FEDERAL MINISTRY OF EDUCATION

National Technical Certificate (NTC) Curriculum in

INDUSTRIAL ELECTRONICS CRAFT

February, 2025

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

Funded by IDEAS project

NATIONAL BOARD FOR TECHNICAL EDUCATION

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

NATIONAL TECHNICAL CERTIFICATE

CURRICULUM AND MOUDULE SPECIFICATIONS IN

INDUSTRIAL ELECTRONICS CRAFT

2025

GENERAL INFORMATION

AIM

To give training and impact the necessary skills leading to the production of skilled personnel that can fit into the Industrial Electronics as craftsmen and self-reliant entrepreneurs.

ENTRY QUALIFICATIONS

Craft Programme

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

Advanced Craft Programme

Candidates should possess the National Technical Certificate or its equivalent and should have had a minimum of two years post qualification cognate industrial experience.

The Curriculum

The Curriculum of each programme is broadly divided into three components:

a. General Education, which accounts for 30% of the total hours required for the programme.

b. Trade Theory, Trade Practice and Related Studies which account for 65% and,

c. Supervised Industrial Training/Work Experience which accounts for about 5% of the total hours required for the programme. This component of the course which may be taken in industry or in the College production unit is compulsory for the full-time students.

Included in the curriculum are the teacher's activity and learning resources required for the guidance of the teacher.

Unit Course/Modules

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

Behavioural Objectives

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

a. General Objectives
b. Specific Learning Outcomes

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

a Electronic Components
b Measuring Instruments
c Digital Circuits

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

General Education in Technical Colleges

The General Education component of the curriculum aims at providing the trainees with knowledge in critical subjects like English Language, Mathematics, Economics, Physics, Chemistry, Biology, and Entrepreneurial Studies, etc. to enhance the understanding of Components/modules, tools and materials of their trades and their application as a foundation for post-secondary technical education for the above average trainees. Hence, it is hoped that trainees who successfully complete their trade and general education may be able to compete with their secondary school counterparts for direct entry into Universities, Polytechnics or Colleges of Education (Technical) for degree, ND or NCE courses respectively.

For the purpose of certification, only the first three courses in mathematics will be required. The remaining modules are optional and are designed for the above average students.

National Certification

The NTC and ANTC programmes are run by Technical Colleges accredited by N.B.T.E.
NABTEB conducts the final national examination and awards certificates.

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

S/NO	LEVEL	CERTIFICATE
	Technical Programme	
1.	NTC	National Technical Certificate
2.	ANTC	Advanced National Technical Certificate

Guidance Notes for Teacher implementing the Curriculum

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

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

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

INTEGRATED APPROACH IN THE TEACHING OF TRADE

Theory, Trade Science and Trade Calculation

The traditional approach of teaching trade science and trade calculation as separate and distinct subjects in Technical College programmes is not relevant to the new programme as it will amount to a duplication of the teaching of mathematics and physical science subjects in the course. The basic concepts and principles in mathematics and physical science are the same as in the trade calculation and trade science. In the new scheme therefore, qualified persons in these fields will teach mathematics and physical science and the instructors will apply the principles and concepts in solving trade science and calculation problems in the trade theory classes. To this end, efforts have been made to ensure that mathematics and science modules required to be able to solve technical problems were taken as pre-requisite.

Evaluation of Programme/Module

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

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

PROGRAMME: **NATIONAL TECHNICAL CERTIFICATE IN INDUSTRIAL ELECTRONICS**

GOAL: The Industrial Electronics Programme is intended to produce Craftsmen who should be able to diagnose faults, carry out repairs and maintenance on industry electronics. The trainees should also have an in-depth theoretical knowledge of its operations.

Contents

CURRICULUM TABLE AND COURSE HOURS/WEEK
PROGRAMME: NATIONAL TECHNICAL CERTIFICATE

Module Code	MODULE	YEAR I						YEAR 2						YEAR 3						TOTAL HOURS
		Term 1		Term 2		Term 3		Term 1		Term 2		Term3		Term 1		Term 2		Term 3		
		T	P	T	P	T	P	T	P	T	P	T	P	T	P	T	P	T	P	
CAM 12 - 15	Mathematics	2	-	2	-	2	-	2	-	2	-	2	-	2	-	2	-	2	-	216
CEN 11 - 17	English	2	-	2	-	2	-	3	-	3	-	3	-	3	-	3	-	3	-	288
CPH 10 - 12	Physics	2	-	2	-	2	-	2	1	2	1	2	1	2	1	2	1	2	1	288
CCH 10 - 12	Chemistry	2	-	2	-	2	1	2	1	2	1	2	1	2	1	2	1	2	1	300
CEC 11 - 13	Economics	2	-	2	-	2	-	2	-	2	-	2	-	2	-	2	-	2	-	216
CBM 11	Entrepreneurship	-	-	-	-	-	-	2	-	2	-	2	-	-	-	-	-	-	-	72
ICT 11 - 15	Computer Studies	-	-	-	-	-	-	1	2	1	2	1	2	1	2	1	2	-	-	180
CTD 11 - 13	Drawings	-	3	-	3	-	3	-	3	-	3	-	2	-	2	-	2	-	2	276
CIE 111	Electrical and Electronics Principles I	3	4	-	-			-	-	-	-	-	-	-	-	-	-	-	-	84
CIE 121	Electrical and Electronics Principles II	-	-	2	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	70
CIE 122	Analogue Electronics	-	-	3	4	2	2	-	-	-	-	-	-	-	-	-	-	-	-	132
CIE 133	Digital Electronics I	-	-	-	-	3	4			-	-	-	-	-	-	-	-	-	-	84
CIE 213	Digital Electronics II							2	2											48
CIE 214	Power Electronics Devices	-	-	-	-	-	-	3	4	2	2	-	-	-	-	-	-	-	-	132
CIE 225	Power Semiconductor Devices	-	-	-	-	-	-	-	-	3	4	3	4	-	-	-	-	-	-	168
CIE 236	Applications and Troubleshooting of Power Electronic	-	-	-	-	-	-	-	-	-	-	2	4	-	-	-	-	-	-	72

