NATIONAL BOARD FOR TECHNICAL EDUCATION, KADUNA.

NATIONAL DIPLOMA (ND)

WELDING AND FABRICATION TECHNOLOGY

CURRICULUM AND COURSE SPECIFICATIONS

GENERAL INFORMATION

Goal of Welding and fabrication Programme

1.0 The programme is intended to impart theoretical knowledge and practical skill to students on engineering design practice, planning, management, operation and maintenance of Welding Engineering system and equipment suitable for a technician.

1.1 General Entry Requirements:

(a) NATIONAL DIPLOMA (ND)

The general entry requirement for the ND programme in *Welding and Fabrication* ***is General Certificate of Education (GCE) Ordinary Level, or the Senior Secondary School Certificate (SSSC) with credit passes in four relevant subjects. The relevant subjects are: Mathematics, Physics, Chemistry and one other subject from Metal Work, Wood Work, Technical Drawing, Basic Electronics, Economics, Statistics, English Language, Additional Mathematics plus a pass in English Language at not more than two sittings.***

(b) Passes at credit level in the four relevant subjects at the Preliminary National Diploma Examination.

(c) The National Technical Certificate (NTC) with credit passes in the four relevant subjects and a pass in English Language.

1.2 Higher National Diploma (HND) Programme:

The general entry requirements for the HND programme include:

(a) all the requirements for admission into the ND programme as stated above;
(b) a minimum of lower credit pass (CGPA 2.50 and above) in the cognate ND examination; and
(c) a minimum of one year cognate work experience.

In exceptional cases, ND diplomates with a pass (CGPA 2.00-2.49) in the ND Examination that had two or more years of cognate experience in the specific field may be considered for admission into the HND programme.

2.0 Curriculum:

2.1 The curriculum of all ND and HND programmes consist of four main components. These are:

i) General Studies/Education
ii) Foundation Courses
iii) Professional Courses
iv) Supervised Industrial Work Experience Scheme (SIWES)

2.2 The General Education Component shall include courses in:
Art and Humanities- ***English Language, Communication, History.***
Social Studies- ***Citizenship (the Nigerian Constitution) Political Science, Sociology, Philosophy, Geography, Entrepreneurship Studies.***

2.3 The General Education component shall account for not more than 15% of total contact hours for the programme.

*2.4 Foundation Course****s include courses in Mathematics, Pure Science, Technical Drawing, Descriptive Geometry, etc. The number of hours will be about 10-15% of the total contact hours.***

2.5 Professional Courses ***are courses which give the student the theory and practical skills he needs to practice*** *Welding and Fabrication* ***at the technician/technologist level. These may account for between 60-70% of the contact hours.***

2.6 Student Industrial Work Experience Scheme (SIWES) ***shall be taken during the long vacation following the end of the second semester of the first year. See details of SIWES at paragraph 7.0.***

3.0 Curriculum Structure:

3.1 ND Programme
The structure of the ND programme consist of four semester of classroom, laboratory and workshop activities in the college and a semester (3-4 months) of Student Industrial Work Experience Scheme (SIWES). Each semester shall be of 17weeks of duration made up as follows:
15 contact weeks of teaching, i.e. recitation, practical exercises, quizzes, test, etc; and 2 weeks for examinations and registration.
SIWES shall take place at the end of the second semester of the first year.

3.2 HND Programme:

The structure of the programme is similar to that of the ND save that the SIWES at the end of the first year is not compulsory.

4.0 ACCREDITATION

Each programme offered either at the ND or HND level shall be accredited by the NBTE before the diplomates can be awarded either of the two diploma certificates. Details about the process of accrediting a programme for the award of the ND or HND are available from the Executive Secretary, Programme Division, National Board for Technical Education, Plot B, Bida Road, P.M.B. 2239, Kaduna, Nigeria.

5.0 Conditions for the Award of the ND/HND:

Institutions offering accredited programmes will award will award the National Diploma to candidates who successfully completed the programme after passing prescribed course-work examinations, diploma project and the supervised industrial work experience. Such candidates should have completed a minimum of between 72 and 80 semester credit units.

6.0 Guidance Note for Teachers Teaching the Programme:

6.1 The new curriculum is drawn in unit courses. This is in keeping with the provisions of the National Policy on Education which stress the need to introduce the semester credit units which will enable a student who so wish to transfer the units already completed in an institution of similar standard from which he is transferring.

6.2 In designing the units, the principle of the modular system by product has been adopted, thus making each of the professional modules, when completed provides the student with technician operative skills, which can be used for employment purposes.

6.3 As the success of the credit unit system depends on the articulation of programmes between the institution and industry, the curriculum content has been written in behavioural objectives, so that it is clear to all the expected performance of the student who successfully completed some of the courses or the diplomates of the programme. There is a slight departure in the presentation of the performance based curriculum which requires the conditions under which the performance are expected to be carried out and the criteria for the acceptable levels of performance. It is a deliberate attempt to further involve the staff of the department teaching the programme to write their own curriculum stating the conditions existing in their institution under which the performance can take place and to follow that with the criteria for determining an acceptable level of performance. Departmental submission on the final curriculum

may be vetted by the Academic Board of the institution. Our aim is to continue to see to it that a solid internal evaluation system exists in each institution for ensuring minimum standard and quality of education in the programmes offered throughout the polytechnic system.

6.4 The teaching of the theory and practical work should, as much as possible, be integrated. Practical exercises, especially those in professional courses and laboratory work should not be taught in isolation from the theory. For each course, there should be a balance of theory to practice in the ratio of 50:50 or 60:40 or the reverse.

7.0 GUIDELINES ON SIWES PROGRAMME.

7.1 For the smooth operation of the SIWES the following g guidelines shall apply:

Responsibility for placement of students

a) Institutions offering the ND programme shall arrange to place the students in industry. by April 30 of each year, six copies of the master list showing where each student has been placed shall be submitted to the Executive Secretary, NBTE which shall in turn, authenticate the list and forward it to the Industrial Training Fund, Jos.

b) The Placement Officer should discuss and agree with industry on the following:

i) a task inventory of what the students should be expected to experience during the period of attachment. It may be wise to adopt the one already approved for each field.

ii) the industry-based supervisor of the students during the period, likewise the institution based supervisor.

iii) the evaluation of the student during the period. It should be noted that the final grading of the student during the period of the attachment should be weighted more on the evaluation by his industry-based supervisor.

7.2 Evaluation of students during the SIWES

In the evaluation of the student, cognizance should be taken of the following items:

a) Punctuality
b) Attendance
c) General Attitude to Work
d) Respect for authority
e) Interest in the field/technical area
f) Technical competence as a potential technician in his field.

7.3 Grading of SIWES

to ensure uniformity of grading scales, the institution should ensure that the uniform grading of students' work which has been agreed to by all polytechnics is adopted.

7.4 The Institution Based supervisor

The institution-based supervisor should initial the log book during each visit. This will enable him to check and determine to what extent the objective of the scheme are being met and to assist students having any problems regarding the specific assignments given to them by their industry-based supervisor.

7.5 Frequency of visit

Institution should ensure that students placed on attachment are visited within one month of their placement. Other visits shall be arranged so that:

(1) there is another visit six weeks after the first visits; and

(2) a final visit in the last month of the attachment.

7.6 Stipends for Students in SIWES

The rate of stipend payable shall be determine from time to time by the Federal Government after due consultation with the Federal Ministry of Education, the Industrial Training Fund and the NBTE.

.*7.7 SIWES as a Component of the Curriculum*

The completion of SIWES is important in the final determination of whether the student is successful in the programme or not. Failure in the SIWES is an indication that the student has not shown sufficient interest in the field or has no potential to become a skilled technician in his field. The SIWES should be graded on a fail or pass basis. Where a student has satisfied all other requirements but failed SIWES, he may only be allowed to repeat another four months SIWES at his own expense. *National Board for Technical Education Kaduna.*

1ST SEMESTER: ND I

Course Code	Course Title	L	T	P	CU	CH
GNS 101	Communication in English (Grammer)	2	-	-	2.0	2.0
GNS 111	Citizenship Education	2	-	-	2.0	2.0
MTH 112	Algebra & Elementary Trigonometry	2	1	-	3.0	3.0
MEC 103	Mechanical Engineering Science	2	-	3	5.0	5.0
MEC 112	Technical Drawing	1	-	3	4.0	4.0
WEC 110	Material Science I	2	-	1	3.0	3.0
WEC 111	Fabrication Technology	1	-	3	4.0	4.0
WEC 112	Welding Technology I	1	-	3	4.0	4.0
ICT 101	Introduction to Computing	-	-	3	3.0	3.0
WEC 113	Welding & Environmental Safety	2	-	-	2.0	2.0
	TOTAL	**15**	**1**	**16**	**32.0**	**32.0**

2ND SEMESTER: ND I

Course Code	Course Title	L	T	P	CU	CH
GNS 102	Communication in English (Essay & Compreh.)	2	-	-	2.0	2.0
SDV 201	Entrepreneurship Development I	2	-	-	2.0	2.0
MTH 211	Calculus	2	-	-	2.0	2.0
MEC 102	Engineering Graphics	1	-	4	5.0	5.0
WEC 120	Materials Science II	2	-	2	4.0	4.0
WEC 121	Welding Metallurgy I	2	-	3	5.0	5.0
WEC 122	Metallography	1	-	3	4.0	4.0
WEC 123	Fabrication Process	1	-	3	4.0	4.0
WEC 124	Welding Technology II	2	-	3	5.0	5.0
	TOTAL	**15**	**-**	**18**	**33.0**	**33.0**

3RD SEMESTER: ND II

Course Code	Course Title	L	T	P	CU	CH
MEC 217	Technical Report Writing	2	-	-	2.0	2.0
MTH 202	Logic and Linear Algebra	2	-	-	2.0	2.0
MEC 201	Engineering Drawing	1	-	4	5.0	5.0
MEC 212	Engineering Measurement	1	-	1	2.0	2.0
WEC 210	Welding Metallurgy II	2	-	-	2.0	2.0
WEC 211	Welding Technology III	2	-	3	5.0	5.0
MEC 214	Fluids Mechanics	2	-	2	4.0	4.0
WEC 212	Basic Thermodynamics	2	-	-	2.0	2.0
WEC 225	Project	-	-	3	3.0	3.0
		14	**-**	**13**	**27**	**27**

4TH SEMESTER: ND II

Course Code	Course Title	L	T	P	CU	CH
MTH 122	Trigonometry and Analytical Geometry	2	1	-	3.0	3.0
ICT 102	Introduction to Computer Programming	1	-	3	4.0	4.0
WEC 220	Welding Technology IV	2	-	3	5.0	5.0
WEC 222	Basic Elements of Welding & Fabrication Design	1	-	3	4.0	4.0
WEC 223	Testing and Evaluation of Welds	2	-	3	5.0	5.0
WEC 224	Introduction to Plastic Welding	1	-	3	4.0	4.0
MEC 222	Strength of Materials	2	-	3	5.0	5.0
WEC 225	Project	-	-	3	3.0	3.0
		11	**1**	**21**	**33**	**33**

