

**Plumbing and Pipe Fitting - National Technical  
Certificate (NTC) and Advanced National Technical  
Certificate (ANTC)**

**Gas and Bronze Welding**

<b>PROGRAMME:</b>	ATIONAL TECHNICAL CERTIFICATE IN PLUMBING AND PIPE FITTING
<b>COURSE:</b>	GAS AND BRONZE WELDING COURSE CODE: CBW11
<b>CONTACT HOURS:</b>	3RS/WEEK
<b>GOAL:</b>	The module is designed to provide the trainee with the knowledge and techniques of gas and bronze welding to enable him carry out all gas and bronze welding operations in normal plumbing work.

**GENERAL OBJECTIVES:** On completion of this module, trainee should be able to:-

1. Understand and apply the general safety precautions related to gas and bronze welding.
2. Know and apply successfully various gas welding processes/operations including the acetylene and oxy-fuel gas cutting processes.
3. Understand the process of manufacture and storage of oxygen and acetylene and associated safety measures.
4. Assemble oxygen and acetylene equipment ready for welding operations.
5. Understand the general principle of brazing and bronze welding and use them in joining metals to a high degree of efficiency.
6. Know and weld together the different types of non-ferrous and ferrous metals.
7. Understand and apply the fuel gas cutting metals to given specification.
8. Know the various welding defects and rectify them.

**PRACTICAL COMPETENCE:** On completion of this module, the trainee should be able to:-

1. Select, use and care for protective wears for carrying out gas welding operations.
2. Weld metals together in down-hand or flat position/leftward and rightward techniques.
3. Carry out bronze welding on prepared joints using slightly oxidizing flame as appropriate and observing necessary safety precautions.
4. Weld stainless steel components using appropriate welding rods, techniques and observing safety precautions.
5. Detect welded joints defects and rectify them.

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<b>Course Specification: Theoretical/Practical Contents</b>			
<b>General Objective: 1.0 Understand and apply the general safety precautions related to Gas and BronzeWelding</b>			
<b>Week</b>	<b>Specific Learning Outcome</b>	<b>Teachers Activities</b>	<b>Resources</b>
1-2	1.1 Understand the essence and emphasis on safety precautions 1.2 Carry, transport and store full and empty gas cylinders safely using appropriate equipment 1.3 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 with inflammable materials, e.g petrol tank c. Gas welding in confined spaces	<ul style="list-style-type: none"> <li>• Emphasise the importance of separation of empty and full cylinders and explain the essence of safety - in carrying and transporting of cylinder bottles.</li> <li>• Prepare explosive containers ready for welding operation</li> <li>• Teacher to provide insulative shield for welding; welding goggles, gloves, etc. e.g. when welding near inflammable materials</li> </ul>	<ul style="list-style-type: none"> <li>• Insulating shield</li> <li>• Fans</li> <li>• Extractors</li> <li>• Safety signs, information sheet and postals</li> <li>• Welding goggles,</li> <li>• Shield overall</li> <li>• Arching tables,</li> <li>• Trolling, etc.</li> </ul>
3	1.4 Select, use and care for protective wears for carrying out the following gas welding operations, e.g. Welding goggles Welding shields Gloves Boots, etc. 1.5 Display safety signs - prohibition, mandatory, warning and information signs.	<ul style="list-style-type: none"> <li>• Explain the importance of fans and cathode extractors when welding in a confined area</li> <li>• Teacher to display safety signs - i.e. prohibition signs, mandatory signs, warning signs and information signs.</li> <li>• Emphasise the importance and use of protective wears, e.g. welding goggles, gloves, booths, nose covers, etc.</li> <li>• Assess the students.</li> </ul>	<ul style="list-style-type: none"> <li>•</li> </ul>