	Systems																			
CIE 317	Basic Instrumentation	-	-	-	-	-	-	-	-	-	-	-	-	2	4	-	-	-	-	72
CIE 328	Microprocessors and PLCs in Industrial Automation	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3	4	-	-	84
CIE 329	Introduction to Variable Frequency Drives (VFDs)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	4	-	-	72
CIE **3110**	Introduction to Industrial Control System	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-	-	-	-	24
		13	7	15	11	15	10	19	13	19	13	19	14	16	10	17	14	11	4	**2878**

<table>
<tr><td colspan="4">PROGRAMME: NATIONAL TECHNICAL CERTIFICATE IN INDUSTRIAL ELECTRONICS</td></tr>
<tr><td colspan="2">MODULE: Electrical and Electronics Principles I</td><td>COURSE CODE: CIE 111</td><td>CONTACT HOURS:</td></tr>
<tr><td>YEAR: 1</td><td>TERM: 1</td><td>PRE: REQUISITE: JSS 3 Certificate</td><td>Theoretical: 36 Hours
Practical: 48 Hours</td></tr>
<tr><td colspan="4">GOAL: This module is designed to introduce the trainees to Electrical and Electronics Principles</td></tr>
<tr><td colspan="4">GENERAL OBJECTIVES:

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

1.0 Understand basic electrical safety.
2.0 Understand basic electrical concepts.
3.0 Understand basic electronic concepts.
4.0 Identify basic electronic components.
5.0 Demonstrate the use of fire extinguishers.
6.0 Carryout measurement of electrical/electronic quantities using appropriate measuring instruments.
7.0 Identify passive and active components.
8.0 Read and interpret active and passive components symbols on circuit diagrams.
9.0 Conduct experiments to investigate how resistance of a wire depends on its length.
1.10 Carryout experiments to confirm the variation of equivalent resistance in series and parallel networks.
1.11 Investigate voltage divider circuits.
1.12 Connect capacitors in series and parallel networks.</td></tr>
</table>

PROGRAMME: NATIONAL TECHNICAL CERTIFICATE IN INDUSTRIAL ELECTRONICS						
MODULE: 1				**COURSE CODE: CIE 111**		**CONTACT HOURS:**
YEAR: 1	**TERM:** 1	**PRE: REQUISITE: JSS 3 Certificate**		**Theoretical:** 36 Hours **Practical:** 48 Hours		
GOAL: This module is designed to introduce the trainees to Electrical and Electronic Principles						
Theoretical Content				**Practical Content**		
GENERAL OBJECTIVE 1.0: Understand basic electrical safety						
Week	**Specific Learning Outcome**	**Teachers Activities**	**Learning Resources**	**Specific Learning Outcome**	**Teachers Activities**	**Learning Resources**
1-2	1.1 Define electrical hazard. 1.2 Describe the various forms of electrical/electronic hazards. 1.3 Describe the factors on which the hazard of electrical current depends. 1.4 Describe general electrical/electronic rules. 1.5 Describe personal safety measures. 1.6 Describe safe handling of electronic components. 1.7 Describe fire and safety preparedness. 1.8 Describe safe use of electronic tools and equipment. 1.9 Describe basic first aid measures to be given to a victim of electric hazard.	1.1 Explain electrical Hazard. 1.2 Describe the various forms of electrical/electronic hazards. 1.3 Explain the factors on which the hazard of electrical current depends. 1.4 Explain general electrical/electronic rules. 1.5 Explain personal safety measures. 1.6 Explain safe handling of electronic components. 1.7 Explain fire and safety to prevent	• White Board • White Board maker • Projector • Internet Textbooks	• Demonstrate the use of fire extinguishers	• Guide the students in the use of fire extinguisher	• Fire extinguisher • Charts • PPE's • Basic electronic tools (defective and normal) • First Aid box and its basic contents

		fire accident. preparedness 1.8 Explain safe use of electronic tools and equipment. 1.9 Explain basic first aid measures to be given to a victim of electric hazard.				
Theoretical Content				**Practical Content**		
GENERAL OBJECTIVE 2.0: Understand basic electrical concepts.						
Week	**Specific Learning Outcome**	**Teachers Activities**	**Learning Resources**	**Specific Learning Outcome**	**Teachers Activities**	**Learning Resources**
3-4	2.1 Define electrical charges. 2.2 Define electrical current (DC/AC). 2.3 Define voltage (DC/AC). 2.4 Describe electrical charges. 2.5 Describe electrical voltage. 2.6 Explain sources of voltage generation (Heat, Chemical, Light, Pressure, Friction, Induction). 2.7 Differentiate voltages (AC & DC). 2.8 Describe Ohm's Law.	2.1 Explain electrical charges. 2.2 Explain direct (DC) and Alternating (AC) currents. 2.3 Explain DC and AC voltages. 2.4 Explain electrical voltage. 2.5 Explain simple processes of voltage generation. 2.6 Differentiate between AC and	• White Board • White Board maker • Projector • Internet • Textbooks	• Carry out measurement of voltage using appropriate instruments • Perform measurement of (DC and AC) current using appropriate measuring instrument	• Guide the students in using Voltmeters to measure the voltage. • Guide the students in using ammeters to measure current.	• Voltmeter • Ammeter (Multimeter)