PROGRAMME: NATIONAL DIPLOMA IN WELDING AND FABRICATION TECHNOLOGY			
COURSE: Material Science I		**Course Code: WEC 110**	**Contact Hours:** 2-0-0
Course Specification: Theoretical			
WEEK	**General Objectives1.0: Understand materials and their properties.**		
	Specific Learning Outcomes	**Teachers Activities**	**Resources**
0-1	1.1 State types of engineering materials 1.2 Define principal mechanical properties: stress, strain, elastic modulus, yield strength, ductility, elongation, reduction of area, hardness and toughness. 1.3 State the role of each property in 1.2 above in engineering application of materials. 1.4 Define thermal expansion, heat capacity and thermal conductivity of material. 1.5 State the relevance of 1.4 above in engineering applications. 1.6 Describe the determination of variables in 1.2 and 1.4 above. 1.7 Define electrical conductivity, resistivity and polarisation of engineering materials. 1.8 State the relationship between electrical conductivity and temperature, strain, composition and thermal conductivity. 1.9 Describe the determination of electrical conductivity and resistivity for engineering materials. 1.10 Solve mathematical problems associated with properties in 1.2, 1.4 and 1.7.	Explain engineering materials and their properties. Explain the determination of properties. State the mathematical expressions, relating the properties to determinable quantities. State problems associated with the properties above. Give exercises.	Sample of Engineering Materials (Plastics, Wood, Metal, Concrete, etc.).
	General Objectives2.0: Know the structure and energy of atoms.		
2-3	2.1 Describe electronic structure of atoms.	Illustrate the electronic configuration of atoms	Structural Model of

	2.2 Give an expression of the relationship between energy possessed by a photon and its wavelength. 2.3 Explain electron notation using S,P,D sub-shell of K,L,M,N,O shells of an atom. 2.4 Explain energy distributions and electron excitations in atoms. 2.5 Solve mathematical problems associated with 2.2 and 2.4 above.	and rotation of sub-shells in K,L,M,N,and O shells. Use the related law to explain energy distribution and electron excitation in atoms. Solve mathematical problems based on energy expressions. Give exercises.	Atoms.
	General Objectives3.0: Understand atomic bonding and coordination.		
4-5	3.1 State the four general types of inter-atomic bonds in materials. 3.2 Explain the occurrence of inter-atomic bonds in materials. 3.3 Explain the expression showing the relationship between energy change of two approaching ions and their inter-ionic distance and electronic charges. 3.4 Define coordination number and ionic radius. 3.5 Relate coordination number with radii ratios. 3.6 State how 3.5 affect ionic and/or covalent bonding. 3.7 Explain the terms: poly-atomic ions and free-radicals. 3.8 State the effect of 3.7 in engineering materials properties.	Explain the different types of bonds and how they result. Give expressions indicating relationship between ions, distance and electronic charges. Relate coordination number to radii ratios and their effect on bonding.	
	General Objectives 4.0: Understand crystalline geometry.		
6-8	4.1 Define a phase, crystalline solids, short and long range orders. 4.2 Give examples of each 4.1 above. 4.3 Describe the close-packed crystals (hcp, fcc) and	Explain crystalline structures in solids. Mention phase, short and long range orders. Explain ionic and molecular structures and polymorphism.	

	body centred cubic (bcc) crystals with examples. 4.4 Describe the structure of ionic and molecular crystals. 4.5 Give examples of 4.4 above.	Give examples of metals with those structures i.e.: b.c.c., f.c.c. & h.c.p.	
	General Objectives 5.0: Understand crystalline phases.		
9-10	5.1 Explain the Bravais lattices. 5.2 Give example of crystal structures belonging to a given Bravais lattice. 5.3 Describe types of symmetry possible within a lattice. 5.4 Determine the Bravais lattice of Nall, CsC. 5.5 Explain the lattice directions with reference to: i vector relationship, ii lattice vectors, iii angles between directions (cubic crystals), iv family of directions, 5.6 Explain lattice planes with reference to Miller indices. 5.7 Describe Miller – Bravais indices (hexagonal crystals) with reference to: i. intersection of planes, ii. direction within a plane. 5.8 Define diffraction in crystals. 5.9 State the Bragg's law. 5.10 Describe diffraction patterns, diffraction lines and second – order diffraction in crystals. 5.11 Perform calculations based on 5.9 above.	Discuss Bravais lattices. Give examples of crystallographic structures for particular lattices. State types of symmetry, lattice direction noting vector relationship, vectors, angles between directions and family of directions. Explain Muller indices with emphasis on directions and plane of intercessions. Explain diffraction. State Bragg's law and diffraction pattern and orders. State mathematical relationship. Solve calculations.	Models of B.C.C., F.C.C. & H.C.P. Structures
	General Objectives 6.0: Know structural disorders in materials.		
11-12	6.1 Explain imperfections in crystals. 6.2 State the relevance of 6.1 in the properties of	Illustrate crystalline imperfections i.e. point defects, dislocation and grain boundaries.	Model of Crystalline Arrangement with

	engineering materials. 6.3 Categorise imperfections into point defects, dislocation (linear defects) and boundaries (two-dimensional discontinuities). 6.4 Explain each of the imperfections in 6.3 above and their micro-structural consequences. 6.5 Perform calculations based on 6.3 above; e.g. energy of dislocations, grain boundary area & energies, and grain size. 6.6 Describe the three-dimensional defects in amorphous or non-crystalline solids and their effects.	Explain their micro structural consequences. Derive expressions for dislocation and grain boundary energy and size. Explain defects in non-crystalline solids. Solve problems.	Defects.
	General Objectives 7.0: Understand molecular phases.		
13-15	7.1 Define micro and macro-molecules. 7.2 Give examples of each in 7.1 above. 7.3 Determine by calculations molecular weights and length of polymer molecules. 7.4 Explain the terms “micelles” and “folded chains ” in polymer crystallisations. 7.5 Describe molecular variations with reference to side radicals, steric inderance, stereo isomers and branching. 7.6 Define unsaturated polymers, cis and trans-isomers and cross-linking. 7.7 Give examples of the terms in 7.6 above. 7.8 State the effects of 7.6 on the physical property of polymer materials.	Illustrate micro and macro molecular phenomenon i.e. weight and length of polymer molecules, folded chains and crystallisation. Explain molecular variation with examples of side radicals, stoic hindrance, stereo-isomers and branching. Give examples of unsaturated polymers, as- and trans-isomers and cross linking.	

PROGRAMME: NATIONAL DIPLOMA IN WELDING AND FABRICATION TECHNOLOGY			
COURSE: Fabrication Technology I		**Course Code: WEC 111**	**Contact Hours:** 1-**0-3**
Course Specification: Theoretical & Practical Content			
WEEK	**General Objectives1.0: Understand the meaning of fabrication engineering.**		
	Specific Learning Outcomes	**Teachers Activities**	**Resources**
1-3	1.1 Explain Fabrication Engineering as a Practice. 1.2 Explain metal fabrication as applied to welding. 1.3 Explain the term pattern development.	Explain the general application of fabrication in engineering. Identify the relationship of metal fabrication to that of welding. Introduce the preliminary stage of pattern making as an object of fabrication. **<u>Practical</u>** **Development of pattern as a template for fabrication.**	Chalk/blackboard Pencil, drawing sheet, drawing board, ruler, tri square etc.
	General Objectives2.0: Know all the marking out tools		
4-7	2.1 Identify the following tools: Carpenter's Saws, Planes, Hand Brace, Buts and Joiner's Marking Gauge, steel tape, various size compasses and dividers, pair of terminal; heads, protractors, back gauges, Engineer's squares, flat squares, hammers, centre and nipple punches, pliers, axe saw frames, sleeves, soft and French chalk, coloured and indelible pencils, crayons.	Explain with the aid of sketches various marking out tools as listed. Explain method of usage of the various tools. Practical Identify various marking out tools and the techniques for handling.	Various tools as listed.
	General Objectives3.0: Know machines used for fabrication		
8-12	3.1 Identify the machines use for fabrication processes; - Shearing, guillotine, sawing, drilling, folding, rolling and grinding.	Explain the basic principle of sharing and guillotine machines. Draw with neat sketch soaring and drilling machine. Explain the technique of selecting correct	Various machines as listed. Reference Books 1. Fabrication and welding

	3.2 State the limitations of the above machine in 3.1 3.3 Selection of appropriate machines for given jobs e.g. folding, and benching action 3.4 Describe special features of the following machines; fly press, hydraulic press, press break, folding, rolling, and bending machines 3.5 Describe operating principles of the following; edge curring, bending, straightening, bottoming, folding/rolling.	machine for a new job. Explain w9ith the aid of sketches rolling and bending machines. Practical Mark out 200mm X 500mm X 1.5mm mild steel plate and use it to produce car exhaust.	engineering by F.J.M Smith. 2. Machine shop I by Champman.
	General Objectives4.0: Know the material suitable for fabrication		
13-15	4.1 Describe materials and their suitability for fabrication; mild steel, stainless steel, aluminium, copper, zinc etc. 4.2 Explain how to identify various metals by colours or testing 4.3 Explain the forces that may act on fabricated objects and how to reduce their effects	Give explanatory notes on properties of ferrous and non-ferrous metals used in fabrication Explain shearing, compressive, tensile forces experienced in fabrication and suggests methods of measuring and reducing them.	Various metal types

PROGRAMME: NATIONAL DIPLOMA IN WELDING AND FABRICATION TECHNOLOGY			
COURSE: Welding Technology I		**Course Code: WEC 112**	**Contact Hours:** 1-**0-3**
Course Specification: Theoretical & Practical Content			
WEEK	**General Objectives1.0: Understand equipment and accessories for welding.**		
	Specific Learning Outcomes	**Teachers Activities**	**Resources**
1-3	1.4 Describe the characteristics of AC Welding Transformer, Rectifiers and the DC Welding Generator. 1.5 Explain the function of Rectifiers (Straight and Reverse Polarity). 1.6 Differentiate between AC and DC Welding Machines. 1.7 Compare the advantages and disadvantages of 1.3 above. 1.8 Identify the equipments in 1.1 above in the workshop. 1.9 State the materials used for electrode coating and their functions. 1.10 Describe Gas Welding/Cutting equipment and their operation. 1.11 Describe the procedure for lighting welding torch, closing down and safety precautions. 1.12 List hand tools that\are used in welding operations.	Explain the characteristics of AC/DC generators. Describe the functions of a DC generator. State the advantages/disadvantages in applications of DC over AC generator and visa vise.	Chalk/blackboard Pencil, drawing sheet, drawing board, ruler, tri square etc.
	General Objectives2.0: Understand different types of metal joining processes and their applications.		
4-7	2.2 State methods available for joining metals (e.g. Mechanical, Soldering, Brazing and Welding). 2.3 Identify joints made from the methods in 2.1 above.	Introduce the students to the various joining processes. Describe the different joints e.g. tap and T-joints. Explain the applications and differences of	Various tools as listed.