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<b>General Objective 2.0: Know and apply successfully various gas welding processes/operations including the acetylene and oxy-fuel gas cutting processes.</b>			
<b>Week</b>	<b>Specific Learning Outcome</b>	<b>Teachers Activities</b>	<b>Resources</b>
4-6	<p>2.1 Identify the following gas welding equipment, describing their features, functions, applications and care:</p> <ol style="list-style-type: none"> <li>generators</li> <li>regulators</li> <li>blow pipes</li> <li>nozzles</li> <li>hoses</li> <li>gas cylinders and their colours</li> <li>economizers</li> <li>check valves</li> </ol> <p>2.2 Differentiate between the following types of generators, stating their merits and demerits.</p> <ol style="list-style-type: none"> <li>Carbide to water generator</li> <li>Calcium carbide to-water generator</li> </ol> <p>2.3 Identify the main parts of the generator e.g.</p> <ol style="list-style-type: none"> <li>hydraulic back pressure valve</li> <li>purifiers</li> <li>carbide trays</li> <li>etc.</li> </ol> <p>2.4 Distinguish between high and low pressure systems of welding.</p> <p>2.5 State the properties of calcium carbide</p>	<ul style="list-style-type: none"> <li>• Identify the welding component and explain the differences</li> <li>• Explain the difference between the two low pressure gas generating equipment. State the advantages and the disadvantages of the two low pressure generating equipment</li> <li>• Analyse the properties of calcium carbide and process of generating acetylene from carbide</li> <li>• Prepare detailed notes.</li> <li>• Assess the students.</li> </ul>	<ul style="list-style-type: none"> <li>• Gas generator</li> <li>• Gas regulator</li> <li>• Blow pipes, Nozzles</li> <li>• Pressure hoses</li> <li>• Gas cylinders</li> <li>• Economizers</li> <li>• Check valves</li> <li>• Carbide trays</li> <li>• Calcium carbide</li> <li>• Pressure valve</li> <li>• Purifiers</li> </ul>

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7-9	<p>2.6 Generate acetylene using calcium carbide guiding against danger or over-charge</p> <p>2.7 Identify types of welding rods stating their properties, compositions, and uses Differentiate between welding and cutting torches</p> <p>2.8 Identify the following flames and describe how they are derived in the oxy-acetylene welding process:</p> <p style="margin-left: 40px;">a. oxidizing flame b. carbonising flame c. neutral flame</p> <p>2.9 State the instances of the application/uses of the type of flames named in (2.8) above</p> <p>2.10 Light the welding torch and adjust the flame to each of the types named in 2.8 above</p> <p>2.11 Prepare plate surfaces and run beads:</p> <p style="margin-left: 40px;">a. without filler rods b. with filler rods</p> <p>2.12 Make neat labelled sketches indicating the conventional symbols for the welded joints, e.g. butt joint, fillet joint and lap joint.</p> <p>2.13 Prepare plate surfaces for the following welding joints and tack weld i. Butt joints, ii. Fillet joint iii. Lap joint</p> <p>2.14 Weld metals together in down-hand or flat position</p> <p>2.15 State the functions of backing bars and strips</p> <p>2.16 Apply backing bars and strips according to instructions.</p>	<ul style="list-style-type: none"> <li>• Identify different welding rods and enumerate their properties composition and uses.</li> <li>• Identify and differentiate between welding and cutting torches</li> <li>• Explain and demonstrate simple processes of gas welding with or without filler</li> <li>• Identify convectional welding symbols and preparation of plate surfaces for carrying out various joint e.g butt and fillet joints.</li> <li>• Demonstrate different welding methods, and emphasise the functions of backing bars and strips.</li> <li>• Prepare detailed notes.</li> <li>• Assess the students.</li> </ul>	<ul style="list-style-type: none"> <li>• Calcium carbide</li> <li>• Carbide trays</li> <li>• Posters and brochures</li> <li>• Listing and identifying part of welding equipment</li> <li>• Set of welding wedge</li> <li>• Cutting tools</li> <li>• Materials</li> <li>• Welding rods, sparklighter</li> <li>• Posters indicating different welding joints.</li> </ul>

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<b>Course Specification: Theoretical/Practical Contents</b>			
<b>General Objective 3.0: Understand the Process of Manufacture and Storage of Oxygen and Acetylene and Associated Safety Measures.</b>			
<b>Week</b>	<b>Specific Learning Outcome</b>	<b>Teachers Activities</b>	<b>Resources</b>
10	3.1 Explain the various methods of manufacture and storage of oxygen and acetylene 3.2 Identify the difference between the equipment for oxygen and acetylene 3.3 State the safety precautions: a. during handling b. during storage c. During assembly and use. EVALUATION: Oral quize with Intermittent Questions	<ul style="list-style-type: none"> <li>• Enumerate the principal components of manufacture of oxygen and acetylene gas (carbide)</li> <li>• Identify the difference between oxygen and acetylene equipment; and emphasise all safety precaution during handling, storage, assembly and use of oxygen and acetylene.</li> <li>• Visitation trip to Industrial Gas manufacturing companies</li> <li>• Assess the students.</li> </ul>	<ul style="list-style-type: none"> <li>• Vehicles</li> </ul>
<b>General Objective 4.0: Assemble oxygen and Acetylene Equipment ready for Welding Operation.</b>			
<b>Week</b>	<b>Specific Learning Outcome</b>	<b>Teachers Activities</b>	<b>Resources</b>
11-12	4.1 Position and secure the acetylene welding cylinders 4.2 Clean the outlet of cylinder of foreign body and fix on the pressure regulators 4.3 Identify the correct hose pipes and fixing them on to pressure regulators 4.4 Fix on the welding blow pipe to the hose pipe and attaching correct nozzle 4.5 Test the completely assembled equipment for leakages using soapy water 4.6 State the functions of the various components, viz a. regulators b. blow-pipe c. nozzles d. hoses, etc. 4.7 Carry out oxy-acetylene welding on any materials applying left ward and rightward techniques	<ul style="list-style-type: none"> <li>• Assemble oxy-acetylene welding equipment</li> <li>• Prepare detailed notes for the students to copy after explaining the activities on 4.1 to 4.7</li> <li>• Assess the students.</li> </ul>	<ul style="list-style-type: none"> <li>• Silver solder</li> <li>• Brazing welding rods</li> <li>• Bend bolt</li> <li>• Tapping hammer</li> <li>• Brazing spectacle</li> <li>• Flux</li> <li>• Bronze materials</li> <li>• Filler rods</li> <li>• Gas - oxy-acetylene</li> <li>• Safety posters</li> </ul>