		DC voltages. 2.7 Explain Ohm's Law.				
5-6	2.9 Define open and closed loop circuits. 2.10 Differentiate between circuits in 2.9 2.11 Explain the difference between conventional and technical direction of current flow.	2.8 Explain open and closed loop circuits. 2.9 Teacher differentiates open and closed loop circuits. 2.10 Define current. 2.11 Explain the direction of electrons.	• White Board • White Board maker • Projector • Internet • Textbooks	• Carry out measurement of current using appropriate instruments	• Gide the students in building a simple circuit to measure current	• Ammeter • Multimeter • Clamp meter
7-8	2.12 Define electrical power. 2.13 Describe electrical power. 2.14 Define electrical energy. 2.15 Define electrical work. 2.16 Explain electrical energy. 2.17 Calculate electrical energy and power. 2.18 Explain electrical power efficiency.	2.12 Explain the concept of electrical Power. 2.13 Discuss electrical power. 2.14 Discuss how to calculate power and energy. 2.15 Describe electrical work. 2.16 Describe electrical energy. 2.17 Calculate electrical energy and power. 2.18 Explain the term efficiency with examples.	• White Board • White Board maker • Projector • Internet • Textbooks			

GENERAL OBJECTIVE 3.0: Understand basic electronic concepts						
Week	**Specific Learning Outcome**	**Teachers Activities**	**Learning Resources**	**Specific Learning Outcome**	**Teachers Activities**	**Learning Resources**
9-10	3.1 Explain passive electronic components. 3.2 Describe active electronic components. 3.3 Identify passive and active electronic components on a circuit board. 3.4 Read and interpret simple passive electronic component symbols. 3.5 Read and interpret simple active electronic component symbols. 3.6 Describe simple circuit applications of passive and active electronic components. 3.7 Explain series and parallel connections involving passive electronic components.	3.1 Describe passive components. 3.2 Describe active electronic components. 3.3 Read and interpret simple passive electronic component symbols. 3.4 Read and interpret simple active electronic component symbols. 3.5 Describe simple circuit applications of passive and active electronic components. 3.6 Describe series and parallel connections involving passive electronic components.	• White Board • White Board maker • Projector • Internet • Textbooks • Chats	• Identify passive and active electronic components • Read and interpret passive and active electronic component symbols.	• Guide the students in identifying passive and active electronic components. • Guide the students in reading and interpreting passive and active components symbols on circuit diagrams.	• PCB's • Electrical technical documentation. • Passive and active components (resistors, capacitors and diodes)

GENERAL OBJECTIVE 4.0: Identify electronic components						
Week	**Specific Learning Outcome**	**Teachers Activities**	**Learning Resources**	**Specific Learning Outcome**	**Teachers Activities**	**Learning Resources**
11-12	4.1 Define electrical resistance. 4.2 Describe resistivity of materials. 4.3 Explain types of resistors. 4.4 Identify various symbols used to represent resistors. 4.5 Explain resistor color coding. 4.6 Explain different resistor connections (series, parallel and combined).	4.1 Explain electrical resistance. 4.2 Describe the resistivity of different electrical materials. 4.3 Explain in detail the types of resistors. 4.4 Identify various symbols used to represent resistors. 4.5 Explain resistor color coding techniques. 4.6 Explain series, parallel and combined connections of resistors.	• White Board • White Board maker • Projector • Internet • Textbooks	• Carry out experiments to investigate how the resistance of the wire depends on its length. • Carry out experiments to investigate how resistance varies in series and parallel connections. • Carry out experiments to measure voltages on different resistor circuit connections.	• Guide the students to investigate how the resistance of the wire varies with length • Guide the students to investigate how the total resistance varies in series and parallel connections. • Guide the students to determine voltages on the different resistor circuit connections.	• Voltmeter • Ammeter • Multimeter • DC power supply • Electronic breadboards • Different Resistors • Switches • Wire with no insulation/jumper wires • Crocodile clips • Meter rule • Connecting leads • Tape
13-15	4.7 Explain what a capacitor is. 4.8 Explain the symbols used to represent various types of capacitors. 4.9 Explain capacitance of a capacitor.	4.7 Explain the term capacitor. 4.8 Describe the symbols of various types of capacitors. 4.9 Explain	• White Board • White Board maker • Projector • Internet • Textbooks	• Demonstrate the connection of capacitors in series and parallel	• Guide the students to demonstrate the connection of capacitors in series and	• DC power supply • Analogue Multimeter • Digital Multimeter

	4.10 Discuss capacitor in DC circuit (charging and discharging). 4.11 Explain capacitor codes. 4.12 Describe connection of capacitors in series and parallel.	capacitance of a capacitor. 4.10 Explain the function of a capacitor in DC circuit. 4.10. Discuss the various types of capacitor codes. 4.11. Explain connection of capacitors in series and parallel.			parallel	• Capacitors • Connecting leads

<table>
<tr><td colspan="5">PROGRAMME: NATIONAL TECHNICAL CERTIFICATE IN INDUSTRIAL ELECTRONICS</td></tr>
<tr><td colspan="3">MODULE: Electrical and Electronics Principles II</td><td colspan="2">COURSE CODE: CIE 121</td><td>CONTACT HOURS:</td></tr>
<tr><td>YEAR: 1</td><td>TERM: 2</td><td colspan="2">PRE: REQUISITE: Term 1 NTC 1</td><td colspan="2">Theoretical: 24 Hours Practical: 24 Hours</td></tr>
<tr><td colspan="6">GOAL: This module is designed to introduce the trainees to Electronics and Electrical Principles.</td></tr>
<tr><td colspan="6">GENERAL OBJECTIVES:

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

1.0 Identify electronic components.
2.0 Use basic measuring instruments.
3.0 Use Oscilloscope to display signals.</td></tr>
</table>

