to: 1. Apply appropriate workshop operation for sheet metal fabrication. 2. Know Sheet Metal 3. Understand Soldering of sheet metal 4. Understand the process of producing finished sheet metal templates to produce projects		

PROGRAMME: NATIONAL TECHNICAL CERTIFICATE IN FABRICATION AND WELDING ENGINEERING CRAFT PRACTICE						
Course Specification: Practical/theoretical Content YEAR2, TERM I& TERM 2						
	COURSE : SHEET METAL WORK	**Course Code: CFW 212/222**		**Contact Hours: 6h/week- T24: P48**		
	Theoretical			**Practical**		
Term 1	**General Objective :1.0 Apply Appropriate Workshop Operations for sheet metal fabrication**					
Week	**Specific Learning Outcome**	**Teacher's Activities**	**Resources**	**Specific Learning Outcome**	**Teacher's Activities**	**Resources**
1-5	6.15 Explain Measurement 1.2 list units of measurements. 1.3 List measurement tools such as steel rule, measuring tape, vernier caliper and micrometer screw-gauge, etc.	Discuss Measurement Discuss units of measurement Describe Measurement tools listed in 1.2	- Charts - poster - pictures, - Textbooks - Multimedia	Convert imperial to SI units for the following: length. Mass, Area, volume Measure length using SI units. Use the following measurement tools: - steel rules, - measuring tape - vernier caliper - micrometer screw- gauge.	Demonstrate conversion of Imperial to SI units for: length, mass, area and volume. Guide students to use steel rule, measuring tape, vernier caliper, micrometer screw-gauge, etc. Guide students to use steel rule, measuring tape, vernier caliper, micrometer screw-gauge, etc.	Tape ruler Vanier caliper Steel rule, Meter Tape Try Square divider, scriber, center punch compass dot punch permanent marker Vernier Caliper

	1.4 Explain the importance of accuracy in measurement 1.5 Explain tolerance in measurement 1.6 List marking out tools such as: • chalk, • pencil, • divider, • scriber, • permanent marker • center punch, • try square • dot punch and • compass. **1.7** List various methods of marking out such as: datum, straight line, dot line, circles thick and dark line and arcs.	Discuss Importance of Accuracy in measurement Explain tolerance in measurement Describe Marking out tools listed in 1.6 Explain various method of marking out such as: datum, straight line, dot line, circles thick and dark line and arcs. Discuss template in marking out operation	- Charts - poster - pictures, - Textbooks - Multimedia	Use the following measurement tools: - Vernier caliper - Micrometer gauge - Steel rule - Measuring tape Calculate allowance for joint using the formula: grooved seam = 11/2 x width of groover Mark out the following projects on sheet metal material applying appropriate tools, techniques and safety practices: a. rectangular container b. funnels Sketch joint c. cylindrical container Use the following marking out tools to mark out sheet metal chalk, pencil, divider,	Guide students to compare the use measuring tools: steel rule measuring tape and vernier caliper, micrometer screw-gauge, etc. Calculate allowance for joint using the formula: grooved seam = 11/2 x width of groover, panned down and knock-up joints. Demonstrate the marking out of projects on sheet metal by applying the appropriate methods. Demonstrate marking out items listed on sheet of metal Demonstrate the use of different types of templates in marking out operations	chalk, pencil, divider, scriber, permanent marker, center punch, try square, dot punch and compass, straight snips, side cutting pliers, hacksaw, power hacksaw, chisel, guillotine, Round files, Triangular files, Rectangular files, Square file, Flat file, Half round, Sandpaper, Files of various of grade (rough and smooth)

	1.8 Explain the use of template in marking out operation 1.9 List cutting tools such as straight snips, side cutting pliers, hacksaw, power hacksaw, chisel and guillotine, etc. 1.10Explain the importance of correct cutting technique and posture 1.11 List types of files	Describe cutting tools such as straight snips, side cutting pliers, hacksaw, power hacksaw, chisel and guillotine. Discuss the importance of correct cutting technique and posture Discuss types of files and their uses		scriber, center punch, tri-square, steel rules and compass etc Use different types of templates for marking out Carryout cutting operation using cutting tools and machine: straight snips, side cutting pliers, hacksaw, power hacksaw, chisel, guillotine, Cut sheet metal to given sizes using Appropriate tools/machines Carry out the following Filling operations using various files	Guide students to cut using cutting tools and machine: straight snips, side cutting pliers, hacksaw, power hacksaw, chisel, guillotine, Demonstrate sheet metal cutting to given sizes using appropriate tools and machines Guide the students to perform filling operation using various types of files	

	1.12 Describe drilling operations 1.13 List drilling tools and accessories	Explain drilling operations Discuss drilling tools and accessories	- Charts - poster - pictures, - Textbooks - Multimedia	Punch and Drill holes for riveting Punch and Drill holes for riveting	Demonstrate punching and drilling holes on metal sheet including removal of burrs. Demonstrate punching and drilling holes on metal sheet including removal of burrs.	Drilling Machine, Drill bits, Hammer, Center Punch, Drill chuck, metal sheet.
	1.14 Explain riveting as joining process 1.15 List tools and accessories used in riveting operation	Discuss riveting as joining process Explain types of rivets used in sheet metal and their properties Discuss tools and accessories used in riveting operation	- Charts - poster - pictures, - Textbooks - Multimedia	Rivet sheet metal using appropriate pin Check for faults in riveting operation	Demonstrate riveting operation on sheet metal. Guide students to detect faults in riveting.	Rivets of various sizes, Centre punch, Riveting Machines, Riveting pin,

	General Objective 2.0: Know Sheet Metal.					
6-10	2.1 State types of metal used in welding operation: Ferrous, Non-ferrous, Alloy steel 2.2 State welding ability and properties of ferrous, nonferrous metal and alloy steel 2.3 State types of sheet metal Mild Steel; Galvanized Steel, Alloy sheet metal 2.4 State Mechanical properties of sheet metal of mild sheet, aluminum sheets, and galvanized sheets.	Explain types of metal used in welding operation Discuss the welding ability and properties of ferrous and non-ferrous and alloy steel Discuss type of sheet Metal Discuss Mechanical properties of sheet metal of mild sheet, aluminum sheets, and galvanized sheets.	- Charts - poster - pictures, - Textbooks - Multimedia	Identify types of metal used in welding operation: Ferrous, Non-ferrous alloy. Identify types of sheet metal: Mild Steel, Galvanized sheet, aluminum sheets.	Show the students how to identify types of metal used in welding operation: Ferrous, Non-ferrous. Show the students how to identify types of metal sheets	Ferrous, non-ferrous, alloy steel, Mild Steel, Galvanized steel, Alloy sheet metal, Aluminum sheets

	2.5 List different sizes of sheet metal; 2mm, 1.7mm, 1.6mm, 1.2mm,1mm, 0.6mmetc	Discuss different sizes of sheet metal; 2mm, 1.7mm, 1.6mm, 1.2mm,1mm, 0.6mmetc	Metal sheet of various sizes: 2mm, 1.7mm, 1.6mm 1.2mm 1mm 0.6mmetc	Identify different sizes of sheet metal	Show students on how to identify different sizes of sheet metal using instrument such as: micrometer screw gauge, vernier caliper.	micrometer screw gauge, vernier caliper.
	2.6 Explain characteristics of sheet metal during welding: Melting point Thermal expansion Oxidation and activity Ductility Hardness and strength	Discuss characteristics of sheet metal during welding Melting point Thermal expansion Oxidation and activity Ductility Hardness and strength	Welding equipment, different types of metals	Identify the characteristics of sheet metal during welding	Demonstrate to students the characteristics of sheet metals during welding.	Welding equipment, different types of metals
	2.7 State the meaning of the following terms: a. edge-stiffening b. work hardening c. beating d. annealing e. hollowing f. planishing g. sandblasting h. galvanizing	Explain the meaning of the terms listed in 2.7 (a - l)	Charts/Posters	Identify the following operation on sheet metals listed in 2.7(a-I)	Demonstrate to students the following operations on sheet metals as listed in 2.7	

	i. plating j. painting k. case hardening l. pre-heat and post-heat treatment					
	2.8 State welding process used for joining sheet metal; • Gas, • Arc (Tig, MMA) • Riveting • Soldering • Brazing • MIG Arc	Discuss welding process used for joining sheet metal; • Gas, • Arc (Tig, MMA) • Riveting • Soldering • Brazing • MIG Arc	Charts posters, and pictures	Identify the welding process used in joining sheet metal	Demonstrate to students the welding process used in joining sheet metals	
TERM 2	**General Objective 3.0: Understand Soldering of sheet metal**					
Week	**Specific Learning Outcomes**	**Teacher's Activities**	**Resources**	**Specific Learning Outcomes**	**Teacher's Activities**	**Resources**
1-5	3.1 Explain soldering Operation 3.2 List types of Soldering techniques used in sheet metals; • Brazing • Hard/Silver • Soft	Describe soldering operation Discuss types of soldering techniques used in sheet metal works	Charts, posters, pictures, textbooks	Identify types of soldering operation Identify soldering techniques used in sheet metals such as: • Brazing • Hard/Silver • Soft	Show students types of soldering operation Demonstrate for students soldering techniques used in sheet metals such as: • Brazing • Hard/Silver • Soft	samples of sheet metals, samples of solders in sheet metalwork

	3.3 List types of solders used in sheet metalwork e.g. Lead-free, Flux-core, silver alloy	Discuss types of solders used in sheet metalwork		Identify types of solders used in sheet metalwork	Show students various types of solders used in sheet metalwork.	
	General Objective 4.0: Understand the process of producing finished sheet metal templates for the production of projects					
Week	**Specific Learning Outcomes**	**Teacher's Activities**	**Resources**	**Specific Learning Outcomes**	**Teacher's Activities**	**Resources**
6-10	4.1 List materials used for templates a. Wood b. Cardboard, etc 4.2 Explain parts of the mechanical drawing e.g. plan and elevation 4.3 Explain how to read working drawing for fabrication job	Explain materials used for making templates Describe parts of mechanical working drawing e.g plan and elevations Discuss how to read working drawing for fabrication job	Charts/Posters CADs, Plastic Material, Wood, Cardboard, Working drawings, Projector, Information Blocks	Identify the materials used for template Construct the blueprint which includes working of the sheet metal projects Read blueprints (which include working drawings) of sheet metal projects Develop templates by using the following methods for the indicated items: a. Parallel line method – for elbows and T-pieces, square and rectangular trays etc. b. Radial line method – for right cone, oblique cone, etc c. Triangulation method – for transition piece and ducting.	Demonstrate to students the use of template materials in the production of finish sheet metals Demonstrate the production of working drawing of sheet metal projects Guide the students to develop templates using the methods listed for indicated items: a. Parallel line method – for elbows and T- pieces, square and rectangular trays etc. b. Radial line method – for right cone, oblique cone, etc	Sample of template materials Sample sheet metal projects Drawing instruments

				d. Cutting plane method – for inclined	c. Triangulation method – for transition piece and ducting. d. Cutting plane method – for inclined plane, branch 'T' pieces.	