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<b>General Objective 5.0: Understand the General Principle of Brazing and Bronze welding and use these Methods in Joining Metals to a high degree of Efficiency</b>			
<b>Week</b>	<b>Specific Learning Outcome</b>	<b>Teachers Activities</b>	<b>Resources</b>
13-15	<p>5.1 Know the relationship and differences between brazing/silver soldering and bronze welding</p> <p>5.2 Light a flame necessary for successful brazing and bronze welding</p> <p>5.3 State the composition of the various types of fluxes and filler rods used for brazing and bronze welding</p> <p>5.4 Prepare metal/edges for brazing</p> <p>5.5 Braze joints using oxy-acetylene flame/brazing lamp, observing necessary safety precautions</p> <p>5.6 Prepare joints for bronze welding e.g. bell mouth, branch joints, joint etc.</p> <p>5.7 Carry out bronze welding on prepared joints using slightly oxidizing flame as appropriate and observing necessary safety precautions.</p> <p>5.8 Explain the importance of using bronze welding for the welding of dissimilar metals; e.g.</p> <ol style="list-style-type: none"> <li>copper and steel</li> <li>cast iron and copper</li> <li>galvanized materials</li> </ol> <p><b>EVALUATION:</b> Students Assessment, through identification of already stated equipment and materials. Students to carry out bronze welding on prepared joints</p>	<ul style="list-style-type: none"> <li>• Explain difference between silver soldering and bronze welding and demonstrates how to obtain suitable flames for brazing and bronze welding</li> <li>• Explain the purpose of flux and enumerate the different various types of fluxes and filler rods used for brazing and bronze welding</li> <li>• Demonstrate the method of preparing metal for brazing and carryout brazing joint using oxy-acetylene flame or brazing lamp</li> <li>• Observe necessary precautions</li> <li>• Students to prepare the following bronze welding joint - bell mouth, branch joint, etc</li> <li>• Set slightly oxidising flame and proceed to carry out bronze welding on prepared welding joint, observing necessary safety precautions.</li> <li>• Explain the importance of bronze welding for successful welding of dissimilar metals; e.g. copper and steel, cast iron and copper, and galvanize materials.</li> <li>• Prepares notes for the students.</li> <li>• Assess the students.</li> </ul>	<ul style="list-style-type: none"> <li>• Oxy-acetylene equipment</li> <li>• Brazing lamp</li> <li>• Brazing rod, fluxes, (paste and powder type).</li> <li>• Pipe expander</li> <li>• Abrasive papers, taping hammer, bend bolt, etc.</li> <li>• Copper plates or rod</li> <li>• Cast iron plates</li> <li>• Galvanized sheet</li> <li>• Steel plates/rod</li> <li>• Safety materials</li> </ul>