	2.4 Define each of the methods in 2.1 above. 2.5 State the applications and differences of the methods in 2.1 above. 2.6 Carry out simple Mechanical Joining. 2.7 Classify welding processes into Fusion and Pressure types. 2.8 Describe the following Fusion Welding Processes: - Gas Method; - Electric Method; - Electron Beam Method; - Thermit Method. 2.9 Carry out simple Fusion Welding using any of the methods in 2.7 above. 2.10 Describe the following Pressure Welding Processes: - Spot Welding; - Seam Welding; - Butt Welding; - Flash Welding; - Cold Welding. 2.11 List the limitations in the items listed in 2.9 above. 2.12 Carry out simple pressure welding using any of the methods in 2.9 above. 2.13 Describe soldering and brazing operations including types of fluxes used. 2.14 List types of tin-lead based solders, their compositions and solidification ranges. 2.15 List types of brazing solders and silver solders,	each method in 2.1. Explain the application of gas pressure welding processes. Distinguish between soldering and brazing. Identify the various types of solder. Draw Lead-Tin alloy equilibrium system. Describe the behaviour and application of solder. State the alloy composition.	

	their compositions and freezing ranges. 2.16 Carry out simple soldering and brazing operations. 2.17 State the factors that affect the strengths of joints produced by the processes in 2.7, 2.9 and 2.12 above.		
	General Objectives3.0: Understand weld joints symbols and specifications.		
8-10	3.1 Identify various welds symbols. 3.2 Interpret the symbols stated above using simple sketches as applicable to engineering drawings. 3.3 Describe different weld joints.	Using sketches where necessary explain 3.1-3.3.	Various machines as listed. Reference Books: Fabrication and welding engineering by F.J.M Smith. Machine shop I by Champman.
	General Objectives 4.0: Understand various types of hand tools and machines used in fabrication engineering.		
11-15	4.1 State fabrication processes, equipment and necessary hand tools. 4.2 Explain shearing. 4.3 Explain working principles and uses of the following cutting machines: - Guillotine; - Nibbling Machine; - Cropping Machine; - Shearing Machine; - Sawing Machine etc. 4.4 Identify the machines listed in 4.3 above. 4.5 State advantages and limitations of the machines in 4.3 above. 4.6 Select the correct machine to use for a given		

	application. 4.7 Cut plate and sheet metal. 4.8 Explain bending action. 4.9 Explain the working principles of the sheet metal forming machines: - Fly-Press; - Hydraulic Press; - Press Brake; - Folding Machine; - Rolling Machine or Bending Rolls, etc. 4.10 Describe the various operations carried out on the above machines: a. Bending; b. Edge Currying; c. Straightening; d. Bottoming; e. Folding; f. Rolling of sheet and plat material. 4.11 State the advantages and limitations of the machines listed in 4.9 above. 4.12 Select the current machine to use for a specific application.		

PROGRAMME: NATIONAL DIPLOMA IN WELDING AND FABRICATION TECHNOLOGY			
COURSE: Welding & Environmental Safety		**Course Code: WEC 113**	**Contact Hours:** 30
Course Specification: Theoretical & Practical Content			
WEEK	**General Objectives1.0: Understand the general principles of safety & environment protection in the welding & fabrication industry.**		
	Specific Learning Outcomes	**Teachers Activities**	**Resources**
1	1.1 Explain the concept of safety. 1.2 State the positive characteristics of safety. 1.3 Enumerate the importance of safety.	Illustrate the implications of unsafe acts using the home & the workshops.	Visits to Workshops & Industries.
	General Objectives2.0: Understand that accidents are caused and that they are serious societal problems.		
	2.1 Define accidents. 2.2 Examine types of accidents in welding & fabrication industry. 2.3 Explain the health, economic and societal effects of accidents.	Explain accidents. Enumerate types of accidents on the worker, his family, the organization etc..	Video Films.
	General Objectives3.0: Understand causes of accidents.		
	3.1 Define the term horse play. 3.2 Explain how 3.1 above cause accidents. 3.3 Explain the effect of skill acquisition on accidents. 3.4 Define fire. 3.5 State the various classes of fire and their extinguishers. 3.6 Define back-fire and flash back as obtained in oxy-acetylene welding process. 3.7 State causes and prevention of back-fire and flash back. 3.8 Explain the following preventable workshops accidents: electric shock, explosions and burns. 3.9 Explain the use of correct tools in accident prevention.	Explain what constitute horse play and its consequences. State the role of skill in performance and how lack of it effects us. Explain fire, its types, causes, prevention and extinguishing. Demonstrate back-fire in the workshop. Explain how flash back arrestor could be installed and its uses. Emphasise proper handling of electrical appliances and machines as well as proper handling and storage of highly inflammable and explosive materials.	Video Films. Extinguishers Fuels Heat Sources

	General Objectives 4.0: Understand the principles and techniques of accidents prevention and control.		
	4.1 Explain the importance of accurate accident reporting and recording. 4.2 Explain the importance of charts, cartoons and signs as means of accidents prevention.	Enumerate the need for accident reports and record in organizations. Use charts cartoons and signs to build up safety consciousness.	Charts Cartoons Signs
	General Objectives 5.0: Understand environmental pollution, causes, prevention and or control.		
	5.1 Define environmental pollution. 5.2 State types and sources of pollution and their control. 5.3 Explain the effects of pollution on the environment. 5.4 Explain the contribution of welding and metal fabrication to the pollution of the environment.	Explain the environment and what it takes to pollute it. Give types and sources of pollution. Enumerate various welding and ancillary activities and how their discharge fail or pollute the system.	Video Clips Reference Textbooks
	General Objectives 6.0: Know safety Acts and Regulations.		
	6.1 Explain the role of government in environment protection and control. 6.2 Explain factory safety acts and regulations. 6.3 Make use of references to the appropriate Nigerian, British and American Safety Standards and Regulations.	Discuss the government agents saddled with environmental protection. Survey Factory Ordinances and Safety Regulations. Examine the role of the Department of Petroleum Resources in checking environmental pollution.	

PROGRAMME: NATIONAL DIPLOMA IN WELDING AND FABRICATION TECHNOLOGY			
COURSE: Material Science II		**Course Code: WEC 120**	**Contact Hours: 2-0-2**
Course Specification: Theoretical & Practical Content			
WEEK	**General Objectives1.0: Understand atom movements.**		
	Specific Learning Outcomes	**Teachers Activities**	**Resources**
1	1.1 Define diffusion as a combination of energetic, dynamic atomic movement. 1.2 Explain the role of vacancies and materials in atomic diffusion. 1.3 Describe the term: diffusion coefficient, activation energy for diffusion. 1.4 State factors affecting diffusion coefficient. 1.5 State Fick's second law. 1.6 Perform calculation based on 1.3 and 1.5 above. 1.7 Explain the term: thermal diffusitivy and inter-diffusion.	Explain diffusion and the contribution of vacancies interstitials spaces. Give a physical description of diffusion Fick's first law and Fick's second law. Explain diffusion coefficients, activation energy. Explain thermal diffusivity and interdiffusion. Explain the factor affecting diffusion coefficients. Carryout calculations based on the 1^{st} and 2^{nd} laws of Fick. Give exercises. Use result of a carburetion exercise to determine case depth (Harden-ability). Based on Fick's law perform hardness test and metallography.	Furnace. Mild Steel rods. Carburising Consumables i.e. BaO_2 Coal etc.
	General Objectives2.0: Understand elastic deformation of solids.		
	2.1 Define elastic deformation. 2.2 Demonstrate elastic deformation using suitable materials e.g. an elastomer. 2.3 Define the terms: Young's modulus, Poison's ratio, bulk modulus and shear modulus. 2.4 Derive expressions for 2.3 above. 2.5 State the the relevance of each term in 2.3 in engineering application of materials.	Illustrate elastic deformation of materials. Derive Young's modulus, Poisson's Ratio, Bulk Modulus and Shear Modulus. Explain the above derivations. Explain the engineering application of these constants. Perform calculations based on above. Explain the effect of lattice constants and	Tensiometer with accessories for generating stress – strain curves. Elastic materials. Plastic materials.

	2.6 Perform calculations on the expressions in 2.4 above. 2.7 Describe the variations in elastic moduli in terms of lattice constraints, anisotropy, solid solutions and temperature. 2.8 Describe the occurrence of An-elasticity and thermo-elasticity in materials. 2.9 Determine the elstic moduli of a metal and an elastomer in the laboratory. 2.10 Draw a stress strain curve for a material with elastic behaviour. 2.11 Explain 2.10 above. 2.12 Describe a procedure for carrying out tensile testing of materials. 2.13 Carry out tensile testing using any metal and plastic. 2.14 Determine from 2.13 above the yield strength, tensile strength, % elongation and % reduction in area. 2.15 Explain the characteristic features on a load extension curve for metals having: a. distinct yield point; b. indistinct yield point.	anisotropy, composition and temperature on elastic moduli. Explain the occurrence of an-elasticity and thermo elasticity in materials. Conduct test experiment to obtain stress strain curves for a material with elastic behaviour. Determine the following from the experiment yield strength, tensile strength, % elongation and % reduction in area. Perform calculation to determine these parameters. Explain features and yield extension curves having distinct and indistinct yield points. Conduct tensile test for an elastic and plastic material.	
	General Objectives3.0: Understand plastic deformation.		
	3.1 Define plastic deformation in crystals. 3.2 Describe plastic deformation by slip. 3.3 Explain plastic slips in compounds as consequence of ductility and brittleness in metals and ceramics respectively. 3.4 Describe deformation by twinning.	Explain plastic deformation. Describe the mechanisms slip and twinning. Discuss plastic slip. Explain how slip results in ductility and brittleness in metals and ceramics. State Schmidt's law.	Brinell or Rockwell testing machines. Tensiometer.

	3.5 State twinning system in metals. 3.6 Distinguish between deformation by slip and twinning. 3.7 Define critical shear stress. 3.8 Derive 3.7 using Schmid's law. 3.9 Define strain hardening. 3.10 State the relevance of 3.9 in engineering practice. 3.11 Give an empirical relationship of strain hardening for a material subjects to plastic deformation. 3.12 Describe the mechanism of strain hardening. 3.13 Distinguish between hot and cold working. 3.14 Perform cold working operation on a metallic material and verify the effect on mechanical properties (hardness, tensile strength, elongation) in the laboratory.	Explain shear stress. Explain strain hardening and its importance. Describe the mechanism strain hardening. State empirical relationship of strain hardening of materials subjected to plastic deformation. Perform some calculation based on relationships. Explain cold and hot working of metal and their effort on material properties. Perform cold operation on materials (metallic). Conduct mechanical testing hardness and elongation on the above materials..	
	General Objectives4.0: Understand visco-elastic deformation.		
	4.1 Describe viscous flow. 4.2 Relate viscosity with fluidity. 4.3 Give expression of viscosity in terms of shear stress and velocity gradient of flow encountered in fluid flow. 4.4 Give expression relating viscosity with temperature. 4.5 Describe the fluidity versus temperature diagram for emorphous engineering solids. 4.6 Explain structural effect on viscosity of amorphous materials using fused silica glass and soda-glass as example. 4.7 Define visco-elasticity. 4.8 Give an expression for the time-strain	Explain viscosity. Relate viscosity to fluidity. State expression relating viscosity to shear stress and velocity gradient. Explain the effect of temperature on viscosity. Explain the structural effect of viscosity on amorphous materials i.e. glass. Discuss visco-elasticity, visco-elastic behaviour of materials and the concept of relaxation time. Perform mathematical calculations. Relate visco-elasticity to creep failures. Conduct experiment to determine relaxation modus.	Stress relaxation equipment.

	relationship of a visco-elastic displacement. 4.9 Describe the visco-elastic behaviour of polymers. 4.10 Define visco-elastic modulus. 4.11 Explain the visco-elastic modulus versus structure diagram of amorphous linear polymer, crystalline polymer, cross-linked polymer and elastomer. 4.12 Explain stress-relaxation under constant strain in visco-elastic flow. 4.13 Derive expression for relaxation time of visco-elastic flow. 4.14 Perform calculations based on the expressions in 4.8 and 4.13 above. 4.15 Explain how glass processing steps are adopted to the viscocity values, using viscocity versus temperature graph.		