PROGRAMME: NATIONAL TECHNICAL CERTIFICATE IN INDUSTRIAL ELECTRONICS					
MODULE: Electrical and Electronics Principles II				**COURSE CODE: CIE 121**	**CONTACT HOURS:**
YEAR: 1	**TERM:** 2	**PRE: REQUISITE: Term 1 NTC 1**		**Theoretical:** 24 Hours **Practical:** 24 Hours	
GOAL: This module is designed to introduce the trainees to Electronics and Electrical Principles.					
Theoretical Content				**Practical Content**	
GENERAL OBJECTIVE 1.0: Identify electronic components.					
Week	**Specific Learning Outcome**	**Teachers Activities**	**Learning Resources**	**Specific Learning Outcome**	**Teachers Activities**	**Learning Resources**
1-4	1.1. Define PN junction diode. 2.2. Describe the P and N type of materials. 1.3. Describe how a PN junction is formed. 1.4. Sketch the schematic symbol of a diode. 1.5. Identify the terminals (polarity) of the diodes.	1.1. Explain PN junction diode with appropriate diagram. 1.2. Explain the P and N type of materials. 1.3. Describe how to form PN junction material. 1.4. Show how to sketch the schematic symbol of a diode. 1.5. Describe the terminals (polarity) of the diode.	• White Board • White Board maker • Projector • Internet • Textbooks	• Demonstrate how to identify the terminal of a PN junction diode. • Demonstrate how to use a multimeter to determine the working condition of a diode.	• Guide the student to identify the terminal of a PN junction diode. • Guide the student to use a multimeter to determine the working condition of a diode.	• DC power supply • Analogue Multimeter • Digital Multimeter • Diodes • Connecting leads • Breadboards
GENERAL OBJECTIVE 2.0: Use basic measuring instruments						
Week	**Specific Learning Outcome**	**Teachers Activities**	**Learning Resources**	**Specific Learning Outcome**	**Teachers Activities**	**Learning Resources**
5-9	2.1. Describe the basic functions of a multimeter. 2.2. Explain how to carry out measurements using a multimeter. 2.3. Differentiate between analogue and digital multimeters	2.1. Discuss the measurement of electrical quantities using a multimeter. 2.2. Describe how to carry out measurements	• White Board • White Board maker • Projector • Internet • Textbooks	• Use a multimeter to measure voltage, current and resistance	• Guide the student to use a multimeter to measure voltage, current and resistance	• DC power supply • Multimeter • Connecting leads • Resistors

		using a multimeter. 2.3. Explain the difference between analogue and digital multimeter.s				
10-15	2.4. Describe the basic functions of an Oscilloscope. 2.5. Explain how to carry out measurements using an Oscilloscope. 2.6 Explain Kirchhoff Laws. 2.7 Calculate loop currents. 2.8 Calculate branch currents. 2.9 Determine Electromotive force (EMF) and potential difference (PD).	2.4. Describe the basic function of the major control nobs of an Oscilloscope. 2.5. Describe how to carry out measurements using an Oscilloscope. 2.2 Explain Kirchhoff Laws (KCL & KVL). 2.3 Explain how to calculate loop currents. 2.4 Explain how to calculate branch currents. 2.9 Explain how to determine EMF and PD.	• White Board • White Board maker • Projector • Internet • Textbooks	• Use an Oscilloscope to display signals	• Guide the student to use an Oscilloscope to display signals	• DC power supply • Multimeter • Connecting leads • Resistors • Oscilloscope

<table>
<tr><td colspan="4">PROGRAMME: NATIONAL TECHNICAL CERTIFICATE IN INDUSTRIAL ELECTRONICS</td></tr>
<tr><td colspan="3">MODULE: Analogue Electronics</td><td>COURSE CODE: CIE 122 | CONTACT HOURS:</td></tr>
<tr><td>YEAR: 1</td><td>TERM: 2</td><td>PRE: REQUISITE: Term 1 NTC 1</td><td>Theoretical: 36 Hours
Practical: 48 Hours</td></tr>
<tr><td colspan="4">GOAL: This module is designed to acquaint the trainees with the basic concept of analogue electronics</td></tr>
<tr><td colspan="4">GENERAL OBJECTIVES:

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

1.0 Analyse basic analogue circuits
2.0 Understand transistor operation and applications.
3.0 Design simple analogue amplifier circuits.</td></tr>
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PROGRAMME: NATIONAL TECHNICAL CERTIFICATE IN INDUSTRIAL ELECTRONICS						
MODULE: Analogue Electronics				**COURSE CODE: CIE 122**		**CONTACT HOURS:**
YEAR: 1	**TERM:** 2	**PRE: REQUISITE: Term 1 NTC 1**		**Theoretical:** 36 Hours **Practical:** 48 Hours		
GOAL: This module is designed to acquaint the trainees with the basic concepts of analogue electronics						
Theoretical Content				**Practical Content**		
GENERAL OBJECTIVE 1.0: Analyze basic analogue circuits.						
Week	**Specific Learning Outcome**	**Teachers Activities**	**Learning Resources**	**Specific Learning Outcome**	**Teachers Activities**	**Learning Resources**
1-3	1.1 Describe an amplifier circuit. 1.2 Describe the configurations of basic amplifier circuit. 1.3 Describe the basic operational amplifiers. 1.4 Sketch the symbol of operational amplifiers. 1.5 Explain the principles of operation of voltage amplifier. 1.6 Explain the configurations of operational amplifier (OP-AMPs).	1.1. Explain the basics of an amplifier. 1.2. Explain basic transistor amplifier. configurations 1.3. Explain the basic operational amplifiers. 1.4. Sketch the symbol of an operational amplifier. 1.5. Explain how to operate op-amp as a voltage amplifier. 1.6. Explain the various configurations of operational amplifier (comparator, inverter, differential, summer, subtractor etc.)	• White Board • White Board maker • Projector • Internet • Textbooks	• Carry out experiments to use op-amp as a voltage amplifier. • Perform experiments on basic configurations (CC, CB, CE). • Demonstrate how to configure Operational amplifier as a Comparator.	• Guide the student to use op-amp as a voltage amplifier. • Guide the student to perform transistor voltage and audio amplifiers. • Guide the student to configure Operational amplifier as a Comparator.	• DC power supply • Multimeter • Connecting leads • Resistors • op-amp • capacitors • transistors • Speaker