PROGRAMME: NATIONAL TECHNICAL CERTIFICATE IN FABRICATION AND WELDING	**Subject Code: CFW 212/222/232**	**Total Hours: 4HRS**
COURSE: OXY-ACETYLENE GAS WELDING AND CUTTING OPERATIONS		**Theoretical: 2 hours/week**
YEAR THREE: Term: 1, 2 & 3	**Pre-requisite:**	**Practical: 4 hours/week**
Goal: This module is designed to equip the trainee with the knowledge and skills to carry out oxy-acetylene gas welding operations.		
General Objectives: On completion of this module the student should be able to: 1. Understand the general safety precautions related to oxy-acetylene gas welding operation. 2. Know oxy-acetylene gas welding operation. 3. Know how to weld types of ferrous and non-ferrous metals using gas. 4. Know how to use oxy-acetylene gas to cut metals to specifications. 5. Know weld defects.		

PROGRAMME: NATIONAL TECHNICAL CERTIFICATE IN FABRICATION AND WELDING						
Course Specification: Theoretical Content YEAR 3, TERM I, TERM 2 & TERM 3						
COURSE: OXY-ACETYLENE GAS WELDING AND CUTTING			**Course Code: CFW 314/324/334**		**Contact Hours: 6h/week- T24: P48**	
	Theoretical			**Practical**		
Term 1	**General Objective:1.0 Understand the general safety precautions related to oxy-acetylene gas welding**					
Week	**Specific Learning Outcome**	**Teacher's Activities**	**Resources**	**Specific Learning Outcome**	**Teacher's Activities**	**RESOURCES**
	1.1 Explain safety precautions in gas welding	Discuss safety precautions in gas welding	Charts, posters, pictures, textbooks, Multimedia	Carry out the following safely using appropriate equipment to: - Move empty gas cylinder - Move Full gas cylinder - Store gas cylinder Apply appropriate safety precautions while carrying out the following: a. Gas welding operations on containers which have been emptied of chemicals, inflammable or explosive liquids. b. Gas welding near containers	Demonstrate to students how to transport and store full and empty gas cylinders Demonstrate to students the appropriate safety precaution while carrying out the following task: a. Gas welding operations on containers which have been emptied of chemicals, inflammable or explosive liquids. b. Gas welding near containers with inflammable	Charts/Posters, Safety signs, Trolley, Soapy water, Gas detector, Fan, Fume Extractor

				with inflammable materials, e.g. petrol tank; and c. Gas welding in confined spaces	materials, e.g. petrol tank; and c. Gas welding in confined spaces	
	1.2 List the Personal Protective Equipment (PPE) used in gas welding process: Welding helmet, hand shield, respirators, goggles, earmuffs/plugs, boots/gloves, gas cylinder with colour code. 1.3 Explain the features of gas welding equipment: • Cylinder colour code, • Cylinder threading • Hose colour code • Regulator colour code • Regulator threading • Blow pipe threading • Flashback arrestor • Gauges colour code	Discuss the Personal Protective Equipment (PPE) used in gas welding process Describe the features of gas welding equipment: - Cylinder colour code, - Cylinder threading - Hose colour code - Regulator colour code - Regulator threading - Blow pipe threading - Flashback arrestor - Gauges colour code Discuss the safety precautions in handling gas cylinders: - Avoid oil/grease on cylinders - Positioning Cylinder - movement/transportation Discuss methods of checking for gas leakages:	Charts, posters, pictures, textbooks, Multimedia	Use protective wear for carrying out gas welding operations: a. welding goggles b. overall c. gloves d. boots etc Identify gas welding equipment using colour code, thread and other accessories Carry out testing for gas leakage using: • Gas detector • Soap solution.	Demonstrate the use of protective wears for carrying out gas welding operations Guide the students to identify gas welding equipment using colour code, thread and other accessories.	Welding helmet, hand shield, respirators, goggles, earmuffs/plugs, boots/gloves, gas cylinder with colour code.

	1.4 Explain the safety precautions in handling gas cylinders: - Avoid oil/grease on cylinders - Positioning Cylinder 1.5 Explain methods of checking gas leakages: • Smell • Hissing sound • Soap solution • Gas detector movement/transportation	Smell, Hissing sound, Soap solution, Gas detector		Identify the methods of checking for gas leakage by: Smell, Hissing sound, Soap solution, Gas detector	Demonstrate how to check for leakages from gas cylinder Demonstrate how to check for gas leakage: Smell, Hissing sound, Soap solution, Gas detector	
	General Objective 2.0: Know various oxy-acetylene gas welding operations.					
Week	**Specific Learning Outcomes**	**Teacher's Activities**	**Resources**	**Specific Learning Outcomes**	**Teacher's Activities**	**Resources**
	2.1 Explain gas welding as a joining process 2.2 List the accessories of gas welding equipment: a. gas welding generators b. Pressure regulators c. Flashback arrestors d. blow pipes e. nozzles f. Gas hoses	Describe gas welding as a joining process Describe the accessories of the gas welding equipment listed in 2.2 State the functions of the gas welding equipment and the care in 2.2	Charts, posters, pictures, textbooks, Multimedia	Identify gas welding operation process Identify the accessories of gas welding equipment in 2.2	Demonstrate to students gas welding as an operation process. Demonstrate to students how to identify accessories gas welding equipment in 2.2	Leveled drawings, Low- and high-pressure gas, welding sets, Calcium carbide, Calcium carbide motor. Gas welding Generator, welding touches,

	g. gas cylinders and their colours					cutting torches, Gas welding rods, Blow pipes, Gas Cylinders, Water, Filler metal, Flux, etc
	h. economizers i. Torches j. Spark lighter k. check valves 2.3 Differentiate between the following types of gas welding generators, stating their merits and demerits a. water-to-carbide generator b. carbide-to-water generator 2.4 List the main parts of the gas welding generator: • hydraulic back pressure valve • purifiers,	Discuss the difference between the two types of generators stating their advantages and disadvantages Describe the main part of the gas welding generator: • hydraulic back pressure valve • purifiers, • carbide trays etc.	Charts, posters, and pictures, textbooks, Multimedia	Generate acetylene using calcium carbide guiding against danger of over-charge Select consumables for gas welding operations Select appropriate accessories for gas welding operations Identify the main parts of the gas welding generator: • hydraulic back pressure valve • purifiers, • carbide trays etc.	Demonstrate how to generate acetylene using calcium carbide Guide students on how to identify the main parts of the gas welding generator	water-to-carbide generator carbide-to-water generator hydraulic back pressure valve purifiers, carbide trays etc.

	• carbide trays etc.					
	2.5 Distinguish between high- and low- pressure systems of welding 2.6 State the composition of calcium carbide e.g calcium (Ca 40%), carbon (C 60%) 2.7 List types of gas welding rods stating their properties, compositions, and uses: • Mild steel gas filler rod • Gas brazing rod • Silver solder • Cast iron filler rod • Aluminum rod 2.8 Differentiate between welding and cutting torches	Discuss the difference between low- and high-pressure systems of gas welding Discuss the composition of calcium carbide: e.g calcium (Ca 40%), carbon (C 60%) Discuss the types of gas welding rods stating their properties, composition and uses Discuss the parts of welding and cutting torches	Charts, posters, pictures, textbooks, Multimedia	Identify the types of welding rods: • Mild steel gas filler rod • Gas brazing rod • Silver solder • Cast iron filler rod • Aluminum rod Identify welding and cutting torches	Show the types of welding rods to students Guide students to identify welding and cutting torches Guide students to differentiate between welding and cutting torches	List the accessories for high- and low-pressure system of gas welding Mild steel gas filler rod, Gas brazing rod, silver solder, Cast iron filler rod, Aluminum Filler rod Posters and pictures
	2.9 Explain how to derive flames in oxy-acetylene welding processes: a. oxidizing flame b. carbonizing flame	Discuss how to drive flames in oxy-acetylene welding process types of gas	Charts, posters, pictures, textbooks, Multimedia	Light the welding torch and adjust the flame to derive each of the types named in 2.9	Demonstrate the lighting and setting up of the flames named in 2.9	Welding torches

	c. neutral flame 2.10 State the use of the different flames named in 2.9 above	Describe uses of the types of flame named in 2.9 above				

	General Objective 3.0: Know how to weld different types of ferrous metals using oxy-acetylene gas					
Week	**Specific Learning Outcomes**	**Teacher's Activities**	**Resources**	**Specific Learning Outcomes**	**Teacher's Activities**	**Resources**
	3.1 List ferrous metal that can be joined using gas welding process. • Steel • Wrought iron • Cast iron 3.2 Explain the ferrous metal listed in 3.1 above in terms of: a. types b. composition c. properties	Explain ferrous metals that can be joined using gas welding process as listed in 3.1Discuss the ferrous metal listed in 3.1 in terms of: a. Types b. Composition c. properties	Charts, posters, pictures, textbooks, Multimedia	Identify the ferrous metals in 3.1 by: • Appearance, • Spark test,	Show the students samples of the following ferrous metals in 3.1 Guide the students to identify through • Appearance, • Spark test,	wrought iron, cast iron, mild steel, etc
	3.3 State different shapes of ferrous metals in common use listed in 3.1 above. a) Pipes • Round • Square, and • Rectangular	Discuss different shapes of ferrous metals listed in 3.3 above. a) Pipes • Round • Square, and • Rectangular	Charts, posters, and pictures, textbooks, Multimedia	Identify the following metal: a) pipe • Round • Square • Rectangular b) Flat sheet of • 0.6mm • 1.2mm	Guide the students to identify the following: a) Pipes of different shapes b) Flat sheets c) Angle irons d) Flat bars e) Rods	Pipes, flat sheets, angle irons