PROGRAMME: NATIONAL DIPLOMA IN WELDING AND FABRICATION TECHNOLOGY			
COURSE: Welding Metallurgy I		**Course Code: WEC 121**	**Contact Hours: 2-0-3**
Course Specification: Theoretical & Practical Content			
WEEK	**General Objectives1.0: Understand phase equilibrium in material system.**		
	Specific Learning Outcomes	**Teachers Activities**	**Resources**
1	1.1 Define binary system. 1.2 Give examples of 1.1 (Cu-Zn; Steel Fe-C, etc.). 1.3 Explain material balance and the lever rule. 1.4 Illustrate 1.3 with Cu alloy system. 1.5 Derive the general term (level rule equation) for the weight ratios of any two phase x and y within a material of composition Co in which the phase composition are C_x and C_y; i.e. Co (X + Y) = C_xX + C_yY. 1.6 Calculate weight fraction of a given binary system using 1.5 above. 1.7 Define eutectic liquid, eutectic temperature and eutectic composition of a binary system. 1.8 Draw Fe – C phase diagram. 1.9 Use 1.8 to explain the following reactions: i. peritectic reaction; ii. eutectoid reaction; iii. peritectoid reaction.	Explain binary system. Explain material balance and Lever rule. Solve calculations problem. Draw Fe-C diagram. Explain the diagram above.	Reference Textbooks. Charts.
	General Objectives 2.0: Understand phase changes in metals.		
	2.1 Define phase change. 2.2 State three types of phase change involving no compositional change (e.g. congruent transformation, ordering and martens tic reaction). 2.3 Describe the following congruent	Define phase changes. Describe congruent transformation. Explain TTT curve. Draw thermal equilibrium diagrams Pb-Sn. Explain the diagram above. Explain nucleation.	Reference Textbooks. Charts.

	transformations: i. reconstructive transformation; ii. displacive transformation. 2.4 Give examples of materials undergoing transformations in 2.3 above. 2.5 Describe orderate transformation. 2.6 Give example of 2.5 above. 2.7 Describe shear (martens tic transformations with examples). 2.8 Verify the effect of 2.7 on hardness of steel samples with different carbon content. 2.9 Explain isothermal transformation of austenite. 2.10 Draw transformation curves for: i. transformation of austenite to pearlite (eutectoid steel). ii. transformation of austenite to ferrite plus pearlite. 2.11 Explain the curves in 2.10 above. 2.12 Illustrate with diagrams the effect of alloy elements on the curves 2.10 above. 2.13 Draw thermal equilibrium diagrams for Lead – Tin and Copper – Zinc alloy system. 2.14 Explain 2.13 above. 2.15 Define nucleation of phase change. 2.16 State conditions for nucleation to occur. 2.17 Derive expression for total free-energy required for a phase change. 2.18 Draw diagram showing variation of nucleation free-energy with grain radius under: ii. homogeneous nucleation;		

	iii. super cooling. 2.19 Explain 2.18 above. 2.20 Solve mathematical problems from 2.17. 2.21 Define heterogeneous nucleation. 2.22 State conditions for 2.20. 2.23 Relate 2.10 and 2.13 to welding situation.		
	General Objectives 3.0: Know solid solution.		
	3.1 Define solid solution. 3.2 Classify solid solution. 3.3 Describe each type of solid solution in 3.2 above. 3.4 State Hume-Rothery's theory on solid solution. 3.5 Explain interstitial solid solution and their to properties of steel. 3.6 Name intermediate phases. 3.7 Describe 3.6 above.	Define solid solutions. Explain solid solutions. classify solid solutions. State Hume Rothery theory on solid solutions.	Ditto.
	General Objectives 4.0: Know strengthening process in metals.		
	4.1 State the importance of strengthening processes in engineering. 4.2 Name strengthening processes (e.g. solution treatment, mechanical deformation processes, precipitation processes, solid-state transformation). 4.3 Explain the relationship of the processes in 4.2 with dislocation. 4.4 Describe solution treatments.	State the importance of strengthening process in engineering. Describe the strengthening processes. Describe the mechanical deformation processes. Describe natural and artificial ageing.	Asbestos Cloth. Screw Press. Anvil, Hammer Tensometer, etc. Reference Textbooks. Heating Furnace. Containers of Sand, Water & Oil.
	General Objectives 5.0: Know the effect of heat treatment on metals.		
	5.1 Define heat treatment. 5.2 State the effects of 5.1 above. 5.3 Describe heat treatment methods. 5.4 Explain the associated features of each operation	Define heat treatment. State types of heat treatment and their application. State the quenching media.	Heating Furnace. Containers of Sand, Water & Oil. Jet of Air.

	in 5.3. 5.5 Explain the application of heat treatment in welding practice. 5.6 Explain the defects caused by operations in 5.3. 5.7 State the remedies of 5.3 above.	Perform heat treatment exercises.	Hand Tools.
	PRACTICAL		
	1. Determine the melting points of various metals & alloys. 2. Distinguish between homogeneous and heterogeneous system. 3. Distinguish the solubility levels in a binary system. 4. Conduct test on strengthening process by mechanical and thermal applications. 5. Carry out various heat treatment processes.		

PROGRAMME: NATIONAL DIPLOMA IN WELDING AND FABRICATION TECHNOLOGY			
COURSE: Metallography		**Course Code: WEC 122**	**Contact Hours:**
Course Specification: Theoretical & Practical Content			
WEEK	**General Objectives1.0: Understand microscopic examination of materials.**		
	Specific Learning Outcomes	**Teachers Activities**	**Resources**
1-2	1.1 Explain microscopic examination.. 1.2 State the application of 1.1 above. 1.3 Explain sulphur printing, its application and limitation. 1.4 carryout sulphur printing on welded joints. 1.5 Describe the reagents used in micro-etching of various metals. 1.6 Perform microscopic examination o Heat – Affected Zone (H A Z) of various joints obtained from different joining processes.	Define microscopic examination. Mention the application of 1.1 above. Define sulphur printing on welded joint. Carryout microscopic examination in HAZ of various joints.	Magnifying Glasses. Enchants, beakers, measuring flasks etc..
	General Objectives2.0: Understand microscopic examination of metals.		
3-4	2.1 Explain microscopic examination of metals. 2.2 State the application of 2.1 above. 2.3 Describe the selection of specimens for microscopic examination. 2.4 Explain the following operations in microscopic examination: - specimen cutting - specimen mounting - grinding of specimen - polishing of specimen - etching. 2.5 State the etching reagents used in micro-examination. 2.6 Perform 2.4 and 2.5 above using cross-section of	Explain various operations such as cutting, mounting, grinding, polishing, and etching of specimens. Carry out practicals on the above. Examine via microscope.	Rotary Pre-grinders. Polishing Machine. Abrasive cut-off machine Etchants.

	welded, soldered and brazed joints.		
	General Objectives3.0: Understand the principle of optical (light) microscopy.		
5-6	3.1 Define light reflection, diffraction, interference and polarisation. 3.2 Explain the principle of reflection light microscopy (principle of contrast). 3.3 Explain the function of objective lens, eye piece lens, lighting and aperture. 3.4 Determine magnification of microscope (image), resolving power and limit of resolution. 3.5 Determine the effect of lens. 3.6 View metallic samples in 2.6 above in a bench metallurgical microscope and microscope with camera attachment.	Explain the properties of light reflection, diffraction, interference and polarisation. Illustrate with sketches the principle of contrast. Describe the principle of operation of microscope. Guide in the examination of samples of metals.	Magnifying glasses Hydraulic Mounting Press.
	General Objectives 4.0: Understand the principle of photomicrography.		
7-9	4.1 Define photomicrography. 4.2 State the operational steps in photomicrography. 4.3 Select films/plates for photomicrograph as: - ordinary grade sensitive to UV and blue. - orthochromatic grade sensitive to blue and blue. - panchromatic grade sensitive to the whole spectrum. 4.4 Explain why orthochromatic films/plates are used for photomicrography. 4.5 Explain types of camera that can be used in photomicrography: - ordinary camera with lens. - a film or plate holder camera. 4.6 Explain six processing steps in production of	Define photomicrograph. Describe the operational steps involve in photomicrography. Carry out practicals in the areas of exposure, development rinsing, fixing, washing and drying of negative and positive prints.	Olympus Inverter Microscopes fitted with Cameras and Computer monitors.

	negative: (exposure, development, rinsing, fixing, washing and drying). 4.7 Describe a typical developer solution. 4.8 Give the composition of a typical fixing solution. 4.9 Produce negative of photomicrograph.		
	General Objectives 5.0: Understand print production.		
9-10	5.1 Describe two ways a positive print may be made a negative: - contact printing using a frame. - projection printing using enlarger. 5.2 Describe printing papers in terms of grade, number and name. 5.3 State the relationship between the negative contrast and paper grade. 5.4 Produce prints of photomicrograph taken on welded structures.	Explain how negative and positive prints are made.	Grinding Papers. Polishing Clothes. Films/Plates Negative. Positive Print Papers.
	General Objectives 6.0: Understand the principle and applications other metallographic techniques.		
11-13	6.1 Describe scanning electron microscopy (SEM) with energy dispensing spectrometer. 6.2 Describe transmission electron microscopy (TEM) and electron microprobe analyser. 6.3 State the application of 6.2 above. 6.4 Describe an X-ray diffractometer for phase and texture analyses. 6.5 Explain the principle of interferometry.	Explain other techniques such as SEM, TEM, X-Ray diffractometer and interferometer.	
	General Objectives 7.0: Understand the use of metallography in phase diagrams.		
14-15	7.1 Explain the determination of phase proportion. 7.2 Explain the determination of grain size using ASTM comparative chart method and linear interpret method.	Describe the phase proportion in phase diagrams. Describe the various grain structures.	

	7.3 State possible experimental errors in 7.2 above. 7.4 Determine grain size by the method in 7.2 above.		

PROGRAMME: NATIONAL DIPLOMA IN WELDING AND FABRICATION TECHNOLOGY			
COURSE: Fabrication Process		**Course Code: WEC 123**	**Contact Hours:**
Course Specification: Theoretical & Practical Content			
WEEK	**General Objectives1.0:**		
	Specific Learning Outcomes	**Teachers Activities**	**Resources**
1-3	1.1 Explain fabrication technology. 1.2 Explain factors to be considered before selecting assembly methods. 1.3 Explain the principle of vice operation with reference to ➢ parallel vice; ➢ leg vice. 1.4 Demonstrate the use of the following files and filing. ➢ flat files; ➢ hand files; ➢ half round files; ➢ square files; ➢ round files; ➢ triangular or three-square files; ➢ warding files; ➢ needle files. 1.5 Demonstrate the use the following: ➢ chiselling; ➢ chopping out; ➢ shearing; ➢ chipping.	Explain fabrication technology. Practically demonstrate how to use various types of files in the workshop.	Sketches of Various Fabrication Equipment.
	General Objectives2.0:		
4-5	2.1 Describe with illustration, sheet metal work process	Explain with illustrations sheet metal work process.	Tin Metal Sheets

	2.2 Explain the use of the following sheet metal work tools: ➢ stakes ➢ half-moon stake ➢ hatchet stake ➢ creasing iron ➢ round bottom or canister stake ➢ Tinman's anvil ➢ funnel stake. 2.3 Explain safe edges. 2.4 Practically demonstrate how safe edges can be made.	Demonstrate in the workshop the use of sheet metal tools in 2.2. Demonstrate how safe edges are made.	
	General Objectives3.0:		
6-7	3.1 Perform the following using the centre lathe: - facing operation - cylindrical turning - step turning - taper turning - boring - parting - knurling - reaming. 3.2 Carry out thread cutting operation on the lathe. 3.3 Carry out exercises involving operations in 1.1 & 1.2.	Explain the application of the operations in 3.1. Demonstrate thread cutting operation in the workshop.	Lathe Machines.
	General Objectives4.0:		
8-9	4.1 Perform simple operations on shaping machine. 4.2 Cut key-way, slots, etc on shaping machine. 4.3 Select the correct work holding devices for different operations on the shaping machine.	Explain shaping machine. Demonstrate the operational principle of shaping machine in the workshop.	Shaping Machine.