4-6	1.7 Define a filter. 1.8 Describe the basic electronic filter. 1.9 Explain the types of filters used in an electronics circuit. 1.10 Explain the following terms: a. Quality Factor; b. Bandwidth; c. Decibel; d. Discrimination; e. Attenuation; f. Frequency cutoff;	1.7. Define a filter. 1.8. Explain the basic electronic filters. 1.9. Explain the various types of filters in an electronics circuit. 1.10. Explain Quality Factor, Bandwidth, Decibel, Discrimination, attenuation and Frequency cutoff as feature of filters.	• White Board • White Board maker • Projector • Internet • Textbooks			
GENERAL OBJECTIVE 2.0: Understand transistor operation and applications.						
Week	**Specific Learning Outcome**	**Teachers Activities**	**Learning Resources**	**Specific Learning Outcome**	**Teachers Activities**	**Learning Resources**
7-11	2.1 Explain the term transistor. 2.2. Explain the operation of a PNP and NPN transistors. 2.3 Describe types of transistors. 2.4. Discuss biasing techniques of transistors. 2.5. Discuss transistor's configurations. 2.6. Explain the transistor circuit applications. 2.7. Define important parameters of a transistor.	2.1 Describe the term transistors. 2.2. Explain the working principles of a transistor. using NPN as an example. 2.3 Discuss transistor types. 2.4. Explain the biasing techniques of a transistor.	• White Board • White Board maker • Projector • Internet • Textbooks	• Measure transistor parameters using a multimeter. • Build a simple transistor circuit with resistors and LEDs to demonstrate switching and amplification.	• Guide the students to measure transistor parameters using a multimeter. • Guide the students to build a simple transistor circuit with resistors and LEDs to demonstrate	• DC power supply • Multimeter • Connecting leads • Resistors • Transistors • LED • Switch

		2.5. Discuss the Configuration of Transistors 2.6. Discuss the Applications of the Transistor Circuit. 2.7. Define the important Parameters of a transistor			switching and amplification	
GENERAL OBJECTIVE 3.0: Design simple analogue amplifier circuits						
Week	**Specific Learning Outcome**	**Teachers Activities**	**Learning Resources**	**Specific Learning Outcome**	**Teachers Activities**	**Learning Resources**
12-15	3.1 Describe the design of a single small transistor audio signal amplifier. 3.2 Describe the design of a "class A" power amplifier.	3.1 Explain the design of a signal transistor audio amplifier. 3.2 Explain the design of a "class A" amplifier.	• White Board • White Board maker • Projector • Internet • Textbooks	• Build a single transistor audio signal amplifier. • Build a simple power amplifier.	• Guide the students to build a single transistor amplifier • Guide the students to build a simple class A power amplifier.	• NPN transistor, Resistors, Power supply, Capacitors

<table>
<tr><td colspan="4">PROGRAMME: NATIONAL TECHNICAL CERTIFICATE IN INDUSTRIAL ELECTRONICS</td></tr>
<tr><td colspan="3">MODULE: Digital Electronics I</td><td>COURSE CODE: CIE 133</td><td>CONTACT HOURS:</td></tr>
<tr><td>YEAR: 1</td><td>TERM: 3</td><td>PRE: REQUISITE: Term 2 NTC 1</td><td colspan="2">Theoretical: 36 Hours
Practical: 48 Hours</td></tr>
<tr><td colspan="5">GOAL: This module is designed to acquaint the trainees with the basic concept of Digital electronics</td></tr>
<tr><td colspan="5">GENERAL OBJECTIVES:

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

1.0 Understand Binary and Hexadecimal Systems.
2.0 Understand Boolean Algebra.
3.0 Understand Logic Gates.</td></tr>
</table>

PROGRAMME: NATIONAL TECHNICAL CERTIFICATE IN INDUSTRIAL ELECTRONICS						
MODULE: Digital Electronics I				**COURSE CODE: CIE 133**		**CONTACT HOURS:**
YEAR: 1	**TERM:** 3	**PRE: REQUISITE: Term 2 NTC 1**	**Theoretical:** 36 Hours **Practical:** 48 Hours			
GOAL: This module is designed to acquaint the trainees with the basic concept of Digital electronics						
Theoretical Content				**Practical Content**		
GENERAL OBJECTIVE 1.0: Understand Binary and Hexadecimal Systems.						
Week	**Specific Learning Outcome**	**Teachers Activities**	**Learning Resources**	**Specific Learning Outcome**	**Teachers Activities**	**Learning Resources**
5-8	1.1. Describe binary digits. 1.2. Describe binary arithmetic. 1.3. Describe the conversion. between binary and decimal. 1.4. Describe binary representation of data. 1.5. State the applications of binary numbers. 1.6. Describe hexadecimal digits. 1.7. Describe the conversion between hexadecimal and decimal number systems. 1.8. Describe the conversion between binary and hexadecimal systems. 1.9. Explain the applications of hexadecimal numbers.	1.1. Explain binary digits. 1.2. Explain binary arithmetic. 1.3. Explain the conversion between binary and decimal. 1.4. Explain binary representation of data. 1.5. Explain with examples the applications of binary numbers. 1.6. Explain hexadecimal digits. 1.7. Explain the conversion between hexadecimal and decimal.	• White Board • White Board maker • Projector • Internet • Textbooks			