	b) Flat Sheet • 2mm • 1.7mm • 1.6mm • 1.2mm • 1mm • 0.6mm c) Angle irons d) U-Channels e) H-beam f) I-section g) flat bar h) rod 3.4 Explain the effects of the following mechanical properties on welding of ferrous metals: a. brittleness b. fusion c. distortion, etc 3.5 State area of application of ferrous metal listed in 3.1 3.6 Explain the effects of welding dissimilar metals such as:	b) Flat Sheet • 2mm • 1.7mm • 1.6mm • 1.2mm • 1mm • 0.6mm c) Angle irons d) U-Channels e) H-beam f) I-section g) flat bar h) rod Discuss the effects of the following mechanical properties on welding of ferrous metals: a. brittleness b. fusion c. distortion, etc Discuss area of application of ferrous metal listed in 3.1		• 1mm • 2mm c) Angle irons d) Flat bar e) Rods f) U-Channels g) H-Beam h) I-Section Carry out welding showing the effect of the following properties using oxy-acetylene process. • Distortion • Lack of fusion • Brittle Weld the following dissimilar metals: a) Mild steel & stainless steel b) Mild steel & cast iron c) Wrought iron & cast iron and identify challenges associated with them. Prepare workpiece for oxy-acetylene welding Set up oxy-acetylene system for welding	f) U-Channels g) H-Beams h) I-Section Guide students to carry out welding to show the effect of the following properties using oxy- acetylene process. • Distortion • Lack of fusion • Brittle Demonstrate how to weld dissimilar metals using oxy-acetylene welding process Guide student on how to prepare workpiece for oxy- acetylene welding Demonstrate to students the setting of oxy-acetylene set Demonstrate how to join metals using left to right and right to left methods	Pieces of Stainless Steel, Soapy cold water, Warm Water, Wire brushes, Sample of metals, oxy-acetylene accessories

	a. Mild steel and stainless steel b. steel and cast-iron c. Wrought iron and cast, etc 3.7 Explain how to prepare workpiece for oxy-acetylene welding. 3.8 Explain how to set up oxy-acetylene system for welding 3.9 Explain the procedure of joining work piece using oxy- acetylene process.	Discuss the effect of welding dissimilar metals such as: a. Mild steel and stainless steel b. steel and cast-iron c. Wrought iron and cast, etc Describe how to prepare workpiece for oxy acetylene welding. Describe how to set up oxy- acetylene system for Welding Discuss the procedures of joining work piece using oxy-acetylene process.		Carryout joining of workpiece by: • Left to right method • Right to left method Carry out the joining using oxy-acetylene process to produce: • Square box 300mm by 300mm using 2mm thick • Basket of 300mm by 300mm using rod • Square of 300mm by 300mm using angle iron. Check for defects. Remedy defects if any.	Demonstrate how to join metals using oxy-acetylene process. Guide students to produce square boxes using 2mm thick sheet metal Guide students to produce baskets using rods. Guide students to produce square using angle iron 2 x 2 x 3mm Guide students to remedy defect	
	General Objective 4.0: Know how to use gas to cut metals to given specifications					
Week	**Specific Learning Outcomes**	**Teacher's Activities**	**Resources**	**Specific Learning Outcomes**	**Teacher's Activities**	**Resources**
	4.1 Explain the procedures for carrying out gas cutting exercise:	Describe the procedures for carrying out gas cutting exercise:	Charts, posters, pictures,	Perform the following exercise on oxy/acetylene set:	Guide the students to carry out the following exercise on oxy/acetylene set:	wrought iron, cast iron, mild steel, etc.

	• assembling, • testing, • lighting, • cutting • shutting down, Disassembling.	• assembling, • testing, • lighting, • Cutting • shutting down, • Disassembling.	textbooks, Multimedia	Assembled, Test for leakage, lighting up, shutting down, Disassembled	Assembled, Test for leakage, lighting up, shutting down, Disassembled.	
	4.2 List types of gases used for cutting: • Propane • Methane • Oxygen • Butane • Acetylene	Discuss the various gases that can be used for cutting: • Propane • Methane • oxygen • butane • Acetylene	Charts, posters, pictures, textbooks, Multimedia	Identify the various gas cylinders using their color codes: • Propane • Methane • oxygen • butane • Acetylene	Guide the students to identify the various gases with their color codes: • Propane • Methane • oxygen • butane • Acetylene	Oxy-acetylene cylinders, and accessories
	4.3 Explain how to set up flame for cutting a given metal	Discuss how to set up flame for cutting of metals.	Charts, posters, pictures, textbooks, Multimedia	Set up the appropriate flame for cutting a given metal	Guide the student to set up appropriate cutting flame	Oxy-acetylene cylinders, and accessories
	4.4 List materials that can easily be cut with oxy/acetylene.	Discuss the materials that can easily be cut with oxy/acetylene		Identify materials that can easily be cut with oxy/acetylene; Low carbon steel, Mild steel, Titanium	Guide students to identify materials that can easily be cut with oxy/acetylene	Low carbon steel, mild steel, and titanium

	Low carbon steel, Mild steel, Titanium	Low carbon steel, Mild steel, Titanium				
	4.5 List materials that cannot be cut with oxy/acetylene: Cast iron, Stainless steel, aluminum, Copper, High carbon steel.	Discuss the materials that cannot be cut with oxy/acetylene: Cast iron, Stainless steel, aluminum, Copper, High carbon steel.		Carry out cutting on the following materials: Cast iron, Stainless steel, aluminum, Copper, High carbon steel.	Guide the students to cut materials using oxy-acetylene process	Cast iron, Stainless steel, aluminium, Copper, High carbon steel.
	4.6 List common oxy/acetylene cutting deficiencies: • Cutting speed too low • Cutting speed too high • Nozzle too far from the surface • Nozzle too close to the surface • Oxygen pressure is too high or low • Excessive preheat flame	Describe common oxy/acetylene cutting deficiencies in 4.6		Carry out cutting exercise with the following parameters in 4.6	Demonstrate to students cutting with oxy/acetylene	Oxy-acetylene cylinders, and accessories.

	• Nozzle is dirty • Plate is not suitable for oxy-fuel cutting					
	4.7 Explain how to cut a workpiece using oxyacetylene set.	Describe how to cut the workpiece using oxyacetylene set.	Charts, posters, and pictures, textbooks, Multimedia	Carry out cutting operation using oxy- acetylene set to cut: • 300mm by 2mm thick. • 300mm by 5/8 rod. • 300mm by 2 x 2 x 3mm	Demonstrate how to cut using oxy-acetylene set.	Oxy acetylene set with samples (300mm by 2mm thick, 300mm by 5/8 rod, 300mm by 2x 2 x 3mm)
	General Objective 5.0: Know the various welding defects					
	5.1 Explain the following defects in oxy-acetylene gas welded joints: A undercut B lack of fusion (side, root, inter-run) C porosity D unequal leg length (uneven alignment) E lack of reinforcement F Inclusion G Cracks H Excess reinforcements	Discuss the defects in oxy- acetylene gas welded joint as listed in 5.1 Discuss how the weld defects in (5.1) above can be avoided in oxy-acetylene welding. Discuss the use of tests to detect defects in welded joint: • non-destructive test		Identify the following defect: A undercut B lack of fusion (side, root, inter-run) C porosity D unequal leg length (uneven alignment) E lack of reinforcement F Inclusion G Cracks H Excess reinforcements	Show students various welding defects Demonstrate welding defects and show students how to avoid it Demonstrate the use of tests to detect defects in welded joints: Demonstrate any tool of non-destructive test to	Sketches/charts Films, Video taper Industrial, visit/execution etc. Test piece, Mechanical test lab Oxy-acetylene resources

	I Excess penetration 5.2 State how the weld defects in (5.1) above can be avoided in oxy-acetylene welding 5.3 Explain the use of non- destructive tests to detect defects in welded joint such as: visual inspection, x-ray test, gamma ray test, ultrasonic tests magnetic Particle test, die penetrant test (DPT) 5.4 Explain the use of destructive test to detect defects in welded joint such as: • bend test, • macro and micro examination 5.5 Explain how to rectify welded joints defects enumerated in 5.1 above	• destructive test Discuss the use of destructive tests to detect defects in welded joints in 5.4 Discuss how to rectify welded joints defects enumerated in 5.1 above		I Excess penetration Identify welding defects and how they can be avoided Carry out two non-destructive tests to detect defects in welded joints such as: Carry out two non-destructive tests to detect defects in welded joints such as: a. bend test, b. Macro and micro examination Rectify welded joints defects	detect defects in welded join such as: • bend test, • macro and micro examination Demonstrate to students' correction of welding defects	

PROGRAMME: NATIONAL TECHNICAL CERTIFICATE IN FABRICATION AND WELDING CRAFT PRACTICE	**Course Code: CFW 233/313/323**	**Total Hours: 4HR**
Course: METAL ARC WELDING		**Theoretical: 2h**
Year: TWO Term: 3 **Year: THREE Term: 2 & 3**		**Practical: 4h**
Goal: This module is designed to equip the trainee with the knowledge and skills to carry out metal arc welding.		
General Objectives: On completion of this module the student should be able to: 1. Understand safety precautions related to metal arc welding 2. Understand the features and working principles of arc welding machines and accessories 3. Know the properties of types of ferrous and non-ferrous metals in welding operation 4. Know how to make different types of welded joints in all positions 5. Know the buildup of worn metallic components 6. Know weld defects		

PROGRAMME: NATIONAL TECHNICAL CERTIFICATE IN FABRICATION AND WELDING CRAFT PRACTICE						
Course Specification: Theoretical/ Practical Content: YEAR 2 TERM 3, YEAR 3 TERM 1 AND TERM 2						
COURSE: METAL ARC WELDING		**Course Code: CFW 233/313/323**		**Contact Hours: 6h/week- T24: P48**		
	Theoretical			**Practical**		
Term 2	**General Objective 1.0: Understand Safety Precautions Related to Metal Arc Welding**					
Week	**Specific Learning Outcome**	**Teacher's Activities**	**Resource**	**Specific Learning Outcome**	**Teacher's Activities**	**Resources**
	1.1 List the hazards related to metal arc welding, e.g. a. arc eye b. burning c. radiation d. electric shock e. toxic fumes, etc	Discuss the hazard related to metal arc welding as listed in 1.1 Discuss how these listed hazards can be avoided	Charts, posters, pictures, textbooks, Multimedia	Take appropriate action to minimize exposure to welding fumes, rays, etc.	Demonstrate appropriate actions to Minimize exposure to hazards such as welding fume rays etc.	Welding equipment, and PPE
	1.2 List personal protective equipment required while carrying out metal arc welding operations, e.g. a. head and hand shield b. hand gloves c. apron d. spats e. overall f. boots and leggings, etc	Describe the use and care for personal protective equipment (PPE) n metal arc welding as listed in 1.2		Select protective wear for use in carrying out metal arc welding operations, e.g. - head and hand shield - goggle - hand gloves - apron - spats - boots and leggings, etc.	Show students protective wears required while carrying out metal arc welding operations	head and hand shield, hand gloves, aprons, overall, spats, boots, leggings, etc