	4.4 Select appropriate tools for different shaping operations.		
	General Objectives5.0:		
10-11	5.1 Explain foundry technology. 5.2 Discuss the history of growth of foundry industry in some countries e.g. Britain, Germany, Russia, India & China etc.. 5.3 Discuss the role of foundry in technology development. 5.4 Classify foundries based on type of production e.g.: - cast iron industry - malleable iron foundries - non-ferrous foundries - jobbing foundries - captive foundries.	Explain the term foundry technology. Explain the history of foundry industries in Nigeria. Discuss materials in 5.4.	Samples of Cast Iron, Non-Ferrous Metals etc.
	General Objectives 6.0:		
12-13	6.1 Carry out exercises involving the following: a. hardening b. annealing c. tempering d. normalising e. case-hardening. 6.2 Select various hand forging tools & equipments for forge work. 6.3 Perform forging operation involving cogging, bending, up-setting, twisting and punching. 6.4 Carry out test on heat treated metals.	Demonstrate how to carry out stages in 6.1. Explain hand forging tools. Perform simple operations involving cogging, bending etc.	Forging Tools.
	General Objectives 7.0:		
14-15	7.1 Explain the following:	Explain the uses of items in 7.1.	

	a. Screw thread b. B.A threads (British Association) c. Square threads d. Acme threads e. Buttress threads f. Crest g. Root of a thread.		

PROGRAMME: NATIONAL DIPLOMA IN WELDING AND FABRICATION TECHNOLOGY			
COURSE: Welding Technology II		**Course Code: WEC 124**	**Contact Hours:**
Course Specification: Theoretical & Practical Content			
WEEK	**General Objectives1.0: understand the knowledge of arc welding, electrode classification, welding processes & limitation**		
	Specific Learning Outcomes	**Teachers Activities**	**Resources**
1	1.1 Define manual arc welding. 1.2 Explain a typical workshop layout for manual arc welding. 1.3 Explain the functions of various part of a welding equipment. 1.4 Use a simple sketch to explain manual arc welding circuit. 1.5 Define jigs, fixture/manipulators and their uses. 1.6 Explain the various methods in measuring temperature.	Explain manual arc welding. Demonstrate the use of the various welding equipments. Explain welding circuit, measuring temperature, instruments, jigs & fixtures.	Drawing , charts and welding equipments.
	General Objectives2.0:		
	2.1 Define earthing and its importance. 2.2 Explain voltage drops across the arc and transference of metal across the arc gap. 2.3 Define the arc length. 2.4 Explain the effect of arc length on welding voltage. 2.5 Explain how to calculate welding voltage, current & resistance. 2.6 Explain magnetic effects produced by current flow such as arc blow. 2.7 Define transformer. 2.8 Explain the function of transformer in welding.	Explain earthing and its importance. Solve problems on welding voltage and resistance. Explain magnetic. Explain magnetic effects produced by current and arc blow.	Drawing , charts and welding transformer.
	General Objectives3.0:		
	3.1 Explain electrode classification according to	Emphasizes on electrode classification with	Text books, lecture notes

	(a)British Standard; (b) American Standard. 3.2 Explain the importance of using welding electrode in its proper classified condition. 3.3 Explain the function of electrode coatings.	reference to British & American standard. Explain and illustrate the problems encountered when damped electrodes are used. Explain the function of electrode coating.	and electrode pieces.
	General Objectives 4.0:		
	4.1 Explain how to strike and maintain the arc. 4.2 Demonstrate practically in the workshop how to strike and maintain the arc. 4.3 Explain and practically demonstrate in the workshop the correct angle of electrode to the job. 4.4 Define hard surfacing. 4.5 Explain the reason for 4.4 above. 4.6 Explain the effect of weather conditions on welding. 4.7 Explain how to control residual stresses and method of stress relieving.. 4.8 Explain various methods of pipe welding. 4.9 Explain the various welding positions and practically demonstrate the position in the workshop. 4.10 Define preheating and post-heating and their importance. 4.11 Explain how to calculate the recovery rate of electrode.	Describe the process of striking and maintaining of arc. Explain hard surfacing and reasons for it. Solve problems on recovery rate of electrode.	Reference Textbooks.
	General Objectives 5.0:		
	5.1 Define what is a sound weld. 5.2 Produced practically in the workshop a sound	Emphasize the importance of a sound weld. Explain how a sound weld is produced.	Reference Textbooks.

	weld. 5.3 Explain the role the following play to produce a sound weld: - metal edge preparation - selection of correct electrode - correct welding voltage and correct - correct welding speed - pre-heating - correct welding techniques - welding jigs, fixture and manipulators - proper cleaning of a weld before depositing another weld bead.	Explain the role of various parameters in the production of a sound weld.	
	General Objectives 6.0:		
	6.1 State the causes and effects of the various hazards in manual arc welding such as: ❖ eye – damaging radiation ❖ burns ❖ noxious fumes ❖ electric shock ❖ suffocation ❖ explosions/fire.	Explain the effect of various hazard in the cause of welding.	

PROGRAMME: NATIONAL DIPLOMA IN WELDING AND FABRICATION TECHNOLOGY			
COURSE: Welding Metallurgy II		**Course Code: WEC 210**	**Contact Hours: 2-0-0**
Course Specification: Theoretical & Practical Content			
WEEK	**General Objectives1.0: Know the developmental perspective of metallurgical industries in Nigeria.**		
	Specific Learning Outcomes	**Teachers Activities**	**Resources**
1	1.1 Explain policy guidelines of the Federal Government in relation to metal production. 1.2 Identify the stages, problems and progress made on the establishment of the major metallurgical plants in Nigeria. 1.3 Describe the development of exploration and mining of metal ores in Nigeria.	Explain FG policy on metal production. Explain stages in the establishment of major metallurgical plants in Nigeria. Describe exploration and mining of metal ores in Nigeria.	Journals/Conference Papers. Flow Charts. Reference Textbooks. Field Trips.
	General Objectives2.0: Understand the production of iron and steel.		
	2.1 Describe the blast furnace manufacture of pig iron - the charge materials - the structure of the blast furnace - blast furnace operation - products of the blast furnace. - economy of the blast furnace. 2.2 Describe the direct-reduction iron making method. 2.3 Describe the steel - making processes, stating the following: - making steel in converters. - the electric furnace steel making. - structure of a steel ingot. 2.4 State classification of steels based on composition: carbon and other alloying elements. 2.5 State the application of steel.	Explain the production processes of iron and steel making.	Sample of Ores. Sample of Steel Products.

	General Objectives 3.0: Understand the production of nonferrous metals (Aluminium).		
	3.1 Describe extraction of aluminium stating: - Ores - Extraction and electrolysis of pure alumina. 3.2 State the properties and uses of aluminium and its alloys.	Describe aluminium extraction. Show aluminium Bauxite. State properties	Reference Textbooks. Field Trips. Reuse Side.
	General Objectives 4.0: Understand the production of nonferrous metals (copper).		
	4.1 Describe the extraction of copper stating: - Ores - Concentration of the ores - Production of blister copper - Copper refining methods. 4.2 State the properties and uses of copper and its alloys.	State properties of copper. Describe commercial grades of copper.	Charts Drawing of Layout. Field Trip Sample of copper alloys Reference Textbooks.
	General Objectives 5.0: Understand the structure, property and application of ferrous metals and alloys.		
	5.1 Explain the various allotropic nature of Iron. 5.2 Draw Fe-C phase diagram. 5.3 Explain the curve in 5.2 above. 5.4 Define steel. 5.5 Classify plain carbon steels. 5.6 Describe the mechanical properties as function of composition and structure. 5.7 State the uses and limitations of plain carbon steel in engineering practice. 5.8 State typical alloying elements and their effect on the structure and property of steel. 5.9 Classify alloying elements based on the ability to: a. stabilise carbide b. graphitise austenite c. stabilise austenite	Explain graph of polymorphism. Explain the Fe – C phase diagram. Explain the effect of alloying elements. State application of steels. Describe the various types of cast iron.	Charts. Sample of Alloying Elements. Reference Textbooks.

	d. stabilise ferrite. 5.10 Use TTT curve to illustrate the effects in 5.9 above. 5.11 State engineering applications of the following alloy steel: i. low alloy steel. ii. high alloy steel (stainless, maraging, heat resisting, tool and die steel. 5.12 Define cast Iron. 5.13 Draw Iron graphite equilibrium diagram. 5.14 Explain the two forms of carbon in cast iron. 5.15 State factors affecting their states. 5.16 Describe the following cast iron varieties: i. malleable cast iron ii. spheroidal graphite cast iron iii. flake graphite cast iron. 5.17 State the uses of 5.16 above.		
	General Objectives 6.0: Understand weld-ability of metals and alloys.		
	6.1 Define weld-ability. 6.2 State factors that affect weld-ability and solution to weld-ability problems. 6.3 Explain the methods of welding dissimilar metals. 6.4 State the advantages and disadvantages of 6.3 above.	Define weld-ability. Explain the factors affecting the weld-ability of metals. Explain solution to weld-ability problems. Define dissimilar metal welding. Explain problems in welding dissimilar metals. Explain methods and techniques involved in dissimilar metal welding. State the advantages and disadvantages of dissimilar welds. Demonstrate welding of dissimilar metals.	

	General Objectives 7.0: Understand the structure, property and application of nonferrous metals and alloys.		
	7.1 State properties which make aluminium an important metal. 7.2 Explain "wrought and cast" aluminium alloys. 7.3 Give examples of non-heat treatable wrought and cast aluminium alloys. 7.4 Enumerate uses of 3.3 above in engineering. 7.5 Give examples of heat-treatable wrought and cast aluminium alloys. 7.6 Enumerate uses of 3.5 in engineering. 7.7 Explain the physical properties of magnesium and its alloys, which have made them useful engineering materials and their disadvantages. 7.8 Describe the three groups of magnesium alloys available. 7.9 State the engineering applications of 7.8 above. 7.10 List various grades of commercial copper. 7.11 State the application of 7.10 above. 7.12 Define copper alloys. 7.13 Classify copper alloys. 7.14 Draw the copper/zinc thermal equilibrium diagram. 7.15 Explain 7.14 above. 7.16 State the properties and applications of copper alloys (Brass & Bronze). 7.17 Explain the allotropic forms of titanium. 7.18 Draw the equilibrium diagram of Ti-alloys based on the effect of alloying elements on alpha and beta change points. 7.19 Explain 7.18 above.	state properties of aluminium. Classify types of aluminium and its alloys. State examples of each class. Explain the physical properties of magnesium. Classify types of magnesium and its alloys. Classify copper alloys. List commercial grades. Draw the Cu – Zn thermal equilibrium diagram. State application of copper alloys. Explain the allotropic forms of titanium. Explain the equilibrium diagram of titanium alloys. Enumerate properties, application of each allotropic form of titanium alloys.	Reference Textbooks. Field Trips. Journals. Samples of pure metals and alloys.

	7.20 Enumerate the properties and engineering applications of alpha, beta, alpha + beta titanium alloys.		
	PRACTICALS		
	1. Carry out physical identification of raw materials for steel production. 2. Conduct physical identification of pig iron and other products. 3. Carryout macro examination of steel ingot. 4. Identify copper by colour and weight. 5. Distinguish between pure copper, copper ores and its alloy. 6. Identify aluminium using its properties. 7. Distinguish between pure aluminium and its alloys. 8. Conduct observation on the changes of the state of steel.. 9. Identify the alloying elements of steel. 10. Distinguish between steel and cast iron. 11. Determine thermal conductivity of metal to be welded. 12. Determine the mechanical properties of metal to be welded. 13. Determine properties of aluminium, magnesium and titanium. 14. Distinguish between the various classes of aluminium, copper, titanium and magnesium.		