		1.8. Explain the conversion between binary and hexadecimal. 1.9. Explain with example the applications of hexadecimal numbers.				
GENERAL OBJECTIVE 2.0: Understand Boolean Algebra						
Week	**Specific Learning Outcome**	**Teachers Activities**	**Learning Resources**	**Specific Learning Outcome**	**Teachers Activities**	**Learning Resources**
9	2.1 Describe Boolean variables and constants. 2.2 Describe Boolean logic operations. 2.3 Describe Boolean laws and rules.	2.1 Explain Boolean variables and constants. 2.2 Explain Boolean logic operations. 2.3 Explain Boolean laws and rules.	• White Board • White Board maker • Projector • Internet • Textbooks			
GENERAL OBJECTIVE 3.0: Understand Logic Gates						
Week	**Specific Learning Outcome**	**Teachers Activities**	**Learning Resources**	**Specific Learning Outcome**	**Teachers Activities**	**Learning Resources**
11-15	2.1. Explain digital electronics. 2.2. State the importance of logic in computers and electronics. 2.3. Explain the basic operation of logic gates. 2.4 Draw logic gates symbols.	2.1. Explain the concept digital electronics. 2.2. Explain the importance of logic in computers and electronics. 2.3. Describe the basic operation of	• White Board • White Board maker • Projector • Internet • Textbooks	• Construct a simple AND gate using basic electronics components. • Construct a simple NOT gate using basic electronic components. • Construct a simple	• Guide students to construct a simple AND gate using basic electronics components. • Guide	• DC power supply • Multimeter • Resistors • Transistors

		logic gates. 2.4 Discuss symbols of various logic gates.		OR gate using basic electronic components.	students to construct a simple NOT gate using basic electronic components • Guide students to construct a simple OR gate using basic electronic components.	

<table>
<tr><td colspan="4">PROGRAMME: NATIONAL TECHNICAL CERTIFICATE IN INDUSTRIAL ELECTRONICS</td></tr>
<tr><td colspan="3">MODULE: Digital Electronics II</td><td>COURSE CODE: CIE 213</td><td>CONTACT HOURS:</td></tr>
<tr><td>YEAR: 2</td><td>TERM: 1</td><td>PRE: REQUISITE: NTC 1</td><td colspan="2">Theoretical: 24 Hours
Practical: 24 Hours</td></tr>
<tr><td colspan="5">GOAL: This module is designed to acquaint the trainees with the basic concept of Digital electronics</td></tr>
<tr><td colspan="5">GENERAL OBJECTIVES:

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

1.0 Understand Logic Gates.
2.0 Describe Microcontrollers.
3.0 Describe Microprocessors.</td></tr>
</table>

PROGRAMME: NATIONAL TECHNICAL CERTIFICATE IN INDUSTRIAL ELECTRONICS						
MODULE: Digital Electronics II				**COURSE CODE: CIE 213**		**CONTACT HOURS:**
YEAR: 2	**TERM:** 1	**PRE: REQUISITE: NTC 1**		**Theoretical:** 24 Hours **Practical:** 24 Hours		
GOAL: This module is designed to acquaint the trainees with the basic concept of Digital electronics						
Theoretical Content				**Practical Content**		
GENERAL OBJECTIVE 1.0: Understand Logic Gates						
Week	**Specific Learning Outcome**	**Teachers Activities**	**Learning Resources**	**Specific Learning Outcome**	**Teachers Activities**	**Learning Resources**
1-5	1.1 Define truth table. 1.2 Discuss the truth table for AND gate. 1.3 Discuss the truth tables for OR gate. 1.4 Discuss the truth table for NOT gate. 1.5 Discuss the Truth table for NAND gate. 1.6 Discuss the Truth table for NOR gate. 1.7 Discuss the Truth table for XOR gate. 1.8 Discuss the Truth tables for XNOR gate.	1.1 Explain Truth table. 1.2 Explain the Truth tables for AND gate. 1.3 Explain the Truth table for OR gate. 1.4 Explain the Truth tables for NOT gate. 1.5. Explain the Truth table for NAND gate. 1.6 Explain the Truth tables for NOR gate. 1.7 Explain the Truth tables for XOR gate. 1.8 Explain the Truth tables for XNOR gate.	• White Board • White Board maker • Projector • Internet • Textbooks	• Demonstrate a truth table for AND gate using basic electronics component. • Demonstrate a truth table for NOT gate using basic electronic components • Demonstrate a truth table for OR gate using basic electronic components.	• Guide students to demonstrate a truth table for AND gate using basic electronic components. • Guide students to demonstrate a truth table for NOT gate using basic electronic components • Guide students to demonstrate a truth table for OR gate using basic electronics component	• DC power supply • Multimeter • Resistors • Transistors

GENERAL OBJECTIVE 2.0: Describe Microcontrollers						
Week	**Specific Learning Outcome**	**Teachers Activities**	**Learning Resources**	**Specific Learning Outcome**	**Teachers Activities**	**Learning Resources**
6-10	2.1 Define microcontroller. 2.2 State the components of a microcontroller. 2.3 State the applications of microcontrollers. 2.4 Discuss the basic architecture of microcontrollers. 2.5 Explain the types of Microcontrollers.	2.1 Describe microcontroller. 2.2 Discuss the components of a microcontroller. 2.3 Discuss the applications of microcontrollers. 2.4 Explain the basic architecture of microcontrollers. 2.5 Discuss the types of Microcontrollers.	• Whiteboard • Whiteboard maker • Projector • Internet • Textbooks	• Identify a microcontroller	• Guide the student to Identify a microcontroller	• A microcontroller
GENERAL OBJECTIVE 3.0: Describe Microprocessors						
Week	**Specific Learning Outcome**	**Teachers Activities**	**Learning Resources**	**Specific Learning Outcome**	**Teachers Activities**	**Learning Resources**
11-15	3.1 Define Microprocessor. 3.2 Describe the basic working principle of a Microprocessor. 3.3 Describe the evolution of Microprocessors (1st to 5th Generation). 3.4 Describe Memory hierarchy in Microprocessors. 3.5 Describe the types of Microprocessors.	3.1 Explain a Microprocessor. 3.2 Explain the basic working principle of Microprocessor. 3.3 Explain the evolution of Microprocessors. 3.4 Discuss the various memory hierarchies in Microprocessors. 3.5 Discuss the types of Microprocessors.	• Whiteboard • Whiteboard maker • Projector • Internet • Textbooks	• Identify a Microprocessor	• Guide the students to identify a Microprocessor	• A Microprocessor