	1.3 Explain appropriate safety precautions while carrying out: a. Arc welding in open space b. arc welding in confined spaces c. arc welding empty vessels or drums that contained inflammable or toxic materials d. arc welding near inflammable materials e. underwater welding f. Arc welding in damp or swamp area 1.4 Explain the need for personal hygiene in welding	Discus safety precautions while carrying out task a -c in 1.3.		Apply safety precautions in handling arc welding equipment: - Avoid oil/grease on work piece - Ensure proper connection of power cables - Ensure avoidance of moisture/wet surface on machines and work environment - Ensure that welding equipment is in good condition - Ensure safe handling of machines and equipment Carry out housekeeping before and after metal arc welding operation	Demonstrate safety precautions in handling metal arc welding Demonstrate housekeeping in metal a welding operation	Soap, solution, Fire extinguisher, Swamp mat, Fire bucket, Water tank, Lay barge, Ram barge, U-boat, navigator
		Explain the appropriate safety precaution while carrying out arc welding as listed in 1.4 Discuss the need for personal hygiene in welding	Charts, posters, pictures, textbooks, Multimedia			

	General Objective 2.0: Understand the features and working principles of arc welding machines and accessories					
Week	**Specific Learning Outcomes**	**Teacher's Activities**	**Resources**	**Specific Learning Outcomes**	**Teacher's Activities**	**Resources**
	2.1 List of types of metal arc welding machines: • A.C. • D.C. • AC/DC	Discuss types of metal arc welding machine in 2.1 Explain the differences between AC. and DC. arc welding machines.	AC, DC, welding machine etc.	Identify types of arc welding machine according to polarity	Guide students to identify types of arc welding machines	AC, DC arc welding machine and accessories
	2.2 Explain the working principles of A.C and DC. welding machines 2.3 State the advantages and disadvantages of AC and DC welding systems 2.4 List types of arc welding processes such as: • Manual Metal Arc (MMA), • Tungsten Inert Gas (TIG), • Flux Cored Arc Welding (FCAW), • Metal-Inert Gas/Metal- Active Gas (MIG/MAG) etc.	Discuss the working principles of AC and DC welding machines Discuss the advantages and disadvantages of AC and DC welding machines. Discuss types of arc welding processes such as: • Manual Metal Arc (MMA), • Tungsten Inert Gas (TIG), • Flux Cored Arc Welding (FCAW),	Charts, posters, and pictures, textbooks, Multimedia	Identify the following arc welding machines: - Manual Metal Arc (MMA), - Tungsten Inert Gas (TIG), - Flux Cored Arc Welding (FCAW), Identify component parts in arc welding machines in 2.5	Guide students how to identify the following ar welding machines: - Manual Metal Arc (MMA), - Tungsten Inert Gas (TIG), Show students component parts of arc welding machine Guide the students identify consumables for arc welding processes Show students metal arc welding consumables	Metal-Inert Gas Metal-Active Gas (MIG/MAG). Multi process machine Electrodes racks • Electrode • Filler rod • Filler wires • Gases (argon,

	2.5 List consumables used for arc welding processes • Electrode • Filler rod • Filler wires • Gases (argon, helium, CO2,) • Tungsten Electrode • Grinding Disc • Cutting Disc • Workpiece etc 2.6 State the functions of the consumables of welding processes in 2.5 above. 2.7 Explain the classification of electrodes in terms of: • Size (2.5mm, 3.2mm, 4mm, etc) • Types (E6010, E6013, E7018 etc)	• Metal-Inert Gas/Metal-Active Gas (MIG/MAG). etc Discuss the advantages and disadvantages in 2.4 Describe the consumables used for arc welding processes as listed in 2.5 Discuss the function of welding consumables as listed in 2.5 Discuss the classification of electrodes in terms of: • Size (2.5mm, 3.2mm, 4mm, etc) • Types (E6010, E6013, E7018 etc) Explain the selection of electrode materials according to parent metals		Selectarc welding consumables for: - Manual Metal Arc (MMA), - Tungsten Inert Gas (TIG), Identify different types of electrodes Select suitable electrodes and machines for welding various types of non-ferrous metals Carry out electrode care by: - Dry storage - Oven storage - Safe handling	- Flux Cored Arc Welding (FCAW), - Metal-Inert Gas/Metal-Active Gas (MIG/MAG). Etc Guide students to select electrode material according to parent system. Guide students to select appropriate welding electrodes for use Guide students to select suitable electrodes and machines for welding various types of given non-ferrous metals Guide students to select suitable electrodes and machines for welding various types of given ferrous metals Demonstrate the method to care for electrodes	helium, CO2,) • Tungsten Electrode • Grinding Disc • Cutting Disc • Workpieces Types of electrodes e.g E6010, E6013, E7018) etc Dry store and oven store

	2.8 List area of application of electrodes listed in 2.7 above 2.9 State the basic methods of electrode care, e.g. a. dry storage b. oven storage c. safe handling	Describe the basic method of electrode care with reference to i. dry storage ii. oven storage iii. safe handling				

	General Objective 3.0: Know the properties of types of ferrous and non-ferrous metals in welding operation					
Week	**Specific Learning Outcomes**	**Teacher's Activities**	**Resources**	**Specific Learning Outcomes**	**Teacher's Activities**	**Resources**
	3.1. State various types of ferrous and non-ferrous metal 3.2 Explain the properties of ferrous and non-ferrous metal: Ductility, malleability, hardness, tenacity, fusion 3.3 State welding process that can be used to join ferrous metal: * Oxy acetylene	Discuss various types of ferrous and non-ferrous metal Discuss the properties of ferrous and non-ferrous metal: Ductility, malleability, hardness, tenacity, fusion Discuss the welding process that can be used to join ferrous metal:	Charts, posters, pictures, textbooks, Multimedia	Identify various types of ferrous metals by inspection. e.g. cast iron, steel, etc Identify by inspection various types of non-ferrous metals. e.g. a. copper b. aluminums c. brass d. iconel e. Mone Identify the process of joining ferrous metal using oxy-	Show Students how to identify various types of ferrous and non-ferrous metal by visual observation Demonstrate the following procedures: a. pre-heating b. post-heating c. fixed ---free--- end welding, etc. Show the student instruments used for measuring temperature during pre-heating and post-heating	Various Type of Ferrous Metals Samples of grey cast iron, white cast iron, and malleable cast iron Welding Equipment. Mild steel Low carbon steel High carbon steel Cutting

	* Arc welding 3.4 List the classification of ferrous metal: * Steel • mild • medium carbon • high carbon • stainless • low alloy steel • high alloy steel * Cast Iron * Wrought Iron 3.5 State the factors that determine the weld ability of ferrous metals: Carbon content, Melting/meting range, Thermal conductivity, etc. 3.6 Explain the behaviour of the following types of cast iron when welded: a. grey cast iron b. white cast iron c. malleable cast iron	* Oxy acetylene * Arc welding Discuss the classification of ferrous metal: * Steel • mild • medium carbon • high carbon • stainless • low alloy steel • high alloy steel * Cast Iron * Wrought Iron Discuss the factors that determine the weld ability of ferrous metals: Carbon content, Melting/meting range Thermal conductivity, etc. Discuss the behaviour of the following types of cast iron when welded: a. grey cast iron		acetylene and arc welding Carry out the following procedures: a. pre-heating b. post-heating c. fixed --- free---end welding, etc. Identify the types of ferrous metal such mils steel, stainless steel, high carbon steel	Guide students to carry out welding processes to join ferrous metals using acetylene and arc welding Demonstrate to students how to identify the types of ferrous metal	machine and accessories Arc welding machines, oxy-acetylene cylinders accessories

	3.7 State the welding process that can be used to join non-ferrous metal: * Brazing * Soldering * TIG * MIG 3.8 State the factors that determine the weld ability of non-ferrous metals: Alloy element, Melting/meting range Thermal conductivity, 3.9 State the use of the following procedures: a. pre-heating b. post-heating c. pining d. fixed ---free---end welding, etc.	b. white cast iron c. malleable cast iron Discuss the welding process that can be used to join non-ferrous metal: * Brazing * Soldering * TIG * MIG Discuss the factors that determine the weld ability of non-ferrous metals: Alloy element, Melting/meting range Thermal conductivity, Discuss the uses of the following procedures as in 3.9				
	3.10 Explain how to weld cast iron pieces using the following techniques:	Describe how to weld cast iron using the following techniques:	Charts, posters, pictures, textbooks, Multimedia	Weld cast iron pieces using the following techniques:	Guide students to weld cast iron pieces Demonstrate to students the appropriate heat treatment	Welding equipment and appropriate consumables

	a. fusion b. bronze c. studding d. buttering 3.11 Explain heat treatment method for a finished welded metal	- fusion - bronze - studding - buttering Discuss the appropriate heat treatment method for finished welded Metals		a. fusion b. bronze c. studding d. buttering Show the appropriate heat treatment method for finished welded metals	method for finished welded metals	Furnace Samples of finish products

	General Objective 4.0: Know how to make different types of welded joints in all positions					
Week	**Specific Learning Outcomes**	**Teacher's Activities**	**Resources**	**Specific Learning Outcomes**	**Teacher's Activities**	**Resources**
	4.1 Explain weld joints 4.2 List types of weld joint: a. T b. Butt - square, - single vee, - double vee, - single U c. Corner d. Edge e. Lap	Discuss weld joints Discuss with sketches the types ofjoints in 4.2 Describe the factors that govern the selection ofjoints to be used for a project with reference to 4.3 Describe the various welding symbols used in engineering working drawing Discuss preparation of edges for welding joints.	Charts, posters, pictures, textbooks, Multimedia	Identify types of joints Identify types of weld joint in 4.2	Show students types of joints Demonstrate to students the identification of welded joints in 4.2	Different components with welded joint, Welding machines, Plates, flat bar, angle iron, pipes., Cutting machines, Grinding machines, Jigs, Vices