PROGRAMME: NATIONAL DIPLOMA IN WELDING AND FABRICATION TECHNOLOGY			
COURSE: Welding Technology III		**Course Code: WEC 211**	**Contact Hours: 2-0-3**
Course Specification: Theoretical & Practical Content			
WEEK	**General Objectives1.0: Know the general classification of arc welding.**		
	Specific Learning Outcomes	**Teachers Activities**	**Resources**
1	1.1 Classify arc welding into carbon arc, metallic arc, submerge arc, gas shield arc (MIG/TIG) etc. 1.2 Describe briefly the processes in 1.1 above. 1.3 State the application of each processes in 1.1 above. 1.4 Explain the advantages and disadvantages of each process in 1.1 above.	Explain the classification of arc welding into carbon arc, metal arc, submerge arc, gas shield arc, etc. State the application of above. Explain the advantages and disadvantages of each processes.	Mild Steel Plate. Arc Welding Equipment.
	General Objectives2.0: Understand manual arc welding and its auxiliary equipments.		
	2.1 Define manual arc welding. 2.2 Explain a typical workshop layout for manual arc welding. 2.3 Explain the functions of the various parts of a welding equipment. 2.4 Use a simple sketch to explain manual arc welding circuit. 2.5 Define jigs, fixtures/manipulators and their uses. 2.6 Explain the selection of welding current and the various metallic measuring welding temperature.	With aid of a typical workshop layout, explain manual metal arc welding. Using simple sketches explain the various parts of welding equipment & welding circuit. Explain the uses of jigs, fixtures and manipulators. Explain the selection of welding current. Explain method of measuring welding temperature.	Jigs, Fixtures & Manipulators.
	General Objectives3.0: Understand the electrical aspect of arc welding.		
	1.1 Define earthing. 1.2 State the importance of earthing. 1.3 Explain voltage drop across the arc and transference of metal across the gap. 1.4 Define arc length. 1.5 Explain the effect of arc length on the	Explain earthing. State the importance of above. Explain voltage drop across arc & transference of metal across gap. Explain the calculation of welding voltage, current resistance and power.	Welding Machine. Electrode AC/DC. Mild Steel Plate.

	welding voltage. 1.6 Explain how to calculate welding voltage, current, resistance and power. 1.7 Explain magnetic effects produced by current flow such as arc blow. 1.8 Define transformer and rectifiers. 1.9 Explain the function of 3.8 in welding.	Define arc length. Explain the effect of arc length on welding voltage. Explain the effect of current flow produced by a magnet. Explain transformer rectifier. Explain the function of transformer rectifier in welding.	
	General Objectives 4.0: Understand electrode specification.		
	4.1 Explain electrode classification according to : - British standard, - American standard. 4.2 Explain the importance of using welding electrode in its proper classified condition. 4.3 Explain the function of electrode coating. 4.4 Explain the problem of welding with damped electrode. 4.5 Explain the factors influencing selection of electrodes.	explain the classification of electrode according to British & American standard. Explain the importance of using electrode in its proper classified condition. Explain the function of electrode coating. Explain the factors influencing selection of electrode. Explain the problem of welding with a damped electrode.	Damped electrode Dried electrode Mild Steel Plate
	General Objectives 5.0: Know the various manual arc welding techniques.		
	5.1 Explain how to strike and maintain the arc. 5.2 Explain the correct angle of electrode to the job. 5.3 Define hard-surfacing materials. 5.4 Explain the reason for using 5.4. 5.5 Explain how to control residual stresses. 5.6 Explain the method of stress relieving. 5.7 Explain various methods of pipe welding. 5.8 Explain the various welding positions & techniques. 5.9 define pre- and post heating.	Explain how to strike and maintain arc. Explain the correct angle of electrode to the job. Explain hard surfacing materials used. Give reason for using hard surfacing materials. Explain the control of residual stresses. Explain the method of stress relieving. With the aid of sketches, explain various pipe welding methods.	

	5.10 State the importance of 5.10 above. 5.11 Explain how to calculate the recovery rate of electrode. 5.12 Explain effect of weather conditions on welding.	Explain various welding positions. Explain the effect of weather condition on welding. Explain how to calculate the recovery rate of electrode.	
	General Objectives 6.0: Know the condition of sound weld.		
	6.1 Define a sound weld. 6.2 Explain the following parameters on sound weld production: - metal edge preparation - selection of the correct electrode - correct welding voltage and current - correct welding speed - pre-heating - correct welding technique - welding jigs, fixture and manipulations - proper cleaning of weld before depositing another weld bead. 6.3 Produce sound weld in the workshop.	Explain a sound weld. Use various parameters to explain sound weld e.g. metal edge preparation, correct welding speed, etc.	Welding Machine. Jig, Fixture & Manipulator.
	General Objectives 7.0: Understand causes of weld defects.		
	7.1 Explain how the following can cause weld defects: - excess current - low current - edge preparation.	Explain how weld defects can be caused by parameters listed in 7.1.	Welding Machine
	PRACTICALS		
	1. Demonstrate arc welding on different joints. 2. Introduce students to the use of jig, fixture and manipulator in the workshop. 3. demonstrate selection of welding current.		

	4. Demonstrate arc welding using jigs, fixture and manipulators. 5. Demonstrate welding with a transformer (AC). 6. Demonstrate welding with a rectifier (DC). 7. Demonstrate welding with a damped electrode. 8. Demonstrate welding with electrode in a proper classified condition. 9. Demonstrate practically in the workshop how to strike and maintain the arc. 10. Practically demonstrate the correct angle of electrode to a job. 11. Practically demonstrate the various welding positions using correct techniques. 12. Practically demonstrate the following in the workshop: - build a pad on a mild steel plate, cut & micro etch the pad. - weld a single "V" butt weld prepare the weld and bend test it (emphasise on penetration and good edge preparation). - weld a double "V" butt weld. - weld fillet weld, fracture the weld and explain any defect found. - weld in various welding positions (down hand, vertical, horizontal and overhead). - weld pipe both straight, branch pipe & flange. - stainless steel welding. - cast iron welding. - hard surfacing.		

	13 Demonstrate the production of a sound weld. 14 Demonstrate with the use of jigs, fixture and manipulator to produce a sound weld. 15 Demonstrate in the workshop how weld defects can be caused by the parameters listed in 7.1.		

PROGRAMME: NATIONAL DIPLOMA IN WELDING AND FABRICATION TECHNOLOGY			
COURSE: Basic Thermodynamics		**Course Code: WEC 212**	**Contact Hours:** 2-0-3
Course Specification: Theoretical & Practical Content			
WEEK	**General Objectives 1.0: Know the concept of temperature and the principles of empirical thermometry**		
	Specific Learning Outcomes	**Teachers Activities**	**Resources**
1	1.1 Define Temperature. 1.2 State The Units Of Temperature Measurement. 1.3 State The Zeroth Law Of Thermodynamics. 1.4 Define Thermometric Substances. 1.5 Solve Simple Problem Related To 1.1 To 1.4. 1.6 Solve Simple Problems On Determination Of Temperature when the thermometric property values at certain fixed points are given and a scale of temperature is prescribed.		
	General Objectives 2.0: Understand thermal energy.		
	2.1 Define specific heat capacity. 2.2 Solve problems associated with mass, specific heat capacity and temperature change. 2.3 Differentiate between specific heat & latent heat. 2.4 Solve simple problems related to specific latent heat. 2.5 Determine experimentally, specific heat capacities for solids, liquids and gases.	.	
	General Objectives 3.0: Understand work transfer.		
	3.1 Explain the basic concepts of systems and surroundings, boundary, control, volume, property state, processes, equilibrium. 3.2 Give the thermodynamic definitions of work transfer. 3.3 Calculate the work transfer by expansion of a gas		

	in a piston cylinder system. 3.4 Solve simple problems relating to work transfer e.g. power transmission via a rotating shaft.		
	General Objectives 4.0: Know the first law of thermodynamics.		
	4.1 State the first law of thermodynamics. 4.2 Explain the relationship between heat transfer (Q), work transfer (W) and the related changes in the properties. 4.3 Prove the corollaries of first law of thermodynamics. 4.4 Express the principle of conservation of energy in thermodynamics systems. 4.5 Derive the non-flow energy equation. 4.6 Derive the steady flow energy equation. 4.7 Solve problems related to 4.1 – 4.5.		
	General Objectives 5.0: Understand the principle of second law of thermodynamics.		
	5.1 Explain the concept of the reversible and irreversible processes. 5.2 State the Kelvi-Plank's and Clausins's version of the second law of thermodynamics. 5.3 Define the carnot cycle of efficiency. 5.4 Define the absolute (Kelvin) thermodynamics scale of temperature. 5.5 Compute the carnot cycle efficiencies assuming typical practical thermal reservoirs.		
	General Objectives 6.0: Understand the concept of entropy		
	6.1 Define entropy. 6.2 Identify entropy as a thermodynamics property of a system. 6.3 Describe entropy as a measure of degree of		

	"disorder" in a system. 6.4 Define an adiabatic reversible process. 6.5 Define isotropic efficiency. 6.6 Compute isotropic efficiencies of turbines and compressors.		
	General Objectives 7.0: Know the relationship between the properties of pure substances.		
	7.1 Define a pure substances 7.2 State the two property rules for pure substances. 7.3 Identify the liquid, vapour and gaseous phase on the P.V. diagram projection for pure substances.		
	General Objectives 8.0: Understand ideal gas laws.		
	8.1 State: (a) Boyle's law; (b) Charles law; (c) The Pressure law; (d) Ideal gas law. 8.2 Solve problems involving laws in 6.1. 8.3 Distinguish between real and ideal gas.		
	General Objectives 9.0: Understand fuels and their combustion.		

	9.1 Define exothermic and endothermic reactions. 9.2 Define fuels. 9.3 Classify fuels into gaseous, liquid or solid. 9.4 Identify the hydrocarbons as fuels. 9.5 Describe the formation of fossil fuels. 9.6 State the composition of natural gases. 9.7 Identify the sources of crude oil. 9.8 Describe the fundamental properties of fossils. 9.9 Identify typical application of fuels in 9.5. 9.10 Define gross and net calorific value of fuels in 9.8. 9.11 Define, experimentally, the calorific values of fuels. 9.12 Analyse the chemical changes which occur when combustion takes place. 9.13 Compute density of gases at S.T.I. 9.14 Describe the chemical changes which takes place during the combustion of: (a) carbon (b) hydrogen (c) hydrocarbons. 9.15 Define complete, incomplete and stoichiometric combustion. 9.16 Define air-fuel ratio, excess air and mixture strength of combustion. 9.17 Explain the causes and effects of incomplete combustion.		