<table>
<tr><td colspan="4">PROGRAMME: NATIONAL TECHNICAL CERTIFICATE IN INDUSTRIAL ELECTRONICS</td></tr>
<tr><td colspan="3">MODULE: Power Electronics Devices</td><td>COURSE CODE: CIE 214</td><td>CONTACT HOURS:</td></tr>
<tr><td>YEAR: 2</td><td>TERM: 2</td><td>PRE: REQUISITE: Term 1 NTC 2</td><td colspan="2">Theoretical: 24 Hours
Practical: 24 Hours</td></tr>
<tr><td colspan="5">GOAL: This module is designed to introduce the trainees to Power Electronics Devices</td></tr>
<tr><td colspan="5">GENERAL OBJECTIVES:

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

1.0 Explain the principles and operation of power electronic devices.
2.0 Describe the characteristics and applications of different power electronic devices.
3.0 Analyse the operation of power electronic circuits and systems.
4.0 Design a voltage rectifier.
5.0 Understand different types of transistors.
6.0 Understand metal oxide field effect transistor.
7.0 Understand thyristors.</td></tr>
</table>

PROGRAMME: NATIONAL TECHNICAL CERTIFICATE IN INDUSTRIAL ELECTRONICS					
MODULE: Power Electronics Devices			**COURSE CODE: CIE 214**	**CONTACT HOURS:**	
YEAR: 2	**TERM:** 2	**PRE: REQUISITE: Term 1 NTC 1**	**Theoretical:** 24 Hours **Practical:** 24 Hours		
GOAL: This module is designed to introduce the trainees to Power Electronics Devices					
Theoretical Content			**Practical Content**		
GENERAL OBJECTIVE 1.0: Explain the principles and operation of power electronic devices					
Week	**Specific Learning Outcome**	**Teachers Activities**	**Learning Resources**	**Specific Learning Outcome**	**Teachers Activities**	**Learning Resources**
1-3	1.1 Describe the operation of power electronic devices. 1.2 Show power electronic devices components. 1.3 Identify power electronic device components. 1.4 Describe the importance of power electronic devices. 1.5 Analyze the operation of power electronic circuits.	1.1 Explain the operation of power electronic devices 1.2 Explain power electronic devices components 1.3 Explain power electronic device components 1.4 Describe the importance of power electronic devices 1.5 Analyze the operation of power electronic circuits	• White Board • White Board maker • Projector • Internet • Textbooks • Charts			
GENERAL OBJECTIVE 2.0: Describe the Characteristics and application of power electronics						
Week	**Specific Learning Outcome**	**Teachers Activities**	**Learning Resources**	**Specific Learning Outcome**	**Teachers Activities**	**Learning Resources**
4-7	2.1 Describe the characteristics of power electronic devices. 2.2 Describe the applications of power electronics.	2.1 Explain the characteristics of power electronic devices voltage and	• Whiteboard • Whiteboard maker • Projector	• Use power electronics data sheet. • Identify power	• Demonstrate how to Read power electronics	• Data Sheet • Text book • Charts • board

	2.3 Read power electronics data sheet. 2.4 Recognize power electronic devices.	current ratings, switching times, and power losses. 2.2 Explain the applications of power electronics, e.g power supplies, motor drives, renewable energy systems, and electric vehicles. 2.3 Explain power electronics data sheet. 2.4 Explain how to recognize power electronic devices.	• Internet • Textbooks • Charts • Data sheet	electronic devices.	data sheet. • Guide the students on how to identify power electronic devices.	• BJT, FET,JFET
GENERAL OBJECTIVE 3.0: Analyse power electronic circuits operation						
Week	**Specific Learning Outcome**	**Teachers Activities**	**Learning Resources**	**Specific Learning Outcome**	**Teachers Activities**	**Learning Resources**
8-11	3.1 Define rectifiers. 3.2 Define converters. 3.3 Discuss DC-DC converters. 3.4 Discuss AC-DC converters. 3.5 Discuss DC-AC converters. 3.6 Define pulse width modulation (PWM). 3.7 Describe voltage, current and power waveforms.	3.1 Explain rectifiers 3.2 Explain Converters 3.3 Explain DC-DC converters 3.4 Explain AC-DC converters 3.5 Explain DC-AC converters 3.6 Explain pulse width modulation (PWM 3.7 Explain voltage, current and power waveform.	• Whiteboard • Whiteboard maker • Projector • Internet • Textbooks			