	4.3 Explain the factors that govern the selection of joints to be used for a project e.g. a. type of metal b. thickness of metal c. shape of plate d. position ofjoint 4.4 Explain various welding symbols and their uses 4.5 Explain how to prepare edges for welding joints in 4.2 above 4.6 Explain the welding ofjoint in the following position: i. Flat ii. horizontal iii. vertical iv. overhead 4.7 Explain how to set up arc welding machine for welding operation 4.8 Explain how to join metals using arc welding processes for:	Discuss the welding ofjoint in the following position: i. Flat ii. horizontal iii. vertical iv. overhead Describe how to set up arc welding machine operation Discuss the joining of metals using arc welding processes in 4.8		Interpret various arc welding symbols and conventions used in engineering working drawing. Carry out the following weld joints preparation: • Tee joints • Butt joints • Corner joints • Edge joints • Lap joints Prepare edges for welding the following joints: square butt, single vee, double vee, single U, open corner, tee joints, edge joints etc Set up arc welding machine and carry out the welding in the positions as in 4.6	Show the various arc welding symbols use engineering working drawing. Demonstrate preparation of edges for welding joints for: • Tee joints • Butt joints • Corner joints • Edge joints • Lap joints Guide students to set up arc welding machines and carry out the welding in the positions as in 4.6 Guide students to set up arc welding machines Demonstrate to students to carry out welding ofjoint in above in all positions observing necessary safety precautions Demonstrate the making of multi-run welds and weaving welds Demonstrate how join metals using welding processes Guide students angle iron	Samples of metals welding machines and accessories Welding machine Arc welding machine and accessories

	a. plates b. flat bar c. angle iron d. pipes. etc			Setup arc welding machine for use Weld the following prepared joints in all positions observing necessary safety precautions.: square butt, single vee, double vee, single U, open corner, tee joints, edge joints etc Carry out multi-run welds Carry out weaving welds Carry out welding using arc welding processes to produce: • Square box of 300mm x 300mm using 4mm thick plate • Square box of 300mm x 300mm using 3x3x5mm	• basket of 300mm x 300mm using 5/8 rod • joint of 150mm x 150mm using 4inches round pipe by 10mm thick Check for defects Remedy defects	

	General Objective 5.0: Know the buildup of worn metallic components					
Week	**Specific Learning Outcomes**	**Teacher's Activities**	**Resources**	**Specific Learning Outcomes**	**Teacher's Activities**	**Resources**
	5.1 Explain the procedure involved in the build-up of worn metallic Components 5.2 Explain how to select appropriate electrodes to build-up worn metallic components 5.3 Explain the factors that determine the type of welding processes to be applied in build-up worn metallic components 5.4 Explain how to carry out build- up worn metallic components	Describe the procedure involved in the build-up of worn metallic components Discuss how to select appropriate electrodes to build worn metallic components Discuss the factors that determine the type of welding processes to be applied in build-up worn metallic components Discuss how to carry out build-up worn metallic components	Charts, posters, pictures, textbooks, Multimedia	Identify by physical appearance the type of metallic components to be built up Select appropriate electrodes to be used in build-up worn metallic Build-up given worn metallic parts to specification using appropriate techniques including controls against distortion	Guide students to identify by physical appearance the type of metallic components to be built up Show students how to select appropriate Components Demonstrate to students the building up of worn metal parts to specification, using appropriate technique and control against distortion	Welding machine Worn metal shaft Worn metal gear Files, Grinding machine Files, Grinding machine

	General Objective 6.0: Know welding defects					
Week	**Specific Learning Outcomes**	**Teacher's Activities**	**Resources**	**Specific Learning Outcomes**	**Teacher's Activities**	**Resources**
	6.1 Define weld defects 6.2 List common defects in arc welded joints: - undercut. - lack of fusion. - porosity. - slag inclusion. -unequal leg length. - lack of reinforcement. - Spatters, etc. 6.3 Explain how to identify welded joint defect	Discuss weld defects Describe major defects in arc welded joint as in 6.2 Discuss how to check for defects in welded joints	Charts, posters, pictures, textbooks, Multimedia	Identify common defects in arc welded joints in 6.2 Identify welded joint defects in different joints using any test instrument	Show students sample defects in arc welded joint. Show students how to identify welded joints defects.	Samples of welded joint Magnifying glass Bend test machine Tensile test machine X-ray machine

	6.4 Explain how weld defects in 6.2 above can be avoided 6.5 Explain how to rectify welded joint defect.	Discuss how weld defects in 6.2 above can be avoided Discuss how to correct defects in welded joints named in 6.2 above	Charts, posters, pictures, textbooks, Multimedia	Apply the following tests to detect defects in arc welded joints: a. non-destructive tests such as dye penetrant test, visual inspection, etc. b. destructive tests such as bend test Rectify welded joint defects named in 6.2	Demonstrate the application of various tests to detect defects i arc welded joints Guide students to rectify welded joint defects.	

PROGRAMME: NATIONAL TECHNICAL CERTIFICATE IN FABRICATION AND WELDING CRAFT PRACTICE	**Course Code: CFW 314/324/334**	**Total Hours: 18HRS**
Course: STRUCTURAL STEEL WORK		**Theoretical: 2 hours/week**
Year: Three Term: 1, 2 & 3	**Pre-requisite:**	**Practical: 4 hours/week**
Goal: This module is designed to equip the trainee with the knowledge and skills to carry out structural steel work		
General Objectives: On completion of this module the student should be able to: 1. Understand the safety rules as applicable to structural steel 2. Know tools and equipment used in structural steel work 3. Understand the process of manufacture of iron and steel 4. Know the structural properties of materials used in structural steel 5. Know the production of simple structural steel projects on the shop floor. 6. Understand the assembly of simple structural steel 7. Know the effect of corrosion on structural steel		

PROGRAMME: NATIONAL TECHNICAL CERTIFICATE IN FABRICATION AND WELDING CRAFT PRACTICE						
Course Specification: Theoretical/ Practical Content YEAR 3, TERM1, TERM 2 & TERM 3						
COURSE WORK: STRUCTURAL STEEL		**Course Code: CFW 314/324/334**		**Contact Hours: 6h/week-T24: P48**		
	Theoretical			**Practical**		
	General Objective 1.0 Understand the safety rules as applicable to structural steel/aluminum work					
Week	**Specific Learning Outcome**	**Teacher's Activities**	**Resource**	**Specific Learning Outcome**	**Teacher's Activities**	**Resources**
	1.1 List personal protective equipment used in structural steel and aluminum work: a. gloves b. aprons/overall c. boots d. goggles, e. helmet etc	Discuss the functions of personal protective equipment used in structural steel and aluminum work	Charts, posters, pictures, textbooks, Multimedia	Select appropriate personal protective equipment used in structural steel and aluminum work. Use personal protective equipment in structural steel and aluminum work	Show students personal protective equipment used in structural steel and aluminum work. Demonstrate the use personal protective equipment used in structural steel work	Posters, Gloves aprons/overall, boots, goggles, helmet etc
	1.2 Explain the safety precautions involved in structural steel and aluminum work	Discuss the precautions involved in structural work safety in steel and aluminum	Charts, posters, pictures, textbooks, Multimedia			

	1.3 Explain hazards associated with structural stee and aluminum work	Discuss hazards associated with structural steel and aluminum work				
	General Objective 2.0: Know tools and equipment used in structural steel work					
	2.1 List tools and equipment used in structural steel work e.g. a. hammers b. shears c. Spanners d. dog drills e. dies f. punches g. chisels h. screw drivers i. pliers j. strips k. riveting gun l. wrenches m. welding machine n. torque spanners of straight edge p. straightening machine q. grinding machine r. guillotine s. punching	Discuss the tools and equipment used in structural steel aluminum work listed in 2.1		Sketch tools and equipment used in structural steel and aluminum work. Select tools and equipment used in structural steel and aluminum work in 2.1	Guide students to Sketch tools and equipment used in structural steel work. Show students how to select tools and equipment used in structural steel work.	a. hammers b. shears c. Spanners d. dog drills e. dies f. punches g. chisels h. screw drivers i. pliers j. strips k. riveting gun l. wrenches m. welding machine n. torque spanners of straight edge

	t. Shearing machine etc					p. straightening machine q. grinding machine r. guillotine s. punching t. shearing machine etc
	2.2 State the use of tools and equipment listed in 2.1 above	Discuss the use of tools and equipment listed 2.1 above.	Posters, textbooks, and charts	Use tools and equipment as listed in 2.1 above	Show students how to use tools and equipment as listed in 2.1	a. hammers b. shears c. Spanners d. dog drills e. dies f. punches g. chisels h. screw drivers i. pliers j. strips k. riveting gun l. wrenches m. welding machine n. torque spanners

						of straight edge p. straightening machine q. grinding machine r. guillotine s. punching t. shearing machine etc
	2.3 Explain how to maintain and store tools and equipment used in structural steel and aluminum work	Discuss how to maintain and store tools and equipment used in structural steel and aluminum work		Carry out maintenance of tools and equipment used in structural steel and aluminum work Store tools and equipment appropriately.	Demonstrate how to maintain tools and equipment used in structural steel and aluminum work Guide students to store tools and equipment used in structural steel work appropriately	Oil and grease cans. Grinding machine

	General Objective 3.0: Know the structural properties of materials used in structural steel and aluminum work.					
Week	**Specific Learning Outcomes**	**Teacher's Activities**	**Resources**	**Specific Learning Outcomes**	**Teacher's Activities**	**Resources**
	3.1 List materials used for structural steel and aluminum: a. plates b. universal channel c. universal beams d. rolled steel joist e. rolled steels f. T-bar g. Angle bar h. Bridge beams, I aluminum sheets J aluminum pipes etc.	Discuss the materials used in structural steel and aluminum work. a. plates b. universal channel c. universal beams d. rolled steel joist e. rolled steel f. T-bar g. Angle bar h. bridge beams, I aluminum sheets J aluminum pipes etc.	Posters/Charts Diagrams, and textbooks	Identify materials used in structural steel and aluminum work as listed in 3.1.	Show students materials used in structural steel and aluminum work.	a. plates b. universal channel c. universal beams d. rolled steel joist e. rolled steels f. T-bar g. Angle bar h. Bridge beams, I aluminum sheets J aluminum pipes etc.
	3.2 State the use and limitations of the structural steel aluminum materials named in 3.1 above 3.3 Explain Hooke's Law as it affects simple structural elements 3.4 Distinguish between the following	Discuss the use and limitations of the structural steel materials in 3.1 Explain Hooke's Law as it affects simple structural elements Discuss stresses in structural steel work in 3.4	Textbooks, charts, and posters Textbooks, diagrams, materials laboratory Textbooks, and charts			

	stresses in structural steelwork: a. tensile stress b. compressive stress c. Shear Stress 3.5. Explain simple calculations involving practical applications of tensile, compressive and shear stresses, e.g. in riveted and welded joints	Formulate simple calculations involving practical application of stress in riveted joints, welded joints etc. Discuss standard specifications used in structural steel work				
		Design Discuss and apply Hooke's Law in the design of simple structural elements				Charts, structural signs and symbols Diagrams, pictures, cardboard, pencils, markers
	3.6 Explain conventional symbols and abbreviations used for representing structural steel aluminum sections	Discuss Conventional symbols and abbreviations used for representing structural steel and aluminum sections	Charts, Structural Signs & symbols	Interpret conventional symbols and abbreviations representing steel and aluminum m sections used for structural	Guide students to interpret conventional symbols and abbreviations used for representing structural steel and aluminum sections	