PROGRAMME: NATIONAL DIPLOMA IN WELDING AND FABRICATION TECHNOLOGY			
COURSE: Welding Technology IV		**Course Code: WEC 220**	**Contact Hours:** 2-0-3
Course Specification: Theoretical & Practical Content			
WEEK	**General Objectives1.0: Understand electrical resistance welding processes and their limitation.**		
	Specific Learning Outcomes	**Teachers Activities**	**Resources**
1 – 5.	1.1 Define resistance welding processes. 1.2 Use various sketches to illustrate each process. 1.3 Explain the operational principles of the processes in 1.1 above. 1.4 Explain the importance of cleaning, degreasing, de-scaling on metal surfaces to be joined by resistance welding. 1.5 Explain the method of heat energy application and mechanical force under the following: - spot welding - flash butt welding, - seam welding, - resistance butt welding. 1.6 Undertake welding of metals using the methods in 1.5 above.	With the aid of suitable sketches, describe resistance welding processes and their operational working principles. Using suitable diagram, explain the effect of heat energy application and mechanical force under spot welding, flash butt welding, seam welding and resistance butt welding.	Welding Machine.
	General Objectives2.0: Know MIG, MAG, TIG welding processes.		
6 –10.	2.1 Define MIG/MAG/TIG welding processes. 2.2 State the shielding gases used in the processes in 7.1 above and reason for their uses. 2.3 Explain with aid of sketches the setting up of the equipment. 2.4 Explain the function of each component. 2.5 Explain the working principles of each process. 2.6 Explain using a sketch volt – ampere curves. 2.7 State advantages and disadvantages of each	Explain the MIG, MAG and TIG welding processes with reference to the shielding gases used. With the aid of diagram, explain the set-up of each equipment, their function and each component. Explain their operational techniques with reference to spray arc, short arc circuiting, globular, wire feed speed and effect on	Various plates. Inert Gas CO_2, Argon, etc. Welding Machine.

	process in 2.1 above. 2.8 Explain the operational techniques of the processes in 2.1 under the following: - Spray arc, - Short arc circuiting, - Globular, - Wire feed speed and effect on current, - Voltage, - Choke of series induction, - Gas flow. 2.9 Use the processes in 2.1 above to weld the following: - mild steel plate from 12mm - aluminium and its alloys - stainless steel - pipe weld penetration bead.	current, voltage, choke of series induction etc.	
	General Objectives3.0: Know how to use other special welding processes.		
	3.1 Describe the working principles of the following special welding processes: - Electro slag arc welding - Submerge arc welding - Atomic hydrogen arc welding - Ultrasonic ,, ,, - Induction electric ,, ,, - Thermit ,, ,,	Explain the various special welding processes stated in 3.0. Acquit students with different equipment and tools to be used. Explain the safety precaution to be observed in the process of these operations.	Welding machine. Materials e.g. electrode etc.
	PRACTICALS		
	2. Demonstrate welding of metals using spot, seam, flash butt and resistance welding processes. 3. Demonstrate the use of the welding processes		

	to weld mild steel plate from 12mm thick aluminium and its alloys, stainless steel and pipe weld penetration bead. 4. Demonstrate practically how to join metals using each of these process.		

PROGRAMME: NATIONAL DIPLOMA IN WELDING AND FABRICATION TECHNOLOGY			
COURSE: Weld Fabrication Design		**Course Code: WEC 222**	**Contact Hours:**
Course Specification: Theoretical & Practical Content			
WEEK	**General Objectives1.0: Understand need for weld design & its effects on welding cost.**		
	Specific Learning Outcomes	**Teachers Activities**	**Resources**
1	1.1 Define weld design and its advantages. 1.2 Explain the economic aspect of weld design. 1.3 Explain the influence of welding process on weld design.	Explain the need for welded joint design before actual fabrication and the consequences of not designing or wrong design. Explain the cost effect of design. Explain the effect welding process has on welded joint design.. Show how different welding processes should be used to weld a specific design and their suitability test through joint evaluation.	Arc Welding & Oxy-Acetylene Machine.
	General Objectives2.0: Know the basic types of joints and welded joint futures.		
	2.1 Describe the basic types of joints. 2.2 Explain types of welds. 2.3 Explain with aid of sketches the features of butt & fillet welds. 2.4 Describe with sketches the following joint preparation recommended for various arc welding processes: - flanged square butt, single V, single U, double-V, double- U, etc. 2.5 Describe the following edge preparation methods: - flame cutting (bevel or J penetration to give a V or U between butted plates). - planning (Bevel or J). - shearing (Bevel to maximum of 25mm	Explain the five basic types of joints Explain the limit of application of above. Explain the features of butt and fillet welds. Discuss why are butt & fillet are necessary. Illustrate the various fillet weld profiles. Illustrate the various edge preparations. Explain why different edge preparations are required. Describe the location of the features using different edge preparation methods to carry out a specific design and comparism made in terms of cost, quality of finish, cut profile and time. Illustrate weld symbols as represented on	

	thickness). - chipping. - build-up by prior welding. 2.6 Demonstrate edge preparation using methods in 2.5 above. 2.7 Explain with diagrams the following weld symbols: - single-bevel butt - double-bevel butt - single-J butt - double-J butt - seating run - backing strip - dressed flush - full penetration butt weld from agreed welding procedure, etc.	drawing.	
	General Objectives3.0: Understand the factors to be considered while designing a weld joint.		
	3.1 Explain the factors under the following headings: - service requirement, - types of loading, - type of edge preparation, - type of metal, - welding position and accessibility - cost of edge preparation.	Explain the various factors that affect joint design. Explain type loading in relation to static, tensile, bending, torsion, manner of loading and failure modes as they affect joint or preparation type. Carry out single V edge preparation on two metal thickness with the same specification to determine the effect on accessibility and strength	
	General Objectives 4.0:		
	4.1 Describe type of joints for brazing and soldering. 4.2 Explain the braze joint design factors	Illustrate the basic joint types and edge preparations required for brazing and	

	4.3 Differentiate between braze and welded joints.	soldering. Explain why are the above different from those used in welding.	
	General Objectives 5.0:		
	5.1 Undertake practically the design of weld joints for: - welding operations - brazing and soldering operations.	Carry out practical design of joints and the preparations required for welding, brazing and soldering.	
	General Objectives 6.0: Know the basic designs for sheet metal fabrication.		
	6.1 Define the following terms used in sheet metal fabrications: - template, - hems, edges, seams and self secured joints. 6.2 Draw single and double hem. 6.3 Explain pattern development in fabrication. 6.4 Describe self secured joints in sheet metal fabrication. 6.5 Explain stiffening methods.	Explain why pattern development is necessary in sheet metal fabrication. Explain why most sheet metal fabrication require self secured joints and stiffening. Illustrate parallel line of radial line development as use in triangulation to produce a two transition piece as is used in the development of a box shape, conical sections, etc. Carry out practical sheet metal fabrication using the above information.	

PROGRAMME: NATIONAL DIPLOMA IN WELDING AND FABRICATION TECHNOLOGY			
COURSE: Testing and Evaluation of Welds		**Course Code: WEC 223**	**Contact Hours: 2-0-3**
Course Specification: Theoretical & Practical Content			
WEEK	**General Objectives 1.0: Know the need for weld testing.**		
	Specific Learning Outcomes	**Teachers Activities**	**Resources**
1	1.1 Explain the importance of welds testing before putting it to service. 1.2 Explain typical weld failure mechanisms.	Sketch a common welded object e.g. water tank with defects. Explain effect of defect on it. List common failure mechanism e.g. stress, corrosion, cracking etc.	Reference Textbooks
	General Objectives 2.0: Know two major methods of testing welds.		
	2.1 Classify testing methods under:- - destructive testing - non destructive testing. 2.2 Explain various loading conditions for mechanical testing. 2.3 Describe the basic principle of mechanical methods of testing welds. 2.4 Conduct practical test in each of the mechanical testing methods.	Explain the testing methods. Explain the principles of: a. bend test b. tensile test c. hardness test d. impact test e. fatigue test f. creep test	Guided Bend, Tensile, Hardness, Impact, Fatigue Testing Machines. 6mm Thick Plate, cut to size. Oxyflame, Emery Cloth Hacksaw, Work Bench. Files
	General Objectives 3.0: Understand classification of weld discontinuities.		
	3.1 Define weld discontinuity. 3.2 State the difference between discontinuity and defect. 3.3 Classify weld defect under: - dimensional requirements - structural discontinuities - metallurgical/defective properties.	Explain weld discontinuities. Explain defects.	Reference Textbooks
	General Objectives 4.0: Know various weld structural discontinuities.		

	4.1 Define the different types of weld defects. 4.2 Identify various weld defects. 4.3 Use wrong welding parameters to weld and produce joints with various weld defects.	Explain with sketches joints with weld defects.	Reference Textbooks AC/DC Welding Machine.
	General Objectives 5.0: Know the strength of various welded joints.		
	5.1 Define strength of weld. 5.2 Determine the strength of a given weld by calculation. 5.3 Explain direct or shear stress as it affects the strength of a weld. 5.4 Describe fatigue. 5.5 Explain how 5.4 can affect the strength of a weld. 5.6 Explain how rough metal edges, wrong choice of electrode/filler rod, welding flame etc. can effect the strength of welds. 5.7 Explain the influence of weld defect on the strength of weld.	Sketch geometrical features which may influence service failures. Solve problems.	Ditto.
	General Objectives 6.0: Understand the dangerous effects of weld defects.		
	6.1 Explain the adverse effects of weld defects e.g. spillage, deformation of metal structures, brittle fracture, corrosion economic consequences.		
	General Objectives 7.0: Know the various non-destructive testing methods.		
	7.1 Describe the basic principle of the following NDT methods: - visual inspection - magnetic particle inspection - dye penetrant inspection - radiographic inspection - ultrasonic inspection.		AWS weld gauge Electromagnetic yorke Particle powder X & Gamma ray equipment.

	General Objectives 8.0: Know how to evaluate weld defects.		
	8.1 Explain how non-destructive and destructive testing methods are used to identify and evaluate weld defects. 8.2 Explain acceptable and unacceptable discontinuities with a given limit base on codes and standards.		Tested Weld Samples Radiographs Reference Textbooks. ASME Code IX. API Code 1104.
	General Objectives 9.0: Know the categories and duties of a welding inspector.		
	9.1 Classify welding inspectors. 9.2 Briefly explain duties of an inspector. 9.3 Explain general welding symbols. 9.4 Explain how to select specimen for weld test. 9.5 State factors to be considered for effective report writing. 9.6 Explain the importance of brevity, clarity.		Reference Textbooks.

PROGRAMME: NATIONAL DIPLOMA IN WELDING AND FABRICATION TECHNOLOGY			
COURSE: Introduction to Plastic Welding		**Course Code: WEC 224**	**Contact Hours:**
Course Specification: Theoretical & Practical Content			
WEEK	**General Objectives1.0: Know types of plastics and their characteristics.**		
	Specific Learning Outcomes	**Teachers Activities**	**Resources**
1	1.1 Define plastics. 1.2 State the various types of plastics. 1.3 Explain the characteristics of various plastics as stated in 1.1 above. 1.4 State the uses of plastics in modern technology. 1.5 Identify various types of plastics. 1.6 Demonstrate the variation in melting points and strength among the plastics.	Explain the uses of plastics in technology. Characterise plastics.	Sample of various types of Plastics.
	General Objectives2.0: Know the safety precaution in plastic welding.		
	2.1 Define safety. 2.2 Explain the need for safety in the workshop. 2.3 Explain the need for proper ventilation in plastic welding area. 2.4 Explain the effect of noxious odours and fumes from plastics during welding. 2.5 Explain how to prevent inhaling the fumes.	Explain safety requirement in plastic welding.	
	General Objectives3.0: Understand the conditions for producing sound plastic welds.		
	3.1 Explain the following conditions affecting a sound plastic weld: - edge preparation - choice of filler plastic rod - correct setting air or gas pressure & temperature. - use of fanning motion to ensure uniform heat distribution.	Explain procedures in plastic welding.	

	- less pressure on the filler plastic rod. - preventing plastic surface from discolouring. - setting up of equipment. - care of the equipment.		
	General Objectives4.0: Understand the various plastic welding techniques.		
	4.1 Demonstrate the following plastic welding techniques: - hot gas welding - high speed welding - heated tool welding - induction welding 4.2 Undertake the following exercise in the workshop: - deposit weld beads on flat surface - practice pad building - practice cutting with nippers - practice manipulation of plastic filler rod during welding - practice restating bead after stopping - practice welding lap joint - track and weld butt flat joint	Demonstrate plastic welding techniques.	Plastic Welding Unit Air Compressor. Plastic Sheets Filler Plastic Rods. Various types of welding tips.