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<b>General Objective 6.0: Know and weld together the different types of Non-ferrous and ferrous Metals</b>			
<b>Week</b>	<b>Specific Learning Outcome</b>	<b>Teachers Activities</b>	<b>Resources</b>
16-18 19-20	<p>6.1 Identify the following non-ferrous metals:</p> <ol style="list-style-type: none"> <li>Copper</li> <li>Aluminium</li> <li>Brass</li> <li>Bronze, etc</li> </ol> <p>6.2 Describe the composition and state the mechanical properties of the above named non-ferrous metals. Mechanical properties to include</p> <ol style="list-style-type: none"> <li>Ductility</li> <li>Malleability</li> <li>Hardness; etc.</li> </ol> <p>6.3 State the properties and composition of fluxes used for welding non-ferrous metals</p> <p>6.4 Prepare and weld non-ferrous metals using appropriate fluxes</p> <p>6.5 Prepare bronze components for welding, avoiding sharp edges and weld to specification.</p> <p>6.6 Identify and state the type, composition and properties of stainless steels used in metal work.</p> <p>6.7 Prepare stainless steel components for welding</p> <p>6.8 Weld stainless steel components using appropriate welding rods, techniques and observing safety precautions.</p> <p>6.9 Explain the effect of welding together two different metals.</p> <p>EVALUATION: Students Assessment, through identification or already stated equipment and materials.</p>	<ul style="list-style-type: none"> <li>Explain the different between ferrous and non-ferrous metals</li> <li>Identify and state the compositions/mechanical properties of - Brass, Bronze, and stainless steel</li> <li>Prepare non-ferrous materials for welding - emphasising suitable fluxes, composition and properties.</li> <li>Demonstrate the process of preparation and welding of bronze components</li> <li>Emphasise the properties of stainless steel and show the technique and material for a successful welding</li> <li>Narrate the effect of welding two dissimilar metals together i.e. Electrolytic corrosion.</li> <li>Prepare detailed notes for the students.</li> <li>Assess the students.</li> </ul>	<ul style="list-style-type: none"> <li>Oxy-acetylene equipment</li> <li>Brazing lamp</li> <li>Brazing rod, fluxes, (paste and powder type)</li> <li>Pipe expander</li> <li>Abrasive papers</li> <li>Taping hammer, bend bolt, etc.</li> <li>Bronze plate</li> <li>Bronze plates</li> <li>Stainless Steel Materials</li> <li>Coppers Materials</li> <li>Aluminium Materials</li> <li>Various types of Welding rods</li> <li>Safety Posters</li> <li>Safety materials</li> </ul>

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<b>General Objective 7.0: Fuel Gas Cutting Process</b>			
<b>Week</b>	<b>Specific Learning Outcome</b>	<b>Teachers Activities</b>	<b>Resources</b>
21	7.1 State the principles and applications of fuel-gas cutting process e.g. <ul style="list-style-type: none"> <li>a. Manual</li> <li>b. Machine</li> </ul> 7.2 Describe various fuel gases used in oxy-fuel cutting: <ul style="list-style-type: none"> <li>a. acetylene</li> <li>b. propane</li> <li>c. butane</li> <li>d. coal gas, etc.</li> </ul> 7.3 State the advantages and disadvantages of using the above mentioned, fuel-gases for oxy-fuel cutting operations, <b>EVALUATION: Assessment of Simple Practical Project</b>	<ul style="list-style-type: none"> <li>• Explain oxidation principles behind fuel-gas cutting and state the different methods of cutting</li> <li>• Enumerate different fuel gases used in oxy-fuel cutting and explain their advantages and disadvantages.</li> <li>• Identify manual and machine cutting equipment.</li> <li>• Prepare detailed notes.</li> <li>• Assess the students.</li> </ul>	<ul style="list-style-type: none"> <li>• Oxy-fuel cutting equipment</li> <li>• Colour code for different fuel-Gases</li> </ul>

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General Objective 8.0: Know the various Welding Defects and Rectify Them.			
Week	Specific Learning Outcome	Teachers Activities	Resources
22-24	<p>8.1 Determine welded joints defects by the known methods e.g.</p> <p style="padding-left: 40px;">a. non-destructive test</p> <p style="padding-left: 40px;">b. destructive test</p> <p>8.2 Rectify welded joint defects enumerated above</p> <p>8.3 State the main causes of defects in welded joints.</p> <p>EVALUATION: Visual examination of the Cutting Parts.</p> <p><b>PRACTICAL EXERCISES</b></p> <p>8.4 Production and storage of oxygen and Acetylene gas using Calcium carbide and electrolysis of water. Position, assemble and test gas welding equipment ready for welding operation</p> <p>8.5 Preparation of plate surfaces for the following welding joint and Tack and weld</p> <p style="padding-left: 40px;">a. Butt joint</p> <p style="padding-left: 40px;">b. fillet joint</p> <p style="padding-left: 40px;">c. Lap joint</p> <p style="padding-left: 40px;">d. Prepare joints for bronze welding e.g bell mouth branch joint, V joint.</p>	<ul style="list-style-type: none"> <li>• Explain and demonstrate method of non destructive and destructive testing of welded joints</li> <li>• Demonstrate how to rectify the enumerated defect</li> <li>• State and explain the causes of defect in welded joints.</li> <li>• Prepare detailed notes for the students.</li> <li>• Assess the students.</li> </ul>	<ul style="list-style-type: none"> <li>• Hacksaw</li> <li>• File</li> <li>• Table Vice</li> <li>• Gammer ray</li> <li>• Or ex-ray machine</li> <li>• Etching fluid</li> <li>• Hammer</li> </ul>