	3.7 Explain how to sketch simple structural steel and aluminum work 3.8 Explain how to read structural work drawings	Describe how to sketch simple structural steel and aluminum work Discuss how to read structural work drawings Give students some problems to solve	Posters, charts, pictures. Samples drawings, posters,	Sketch the following forms of structural steel and aluminum materials in 3.1 Sketch simple structural steel and aluminum work with details Read structural work drawing	Show students how to sketch structural steel and aluminum materials Guide students to check simple structural steel and aluminum work with details. Show students how to read structural work drawing	

	General Objective 4.0: Produce simple structural steel and aluminum projects on the shop floor					
	4.1 Explain calculations of allowances for forming thick metal or angle bar rings using mean line and neutral line method.	Discuss calculations of allowances for forming thick metal or angle bar rings using mean line and neutral line method	Textbooks	Calculate allowances for forming thick metal or angle bar rings using the following methods: a. mean line method b. neutral line method	Guide students to Calculate allowances for forming thick metal or angle bar rings using the following methods: a. mean line method b. neutral line method	Textbooks welding machine and equipment, consumables, drawings, cutting list etc Drawing instruments with cardboards, plywood etc

	4.2 Explain the job sequence in the production of simple projects in structural steel and aluminum work	Discuss sequence in the production of simple project in structural steel and aluminum work.	Charts, and posters, diagrams	Produce simple projects in structural steel and aluminum work	Guide students to produce simple projects in structural steel and aluminum work	
	4.3 Explain how to develop templates with regular surfaces	Discuss how to develop templates with regular surfaces	Drawing instruments with cardboards, plywood etc	Develop templates with regular surfaces e.g. cardboards, and plywood etc	Demonstrate how to develop templates with regular surfaces e.g. cardboard papers	
	4.4 Explain how to cut out templates from the following materials:	Describe cutting of templates from various	a. wood b. cardboard	Cut out templates from the following	Demonstrate to students how to cut templates from	a. wood b. cardboard c. drawing instrument and marker
	a. wood b. cardboard	materials in 4.4		materials: a. wood b. cardboard c. any other materials Reproduce simple jobs on structural steel and aluminum materials using templates cut in 4.4 above	various materials Demonstrate to students how to reproduce simple jobs on structural steel materials using templates in 4.4 above.	
	4.5 Explain simple working jigs, e.g. jig for mass production of	Discuss simple working jigs, e.g. jig for mass production of	Charts/Posters Sketches	Sketch working jigs, e.g. jig for mass production of stanchions,	Demonstrate how to sketch and produce simple working jigs.	Charts/Posters Sketches

	stanchions, rafters, etc., on the shop floor	stanchions, rafters, etc., on the shop floor		rafters, etc., on the shop floor Produce simple working jigs, e.g. jigs for mass production of stanchions, rafters, etc., on the shop floor Produce project involving the application of safety rules in structural steel and aluminum work		
	General Objective 5.0: Understand the process of manufacture of iron, steel and aluminum					
Week	**Specific Learning Outcomes**	**Teacher's Activities**	**Resources**	**Specific Learning Outcomes**	**Teacher's Activities**	
	5.1 Explain the working principle of blast furnace and describe its working principles	Discuss the working principle of blast furnace and explain the working principles	Posters/Chart Industrial Visit Furnace	Sketch a blast furnace and describe its working principles	Show students how to sketch and label a blast furnace and explain the working principles	Blast furnace
	5.2 State the name of fuel and state the composition of charge used in blast furnace	Discuss the type of fuel and the composition of charge used in blast furnace				Charts Coke Chemical charge, Electric charge

	5.3 Outline the characteristics of pig iron, cast iron and low carbon steel	Describe the characteristics of pig iron, cast iron and low carbon steel				Cast iron specimens Carbon steel Aluminum
	General Objective 6.0: Understand the assembly of simple structural steel components					
	6.1 Explain the uses of fixtures and bolts in the assembly of structural components	Discuss the uses of fixtures and bolts in the assembly of structural components	Bolts, and nuts screw Charts/Posters	Identify bolts, nuts and fixtures used in assembly of structural components	Show students bolts, nuts, screws and fixtures used in assembly of structural components	Bolts, and nuts screw Sample of structures Screws, bolt, nut, rivet of various sizes
	6.2 Explain how to assemble simple structural components such as rafter bracing, simple canopy simple roof trusses, aluminum doors and windows etc.	Discuss how to assemble simple structural components, using bolts, rivets, screws, and welding operation	Screws, bolt, nut, rivet of various sizes	Assemble simple structural components such as rafter bracing, simple canopy simple roof trusses, aluminum doors and windows etc.	Demonstrate how to assemble simple structural components, using bolts, rivets and welding operation	
	6.3 State the safety precaution involved in assemble of structural steel and aluminum component	Discuss the safety precaution involved in assembling structural steel and aluminum component				Personal protective equipment (PPEs)

	General Objective 7.0: Know the effect of corrosion on structural steel materials					
6	7.1 List some common causes of corrosion on steel e.g. a. Atmospheric b. chemicals such as electrolytic action. etc	Describe some common causes of corrosion on steel in 7.1		Identify samples of corroded steel.	Guide students to samples of corroded steel.	Charts, Brush, Undercoats, Solvents (degreasing agents), Sample of corroded steel.
7	7.2 Explain the effect of corrosion on structural steel, e.g. a. weakening of structure b. defacing of steel	Discuss the effects of corrosion on structural steel	Textbooks			
8 - 12	7.3 State the purposes of applying undercoat to structural steel components	Discuss the purposes of applying undercoat to structural steel components	Textbooks			Brushes, grease can, and electroplating Electroplating equipment
	7.4 Explain how to prepare the surfaces of structural steel components for finishing with the following methods:	Discuss how to prepare the surface of structural steel components for finishing		Prepare the surfaces of structural steel components for finishing with the following methods:	Demonstrate how to prepare the surface of structural steel components for finishing Ask the student to	
	a. brushing b. de-greasing c. de-scaling			a. brushing b. de-greasing **c.** de-scaling	perform the operation above	Paint, thinner, brush and

	7.5 List types of common undercoat used for structural steel work	Discuss types of common undercoat used for structural steel work.		Identify common types of undercoat materials used for structural steel work	Demonstrate to students how to identify types of common undercoat materials used for structural steel work	spraying gums
	7.6 Explain how to apply suitable undercoat to structural steel components.	Discuss the application of suitable undercoat to structural steel components		Apply suitable undercoat to a given structural steel components while observing safety precaution	Demonstrate the application of suitable undercoat to structural steel components and observe safety precautions.	

PROGRAMME: NATIONAL TECHNICAL CERTIFICATE IN FABRICATION AND WELDING CRAFT PRACTICE	**Course Code: CFW 315/325**	**Total Hours: 18HRS**
Course: ALUMINUM WORK I & II		**Theoretical: 2hours/week**
Year: Term: 1, 2 **THREE**	**Pre-requisite:**	**Practical: 4hours/week**
Goal: This module is designed to equip the trainee with the knowledge and skills to carry out Aluminum work		
General Objectives: On completion of this module the student should be able to: 1. Understand the safety rules as applicable to Aluminum work 2. Know tools and equipment used in aluminum works 3. Know the structural properties of materials used in aluminum work. 4. Know the production of simple aluminum projects on the shop floor 5. Know Aluminum Cutting, Forming and Joining Operations 6. Understand the assembly of simple aluminum components. 7. Know Aluminum Welding techniques		

PROGRAMME: NATIONAL TECHNICAL CERTIFICATE IN FABRICATION AND WELDING CRAFT PRACTICE						
Course Specification: Theoretical/ Practical Content YEAR 3, TERM 1 & TERM 2						
COURSE WORK: ALUMINUM WORK		**Course Code: CFW 315/325**		**Contact Hours: 6/week- T24: P48**		
	Theoretical			**Practical**		
Term 1	**General Objective 1.0 Understand the safety rules as applicable in aluminum work**					
Week	**Specific Learning Outcome**	**Teacher's Activities**	**Resource**	**Specific Learning Outcome**	**Teacher's Activities**	**Resources**
1-3	1.1 List personal protective equipment used in aluminum work: a. gloves b. aprons/overall c. boots d. goggles, e. helmet f. Nose mask etc	Discuss the functions of personal protective equipment used in aluminum work		Select appropriate personal protective equipment used in aluminum work. Use personal protective equipment in aluminum work	Show students personal protective equipment used in aluminum work. Demonstrate the use personal protective equipment used in aluminum work	Posters, Gloves aprons/overall, boots, goggles, helmet etc
	1.2 Explain the safety precautions involved in aluminum work 1.3 Explain hazards associated with aluminum work 1.4 Explain handling of aluminum sheets and rods	Discuss the precautions involved in structural work safety in steel and aluminum Discuss hazards associated with aluminum work		Set-up workshop for aluminum welding work for safety compliance	Guide students to set up aluminum welding works for safety compliance	

		Describe handling of aluminum sheets and rods				
	General Objective 2.0: Know tools and equipment used in aluminum work					
4-6	2.1 List tools and equipment used in aluminum work e.g. a. hammers b. shears c. Spanners d. dog drills e. dies f. punches g. chisels h. screw drivers i. pliers j. strips k. riveting gun l. wrenches m. welding machine n. torque spanners of straight edge p. straightening machine q. grinding machine r. guillotine s. punching	Discuss the tools and equipment used in aluminum work listed in 2.1		Sketch tools and equipment used in aluminum work. Select tools and equipment used in aluminum steel and aluminum work in 2.1	Guide students to Sketch t o o l s and equipment used in aluminum work. Show students how to select tools and equipment used in aluminum work.	