LIST OF EQUIPMENT/TOOLS

(A) WORKSHOPS/STUDIOS

(1) FITTING/MACHINE SHOP

FITTING

1.	Work benches for 30 Students	10
2.	Bench Vices	20
3.	Pillar Drilling Machine	1
4.	Marking out Table	1
5.	Surface plate	2
6.	Bench Drilling Machine	1
7.	Radial Drilling Machine	1
8.	Pedestal Grinding Machine	1
9.	Power Hacksaw	1
10.	Arbor Press	1
11.	Flat Rough File (300mm)	20
12.	Round (Rough & Smooth) File (300mm)	20each
13.	Square Rough File (300mm)	20
14.	Flat Smooth File (250mm)	20
15.	Half-Round Rough File (150mm)	20

16.	Triangular Rough File (150mm)	20
17.	Half-Round Smooth File (250mm)	20
18.	Triangular Smooth File (150mm)	20
19.	Try Square	20
20.	Dividers	20
21.	Wallet of Wording File	10 sets
22.	Scribers	10
23.	Vee Block and Clamp	2
24.	Scribing Block	2
25.	Stock and Dies (set) metric	3 sets
26.	Tap and Wrenches set (metric)	3 sets
27.	Hacksaw Frame	20
28.	Centre Punches	20
29.	Scrapers (set)	10 sets
30.	Hand Drill	2
31.	Centre Drills (sets)	10 sets
32.	Tap Extractor (sets)	2 sets
33.	Screw Extractors (set)	2 sets
34.	Screw Gauges (assorted)	5 each
35.	Hammers (assorted weights)	10 each

36.	Hydraulic Press	1
37.	Hand Shear	5
38.	Letter Stamps	2
39.	Number Stamps	2
40.	Vernier Height Gauge	2
41.	Electric and Grinder/Sander	2
42.	Electric Hand Drill	2
43.	Dial Indicators & Stand	2

MACHINES

1.	Shaping Machine	1
2.	Planing Machine	1
3.	Guillotines	
	(i) Gabro-type Box/Pan folder BF 620	1
	(ii) Gabro-type Combined Apparture Guillotine	1
4.	Turret or Capstan Lathe	1
5.	Harrison Trainer 250 – dual purpose CNC/	
	Manual lathe, Complete with Bench Speed Head Stock	1
6.	Bench Lathe (Melcer -3 model)	1
7.	Riveting Machine	1

8.	Pliers (Engineer's Combination, multi-groove, vice grip, diagonal cutting, Long nose, slide cutting)		6 each
9.	Screw Driver		
	(i)	Standard Tip (6 x 100mm)	5
	(ii)	Standard Tip (4 x 400mm)	5
	(iii)	Offset Straight Up 1 & 2	5 each
	(iv)	Straight Tip Spring Chip (12 x 150mm)	5
	(v)	Philips (2 – 6mm)	5 each
10.	Spanners		
	(i)	BSW Spanner & Wrench	5 sets
	(ii)	Open-Ended Spanner sets British Whitworth set (metric)	3 sets
	(iii)	Ring Spanner Sets	3 sets
	(iv)	Miniature Spanner Set	3 sets
	(v)	Socket Spanner Set (12mm drive)	3 each
11.	Micrometers (three sizes with capacities 0 – 25mm – 50mm 50 – 75mm) outside & inside sets		3 each

(2) FABRICATION/WELDING/HEAT TREATMENT WORKSHOP

(i) Welding Section

1.	Spot Welding Machine	5
2.	TIG Welding Machine	5

3.	Manual Arc Welding Machine	5
4.	MIG/MAG Welding Machine	5
5.	Welding Machine Generator	5
6.	Welding Machine Transformer	5
7.	Oxygen Cylinders	5
8.	Acetylene Cylinders	5
9.	Argon Cylinders	5
10.	CO_2	5
11.	Oxy-Acetylene Welding Manifold	10
12.	Weld Joint Teaching Aids (Diagrams)	3
13.	Apron	30
14.	Hand Gloves	30 pairs
15.	Welding Head Shield	30
16.	Electrode Oven	1
17.	Work Benches for each Welding Machine	20
18.	Portable Profile Gas Gutting Machine	1
19.	Soldering Iron	10
20.	Oxy-Acetylene Regulators	5 each
21.	Booth Screen	20
22.	Gas Welding Goggles	20
23.	Electrode Holder	30
24.	Welding Chipping Hammer	15
25.	Wire Brush (bench type)	10
26.	Gas Cylinder Trolley	2
27.	Spark Lighter	56
28.	Brazing Rods	10kg
29.	Soldering Flux	10 tins
30.	Bending Machine for Testing Welds	1
31.	Flash Welding Machine	1
32.	Submerge-Arc Welding Machine	1

33.	Plastic Welding Machine	1
34.	Profile Heavy Duty Cutter Gas	1
35.	Gas Welding Blow Pipe	5
36.	Gas Welding Cutting Blow Pipe	5
37.	Oxy-Acetylene Welding Hoses	30 metres each
38.	MAG (CO_2) Regulator	5
39.	Welding Face Shield	20
40.	Argon Regulator	5
41.	Leggings	10 pairs
42.	Safety Charts	Assorted

(ii) Fabrication Section

1.	Hand Drilling Machine	2
2.	Jig Saw Cutting Machine	2
3.	Vernier Calliper	4
4.	Calibrated Try Square	5
5.	Callipers	4
6.	Sup Shear	2
7.	Tool Boxes containing Flat Spanners and Socket Spanners	2
8.	Panel Beating Tool Set	4 sets
9.	Number Stamp	1 sets
10.	Giant Ring Spanners	4
11.	Long Nose Pliers	5
12.	Shifting Pliers	1
13.	Allen Keys	10
14.	Sledge Hammer	2
15.	Giant Socket Spanners	4
16.	Bench Grinding Machine	5

17.	Anvil and Stand	5
18.	Clamp	5
19.	Steel Rule	4
20.	Twist Drill Set	10
21.	Power Saw Cutting Machine	4 sets
22.	Pipe and Flange Cutting Machine	2
23.	Band Saw Machine	2
24.	Hand Shearing Machine	1
25.	Guillotine Cutting Machine	1
26.	Manual Drilling Machine	1
27.	Air Compressor	1
28.	Break Press Machine	1
29.	Screw Press	2
30.	Pipe Bending Machine	2
31.	Table Tool Grinder	1
32.	Work Bench (Wood)	10
33.	Work Bench (Metal)	10
34.	Vices	30
35.	Marking off Table	1
36.	Snap Rod Cutter	1
37.	Auto Body Fender Set	2
38.	Erichsen Cupping Test Machine	1

(iii) Heat Treatment

1.	Medium Size Muffle Furnace (0 – 1200 ^{0}C)	1
2.	Metal Tong	5
3.	Thermocouples (assorted)	1 each
4.	Pyrometer (optical type)	1
5.	Quenching Bath (oil, water, salt solution)	

	Thermostatically controlled.	1 each
6.	Salt Bath Furnace (oil fired)	1
7.	Cooling Curve Determination Set	1
8.	Jominy End-Quench Test Apparatus	1

(iv) Engineering Drawing Studio

1.	Drawing Table complete with Drafting Machine	2
2.	Drawing Board with Tee Squares	30
3.	Adjustable Set Squares	2
4.	Desk Sharpener	4
5.	Scale Rule (triangular and flat)	2 each
6.	Black Board Rule	2
7.	Black Board Set Square (45^0, 60^0)	2 each
8.	Black Board Protractor	2
9.	Black Board Compasses	2
10.	French Curve	2
11.	Letter and Number Stencils 2mm, 4mm, 5mm, 7mm, 8mm and 10mm	2 each

(v) Computer Studio

* Not less than (30 nos.) computer sets should be available for software practice.

(B) LABORATORIES

(i) Metallography

1.	Metallurgical Microscope (bench type)	2

2.	Metallurgical Microscope with built-in transformer	
	And rheostat accessories;	1
	(i) Telescope Camera	1
	(ii) Films	20 pkts
	(iii) Development Paper	20 pkts
3.	Grinding and Polishing Rotary Machine,	
	203mm wheel, 50 – 500rpm.	2
4.	Spare Aluminium Wheel (230mm) for item 3 above	2
5.	Four (4) Stage Roll Hand Grinder with water flow	2
6.	Grinding Paper (Silicon Carbide) with grits	
	240, 320, 600, 800	3 pkts each.
7.	Metallurgical Sample mounting hydraulic press with	
	Accessories and thermostatically controlled heater	1
8.	Paper Disc, 203mm with PSA adhesive back	10
9.	Polishing Cloths (micro cloths)	2 pkts
10.	Phenolic Powder Dispenser	1 tin
11.	Mould Release (Silicone)	1
12.	Polishing Powder A1-203 (0.3 micron)	2 tins
	,, ,, ,, (0.5 micron)	2 tins
	,, ,, ,, (1.0 micron)	2 tins
13.	Polishing Suspension $CO2O_3$ (1.0 micron)	1 tin
14.	Desiccators Specimen Cabinet	1
15.	Cold/Hot Blower (hand operated)	2
16.	Etching Reagents (Nital, Ferric Chloride, diluted	
	Sulphuric Acid, diluted Hydrochloric Acid)	Assorted
17.	Fume Cup-Board	1

(ii) Material Testing Laboratory

DESTRUCTIVE TESTING

1.	Floor Mounted Universal Tensile/Compressive Testing Machine With accessories, with loading capacity up to 100KN	1
2.	Table Top Tensometer with accessories	1
3.	Impact Testing Machine (Izod, Charpy)	1
4.	Macro-hardness Testing Machine with accessories (Brinell, Vickers and Rockwell).	1 each
5.	Metal cutting-off disc machine	1
6.	Macro-hardness Testing Machine	1

(iii) Metrology Laboratory

1.	Sine Bars	3
2.	Slip Gauges	4
3.	Depth Gauges (1/20, 200 mml)	15
4.	Vernier Callipers	15
5.	Slide Gauges with dial indicators	10
6.	Micrometer Screw Gauge (100mm – 200mm)	10
7.	Universal Dial Gauge Stand	5
8.	Angle Gauges (200 - 300)	5
9.	Steel Measure (500mm length)	5
10.	Spring headed pointed callipers	10
11.	Steel Measuring Tapes (2 metres)	5
12.	Inside and Outside Callipers	10
13.	Screw Drivers (set of various types)	4 sets
14.	Vibratory Engraver	2
15.	Horizontal and Vertical Comparator	1

16.	Surface Measuring Instrument (tally surf)	1
17.	Roundness Measuring Instrument (tally round)	1
18.	Flatness Inter Ferro-meter	1
19.	Optical Bevel Protractor	1
20.	Tool Makers Microscope	1
21.	Universal Pitch Measuring Machine	1
22.	Universal Gear Measuring Machine	1

(iv) Strength of Materials Laboratory

1.	Shear Force Apparatus	1
2.	Bending Moment Apparatus	1
3.	Gyroscope Apparatus	1
4.	Polygon of Force Apparatus	1
5.	Young's Modulus Apparatus	1

SAFETY EQUIPMENT FOR EACH WORKSHOP AND LABORATORY

1.	First Aid Box	2 sets
2.	Safety Boots	20 pairs
3.	Leather Apron	30
4.	Leather Hand Gloves	30 pairs
5.	Fire Extinguishers	30
6.	Sand Buckets	30
7.	Safety Charts and Drawings	assorted.

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