	t. Shearing machine etc					
	2.2 State the use of tools and equipment listed in 2.1 above	Discuss the use of tools and equipment listed 2.1 above.	Posters, textbooks, and charts	Use tools and equipment as listed in 2.1 above	Show students how to use tools and equipment as listed in 2.1	a. hammers b. shears c. spanners d. dog drills e. dies f. punches g. chisels h. screw drivers i. pliers j. strips k. riveting gun l. wrenches m. welding machine n. torque spanners of straight edge p. straightening machine q. grinding machine r. guillotine s. punching t. shearing machine etc
	2.3 Explain how to maintain and store tools and equipment	Discuss how to maintain and store tools and	Stores and toolbox	Carry out maintenance of tools	Demonstrate how to maintain tools and	Oil and grease cans. Grinding machine

	used in aluminum structural work	equipment used in aluminum structural work		and equipment used in aluminum work Store tools and equipment appropriately.	equipment used in aluminum work Guide students to store tools and equipment used in work appropriately	

	General Objective 3.0: Know the properties of materials used in aluminum structural work.					
Week	**Specific Learning Outcomes**	**Teacher's Activities**	**Resources**	**Specific Learning Outcomes**	**Teacher's Activities**	**Resources**
7-9	3.1 Define aluminum 3.2 State the importance of Aluminum in welding Industry 3.3 State the characteristics of aluminum including physical, chemical and mechanical properties: e.g. lightweight, corrosion resistance, conductivity 3.4 Explain the following aluminum properties:	Explain Aluminum as a metal Discuss the importance of Aluminum in welding Industry Explain the characteristics of aluminum including physical, chemical and mechanical properties. Discuss the following	Posters/Charts Diagrams, and textbooks			

	• Tensile Strength • Hardness • Ductility • Fatigue resistance of Aluminum	Aluminum properties Tensile Strength Hardness Ductility Fatigue resistance of Aluminum				
	3.5 Describe common applications of aluminum e.g. automotive, aerospace, construction	Explain common application of aluminum e.g. automotive, aerospace, construction	Textbooks, charts, and posters			
	General Objective 4.0: Produce simple aluminum projects on the shop floor					
10-12	4.1 Explain calculations of allowances for forming aluminum or angle bar rings using mean line and neutral line method.	Discuss calculations of allowances for forming aluminum or angle bar rings using mean line and neutral line method	Textbooks, charts, posters, diagram, multimedia	Calculate allowances for forming aluminum or angle bar rings using the following methods: a. mean line method b. neutral line method	Guide students to Calculate allowances for forming aluminum or angle bar rings using the following methods: a. mean line method b. neutral line method	welding machine and equipment, consumables, drawings, cutting list etc Drawing instruments with cardboards, plywood etc
	4.2 Explain the job sequence in the production of simple	Discuss sequence in the production of simple project in aluminum work.	Textbooks, charts, posters, diagram, multimedia	Producing simple projects in aluminum work	Guide students to produce simple projects in aluminum work	

	project in aluminum work					
	4.3 Explain how to develop templates with regular surfaces	Discuss how to develop templates with regular surfaces	Textbooks, charts, posters, diagram, multimedia	Develop templates with regular surfaces e.g cardboard, plywood etc	Demonstrate how to develop templates with regular surfaces e.g cardboard papers	
	4.4 Explain how to cut out templates from the following materials: a. wood b. cardboard	Describe cutting of templates from various materials in 4.4	Textbooks, charts, posters, diagram, multimedia	Cut out templates from the following materials: a. wood b. cardboard c. any other materials Reproduce simple jobs on structural steel and aluminum materials using templates cut in 4.4 above	Demonstrate to students how to cut templates from various materials Demonstrate to students how to reproduce simple jobs on structural steel materials using templates in 4.4 above.	a. wood b. cardboard c. drawing instrument and marker

	4.5 Explain simple working jigs and fixtures on the shop floor	Discuss simple working jigs and fixtures on the shop floor	Textbooks, charts, posters, diagram, multimedia	Sketch working jigs, e.g. jig for mass production of stanchions, rafters, etc., on the shop floor Produce simple working jigs, e.g. jig for mass production of stanchions, rafters, etc., on the shop floor Produce project involving the application of safety rules in aluminum work	Demonstrate how to sketch and produce simple working jigs.	Charts/Posters Sketches

Term 2	**General Objective 5.0: Know Aluminum Cutting, Forming and Joining Operation**					
1-4	5.1 Explain cutting operation as it relates to Aluminum Structural work	Discuss cutting operation as it relates to aluminum structural work	Textbooks, charts, posters, diagram, multimedia			Bolts, and nuts screw Sample of structures Screws, bolt, nut, rivet of various sizes PPEs
	5.2 List equipment used in cutting of aluminum structural work e.g. angle grinder, plasma cutter, laser cutter,	Discuss equipment used in cutting aluminum e.g angle grinder, plasma cutter, laser cutter, waterjet cutter, shears etc.	Textbooks, charts, posters, diagram, multimedia	Cut aluminum sheets using shears From simple aluminum sheets using angle cutter		

	waterjet cutter, shears etc. 5.3 Explain Aluminum forming processes 5.4 List forming process: bending, rolling, stamping, extrusion, Stretching, Hydroforming etc 5.5 Describe the equipment used in forming processing in aluminum structural work as mentioned in 5.4 i.e. Mechanical stamping Machine, Hydraulic press brake, direct extrusion press, pneumatic hammer,	Describe Aluminum Forming processes Explain Forming processes such as bending, rolling, stamping, extrusion, stretching, hydroforming etc Discuss the equipment used in the forming process in aluminum structural work i.e. Mechanical stamping Machine, Hydraulic press brake, direct extrusion press, pneumatic hammer				
	5.6 Explain Joining in Aluminum Structural work 5.5 Explain joining techniques used in aluminum structural:	Describe joining in Aluminum structural work Discuss the joining techniques in aluminum structural work: Riveting, welding, adhesive bonding, fasteners	Textbooks, charts, posters, diagram, multimedia			

	Riveting, welding, adhesive bonding, fasteners					

	General Objective 6.0: Understand the assembly of simple aluminum components					
5-8	6.1 Explain the uses of fixtures and bolts in the assembly of structural components	Discuss the uses of fixtures and bolts in the assembly of structural components	Bolts, and nuts screw Charts/Posters	Identify bolts, nuts and fixtures used in assembly of structural components	Show students bolts, nuts, screws and fixtures used in assembly of structural components	Bolts, and nuts screw Sample of structures Screws, bolt, nut, rivet of various sizes PPEs, Paint, thinner, brush and spraying gums
	6.2 Explain how to assemble simple structural components such as • rafter • bracing, • simple canopy • simple roof • trusses, • aluminum doors • windows etc. 6.3 State the safety precaution involved in assembling of aluminum component.	Discuss how to assemble simple structural components, using bolts, rivets, screws, and welding operation Discuss the safety precaution involved in assemble of aluminum component a. brushing b. de-greasing		Assemble simple structural components such as rafter bracing, simple canopy simple roof trusses, aluminum doors and windows etc.	Demonstrate how to assemble simple structural components, using bolts, rivets and welding operation	

	a. brushing b. de-greasing c. de-scaling	c. de-scaling				
	5.4 List types of common undercoat used for structural steel work	Discuss types of common undercoat used for structural steel work.	Electroplating gadgets	Identify common types of undercoat materials used for structural steel work	Demonstrate to students how to identify types of common undercoat materials used for structural steel work	
	6.5 Explain how to apply suitable undercoats to aluminum components.	Discuss the application of suitable undercoat to aluminum components		Apply suitable undercoat to a given aluminum components while observing safety precaution	Demonstrate the application of suitable undercoat to aluminum components and observe safety precautions.	
	General Objective 7.0: Know Aluminum Welding					
9-12	7.1 Describe Aluminum welding using the following processes: Oxy-acetylene techniques, TIG Welding, SMAW, GMAW	Discuss Aluminum welding using the following techniques: Oxy-acetylene processes, TIG Welding, SMAW, GMAW	Textbooks, charts, posters, diagram, multimedia	Identify TIG welding process in Aluminum structural work	Guide students to Identify TIG welding process in Aluminum structural work	Colet, ceramic cup, gas diffuser, Tail, Tungsten electrode: • 2% Thoriated (Red color) • 1.5% Lanthanotid (Gold) • 2% Ceraiated (Grey) former Orange
	7.2 Describe TIG welding process for aluminum work	Describe the setting up of TIG welding machine for aluminum work	Textbooks, charts, posters,	Identify the accessories for TIG		

	7.3 List the accessories for TIG Welding process such as Colet, ceramic cup, gas diffuser, Tail. 7.5 List various consumables for TIG welding process: a) Gas: Argon and Helium b) Filler rod 7.6 Describe various techniques for TIG welding in aluminum structural work such as layers, capping, ringing etc 7.11 Explain types of Tungsten electrode: • 2% Thoriated (Red color) • 1.5% Lanthanotid (Gold) • 2% Corradiated	Discuss accessories for TIG Welding process such as Colet, ceramic cup, gas diffuser, Tail. Discuss various consumables for the TIG welding process: a) Gas: Argon and Helium b) Filler rod Discuss various techniques for TIG welding such as layers, capping, ringing etc Discuss types of Tungsten electrode: • 2% Thoriated (Red color) • 1.5% Lanthanotid (Gold) • 2% Corradiated (Grey) former Orange	diagram, multimedia	Welding process such as Colet, ceramic cup, gas diffuser, Tail Identify various consumables for the TIG welding process: a) Gas: Argon and Helium b) Filler rod Select appropriate consumables for a given job Apply techniques in aluminum structural work Identify types of Tungsten electrode: • 2% Thoriated (Red color) • 1.5% Lanthanotid (Gold) • 2% Corradiated (Grey) former Orange	Guide students to Identify the accessories for TIG Welding process such as Colet, ceramic cup, gas diffuser, Tail Identify various consumables for the TIG welding process: a) Gas: Argon and Helium b) Filler rod Guide students to Select appropriate consumables for a given job Guide students to apply techniques in aluminum structural work Guide students to identify types of Tungsten electrode: • 2% Thoriated (Red color) • 1.5% Lanthanotid (Gold)	• 0.8% Zirconated (White) • Pure green

	(Grey) former Orange • 0.8% Zirconated (White) • Pure green	• 0.8% Zirconated (White) • Pure green		• 0.8% Zirconated (White) • Pure green Carry out appropriate preparation of tungsten electrode Set up a TIG machine for a given task Carry out TIG welding in fillet joints and positions 1F, 2F, 3F, 4F, Pipe on flange 5F, 4F	• 2% Corradiated (Grey) former Orange • 0.8% Zirconated (White) • Pure green Guide students to carry out appropriate preparation of tungsten electrode Show students the set-up of a TIG machine for a given task Show students to carry out TIG welding in fillet joints and positions 1F, 2F, 3F, 4F, Pipe on flange 5F, 4F	

APPENDIX I

LIST OF TOOLS AND EQUIPMENT FOR WELDING, FABRICATION AND ALUMINIUM WORKS

S/NO		MINIMUM QUANTITY REQUIRED	QUANTITY AVAILABLE	ADDITIONAL QUANTITY REQUIRED
1	Power guillotine of capacity 10swgx 36 in length (Fabrication)	2		
2	Treadle guillotine of capacity 20swgx 36 length(Fabrication)	2		
3	Swing beam folder 10swgx 3'-6' capacity(Fabrication)	2		
4	Bending roller capacity 40"x2" dia(Fabrication)	3		
5	Bending roller capacity 18"x11/4 dia(Fabrication)	3		
6	Bench mounted cone roller(Fabrication)	4		
7	Hand-operated copper capacity 3/32 in mild steel(Fabrication)	5		
8	Power bench grinding machine(Fabrication)	10		
9	Double-ended buffer and polisher(Fabrication)	10		
10	Universal beading and swaging machine(Fabrication)	10		
11	Power-operated drilling machine maximum capacity 3/8" (Fabrication)	3		
12	Wheeling machine(Fabrication)	3		
13	Fly Press(Fabrication)	3		
14	Hand nibbling Machine(Fabrication)	3		
15	Left and right hand snips(Fabrication)	20		
16	Straight snips(Fabrication)	15		
17	A "kit" of tools consisting of hammer, mallet, steel rule, scriber and wing compass, vernier caliper etc. (Consumables)	10		
18	Bench shears(Fabrication)	3		
19	Power saw cutting machine 10mm(Fabrication)	2		
20	Disc cutting machine(Fabrication)	10big; 5 small		
21	Profile cutting machine with gas cutting nozzles(Fabrication)	3		
22	Piller drilling machine(Fabrication)	3		
23	Louver shearing machine (manual) (Fabrication)	3		
24	Straightening machine	2		
25	Cropping machine	3		
26	Straight edge	2		

27	Trammels dividers (set)	20		
28	Hammers	20		
29	Chisels	20		
30	Punches	20		
31	Try-squares	20		
32	Steel rules	20		
33	Smith open forge	2		
34	Vee blocks	5		
35	Electrode holders	10		
36	Electrode drying oven	2		
37	Heavy duty grinding machine	5		
38	Bench-type grinding machine	5		
39	CO_2 cylinders	5		
40	Aprons (assorted) (Consumables)	40		
41	Hand gloves	40		
42	Hand shields and head caps	20		
43	Wire brushes	20		
44	Electrical Heaters	5		
45	Pliers – assorted	20		
46	Gas welding goggles	20		
47	Double cylinder trolley	3		
48	Oxygen regulators	10 sets		
49	Acetylene regulators	10 sets		
50	Hoses and clips and all attachments set	10 sets		
51	Blowpipes (low and high pressure)	10 sets		
52	Tongs	20		
53	Combined set of cutting welding outfit	20		
54	D.C generators with all connections	10		
55	A.C transformer (Argon) with all the connections	10		
56	Argon cylinders	3		
57	Regulators with flow meters	5 sets		
58	Hacksaw blades (Consumables)	100		

59	Hacksaw Frame (Consumables)	40		
60	Water to carbide generators	5		
61	Carbide to water generators	5		
62	Overhead projector	2		
64	ANVIL	5		
65	Swage block	5		
66	Chipping hammers	20		
67	Plain goggles	10		
68	First aid box	4		
69	Sledge Hammer	20		
70	G. Clamps - assorted	20		
71	Self grip pliers - assorted	20		
72	Magnetic clamp	10		
73	Flatters	20		
74	Mole grip	20		
75	ArcWelding Booths	20		
76	Gas Welding Booths	20		
77	Clamps	20		
78	Various sizes of metal sheet (0.6mm, 1mm, 1.5mm, 2mm, 2.5mm, 3mm)	3 each		
79	Drill Bits of various sizes	10sets		
80	CNC Lathe Machine	1		
81	Rivets gun	10		
82	Grinding Disc	40 pieces		
83	Charts/Posters	As required		
84	Soldering Machines(Welding)	10		
85	Swagging Machine	2		
86	Backsaw	2		
87	Emry Cloths	10 packets/sheets		

88	Respirators	20		
89	Ear Muffs/Plug	20		
90	Boots	20 pairs		
91	Flash Back Arrestor	10		
92	Blow pipe	10		
93	Wheelbarrow	5		
94	Gas Detector	5		
95	Fire Extinguisher	10		
96	Soap Solution	250 litres		
97	Welding Rods	20 packets		
98	Blower	2		
99	Samples of Ferrous and Non-Ferrous metal	As required		
100	Filler Rods	20 bundles		
101	AC and DC (Inverter) Welding Machines	20		
102	Flat Bar	40		
103	Electric Furnace	3		
104	Oil and Grease	1 Drum oil and 2 buckets of grease		
105	Sample of corroded Steel	As required		
106	Work Benches	10		
107	Micrometer Screw gauge	20		
108	Measuring Tape	40		
109	Center Punch	20		
110	Riveting Machine	10		
111	Riveting Pin	10 packets		
112	Soldering Lead	10 rolls		

113	Gas Cylinders with colour code	3 sets		
114	Calcium Carbide	2 drums		
115	Cutting Touches	10 sets		
116	Welding Torches	10 sets		
117	Wrought Iron/Cast Iron/Mild Steel/Stainless Steel samples	As required		
118	Plates of various sizes	As required		
119	Pipes of various sizes	As required		
120	Angle bars	As required		
121	Filler Wire	5 rolls		
122	MMA, MIG/MAG, FCAW machines (Multi process machine)	5		
123	Tungsten	1 cartoons		
124	Worn metal shafts and Worn metal gear	As required		
125	Wrench box	5		
126	Torque Spanner	5		
127	Bolts and Feature	40		
128	Undercoats	5 gallons		
129	Solvents	5 gallons		
130	Angle Grinder/Pedestal Grinder/Cylindrical Grinder	5 each		
131	Stamping Machine	1 set		
132	Rolling Machine	1 set		
133	Bending Machine	1 set		
134	Press Machine	1 set		
135	Power hose	1 roll		
144	Chipping Hammer	20		

NATIONAL/ADVANCE TECHNICAL CERTIFICATE IN REFRIGERATION AND AIRCONDITIONING WORK

GUIDELINES FOR TEXTBOOK WRITERS

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

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

- One book should be produced for each syllabus
- Page size should be A4
- The front size should be 12 points for normal text and 14 point where emphasis is needed.
- Line spacing should be set to 1.5 lines
- Headings and subheadings should be emboldened
- Photographs, diagrams and charts should used extensively throughout the book, and these items must be up-to-date
- In all cases the material must be related to industry and commerce, using real life examples wherever possible so that the book is not just a theory book. It must help the students to see the subject in the context of the `real word'
- The philosophy of the courses is one of an integrated approach to theory and practice, and as such the books should reflect this by not making an artificial divide between theory and practice.
- Examples should drawn from Nigeria wherever possible, so that the information is set in a country text.
- Each chapter should end with student self-assessment questions (SAG) so that students can check their own master of the subject.
- Accurate instructions should be given for any practical work having first conducted the practical to check that the instructions do indeed work.
- The books must have a proper index or table of contents, a list of references and an introduction based on the overall course philosophy an aims of the syllabus.
- Symbols and units must be listed and a unified approach used throughout the book.
- In case of queries regarding the contents o the books and the depth of information, the author must contact the relevant curriculum committee via the National Board for Technical Education.
- The final draft version of the books should be submitted to Nigerian members of the curriculum working groups for their comments regarding the content in relation to the desired syllabus.

RECOMMENDED BOOKS FOR FABRICATION AND WELDING ENGINEERING CRAFT PRACTICE

S/NO	BOOKS	AUTHORS
1.	BASIC WELDING AND FABRICATION	W. KENYON
2.	BASIC ENGINEERING CRAFT STUDENTS: FABRICATION AND WELDING 05	BOURBOUSSON & ASHWORTH
3.	THE TECHNOLOGY OF SHEET METAL WORK FOR STUDENTS AND CRAFTSMEN	A. DICKSON
4.	THE GEOMETRY OF SHEET METAL WORK FOR STUDENTS AND CRAFTSMEN	A. DICKSON
5.	THE CALCULATION OF SHEET METAL WORK FOR STUDENTS AND CRAFTSMEN	A. DICKSON
6.	METAL: DESIGN AND CONSTRUCTION	A.C. DAVIS - Tenth Edition
7.	WELDING TECHNOLOGY	J. CARDENER
8.	FABRICATION AND WELDING TECHNOLOGY	KOENISBERGE
9.	BASIC WELDING - Macmillian Publisher Ltd London, 1986	A. SMITH
11.	WELDING CRAFT PRACTICE - Part 1 Volume I Oxy-acetylene Gas Welding and Related Studies	P. SOMSKY
12.	WELDING CRAFT PRACTICE - Part 1. Volume 2: Electrical Arc Welding and Related Studies	N. PARKIN & C.R. FLOOD
13.	Aluminium Fabrication	Roger Creasey
14	Aluminium Design and Construction	J. Randolph Kissell & Robert L. Ferry

LIST OF PARTICIPANTS FOR REVIEW AND DEVELOPMENT

S/No	Name	Address
1	Engr. Muhammad Mukhtar Zakirai (Chairman)	MetalFocus Engineering Ltd Technology Incubation Centre Farm Centre Kano mukhtarzakirai@gmail.com
2	Joel Joseph	Government Technical College Malali Kaduna joeljkduniya@mail.com
3	Shehu Usman Abdu	National Board for Technical Education Kaduna (NBTE) Shehuwa1@gmail.com

LIST OF PARTICIPANTS FOR CRITIQUE

S/No	Name	Address
1	Mr. Godiya Mayi (Chairman)	Defence Industries Corporation Of Nigeria (DICON), Kaduna, Kaduna State mayigodiya@gmail.com
2	Mr. James O. Eguavoen	National Business And Technical Examination Board (NABTEB), Benin City, Edo State. jamog50@yahoo.com
3	Opoola Damilola John	National Board for Technical Education Kaduna (NBTE) opooladamilola@gmail.com
4	Olubode Daniel Majiyagbe	Skills Nigerian Company Limited, Kaduna dannymajis@yahoo.com

World Bank – National Board
for Technical Education, Nigeria
Project on Innovation Development
and Effectiveness in the Acquisition
of Skills (IDEAS)

Plot B, Bida Road, PMB 2239,Kaduna
ideasworldbankproject@nbte.gov.ng
Tel: +234 (0) 802 4728 042