GENERAL OBJECTIVE 4.0: Designing of Voltage Rectifier						
Week	**Specific Learning Outcome**	**Teachers Activities**	**Learning Resources**	**Specific Learning Outcome**	**Teachers Activities**	**Learning Resources**
12-15	4.1 Identify the components of voltage rectifier. 4.2 Discuss types of voltage rectification. 4.3 Discuss diode as a component of voltage rectifier. 4.4 Discuss full-wave rectification (centre tapped, bridge). 4.5 Discuss the concept of ripple filtering in full-wave rectification. 4.6 Design a half wave voltage rectifier. 4.7 Design a full wave voltage rectifier.	4.1 Explain the components of voltage rectifier 4.2 Discuss types of voltage rectification 4.3 Discuss diode as a component of voltage rectifier 4.4 Discuss full-wave rectification (centre tapped, bridge) 4.5 Discuss the concept of ripple filtering in full-wave rectification 4.6 Explain half wave voltage rectifier 4.7 Explain full wave voltage rectifier	• Whiteboard • Whiteboard maker • Projector • Internet • Textbooks	• Design a simple full-wave rectifier • Build and test a full-wave rectifier with ripple filtering	• Guide the student to design a simple full-wave rectifier • Guide the student to build and test a full-wave rectifier with ripple filtering	• AC power source • Low voltage transformers • Diodes • Bread board • Capacitors • Connecting leads • Switch

<table>
<tr><td colspan="4">PROGRAMME: NATIONAL TECHNICAL CERTIFICATE IN INDUSTRIAL ELECTRONICS</td></tr>
<tr><td colspan="2">MODULE: Power Semiconductor Devices</td><td>COURSE CODE: CIE 225</td><td>CONTACT HOURS:</td></tr>
<tr><td>YEAR: 2</td><td>TERM: 2</td><td>PRE: REQUISITE: TERM 1 NTC 2</td><td>Theoretical: 36 Hours
Practical: 48 Hours</td></tr>
<tr><td colspan="4">GOAL: This module is designed to introduce the trainees to power semiconductor devices</td></tr>
<tr><td colspan="4">GENERAL OBJECTIVES:

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

1.0 Understand what semiconductor devices are.
2.0 Understand operation of semiconductors devices.
3.0 Characteristics of semiconductor devices.</td></tr>
</table>

PROGRAMME: NATIONAL TECHNICAL CERTIFICATE IN INDUSTRIAL ELECTRONICS						
MODULE: Power Semiconductor Devices				**COURSE CODE: CIE 225**		**CONTACT HOURS:**
YEAR: 2	**TERM:** 2	**PRE: REQUISITE: TERM 1 NTC 2**		**Theoretical:** 36 Hours **Practical:** 48 Hours		
GOAL: This module is designed to introduce the trainees to Power Semiconductor Devices						
Theoretical Content				**Practical Content**		
GENERAL OBJECTIVE 1.0: Understand semiconductor devices						
Week	**Specific Learning Outcome**	**Teachers Activities**	**Learning Resources**	**Specific Learning Outcome**	**Teachers Activities**	**Learning Resources**
1	1.1. Define what is semiconductor. 1.2. List different types of semiconductor devices. 1.3. Discuss the function of semiconductor devices. 1.4. State basic application of semiconductor devices.	1.1 Explain semiconductor. 1.1. Explain different types of semiconductor devices. 1.2. Explain the biasing of junction field effect transistor (JFET). 1.3. Explain the basic application of semiconductor devices.	• Whiteboard • Whiteboard maker • Projector • Internet • Textbooks			
GENERAL OBJECTIVE 2.0: Understand the operation of semiconductor devices						
Week	**Specific Learning Outcome**	**Teachers Activities**	**Learning Resources**	**Specific Learning Outcome**	**Teachers Activities**	**Learning Resources**
2-3	2.1 Describe basic operation of semiconductor devices. 2.2 Describe the basic structure of semiconductor devices (PN Junction).	2.1 Explain basic operation of semiconductor devices of MOSFET.	• Whiteboard • Whiteboard maker • Projector • Internet	• Build and test a switching circuit using BTJ. • Build and test a switching circuit	• Guide the student to build and test a switching circuit using	• Variable DC power supply • Multimeters • BJT • FET

	2.3 Discuss the operating principles of semiconductor devices. 2.4 Discuss the characteristics of semiconductor devices. 2.5 Describe the biasing methods of semiconductor devices. 2.6 Demonstrate the work of semiconductor devices as a switch.	2.2 Explain the basic structure of semiconductor devices (PN Junction). 2.3 Explain the operating principle of semiconductor. 2.4 Explain the characteristics of semiconductor devices. 2.5 Explain the biasing methods of semiconductor devices. 2.6 Demonstrate semiconductor devices as a switch.	• Textbooks	using FET. • Build and test a switching circuit using JFET. • Build and test a switching circuit using MOSFET. • Illustrate the biasing methods of semiconductor.	BJT • Guide the student to build and test a switching circuit using FET • Guide the student to build and test a switching circuit using JFET • Guide the student to build and test a switching circuit using MOSFET	• JFET • MOSFETs • Bread board • Resistors • Capacitors
GENERAL OBJECTIVE 3.0: Understand characteristics of semiconductor devices.						
Week	**Specific Learning Outcome**	**Teachers Activities**	**Learning Resources**	**Specific Learning Outcome**	**Teachers Activities**	**Learning Resources**
4-5	3.1 Discuss the characteristics of semiconductor devices. 3.2 Discuss conductivity of semiconductor devices. 3.3 Discuss the voltage and current characteristics of semiconductor devices.	3.1 Explain the characteristics of semiconductor devices. 3.2 Explain conductivity of semiconductor	• Whiteboard • Whiteboard maker • Projector • Internet • Textbooks	• Build and test a Phase-controlled rectifier circuit using SCR • Build and test simple speed control circuits for a	• Guide the students to build and test a Phase-controlled rectifier using SCR	• Variable DC power supply • Multimeters • SCR • TRIAC • Bread board • Resistors

	3.4 Illustrate the switching speed of different semiconductor devices. 3.5 Discuss the application of semiconductor devices in power supply.	devices. 3.3 Explain the voltage and current characteristics of semiconductor devices. 3.4 Explain the switching speed of different semiconductor devices. 3.5 Explain the application of semiconductor devices in power supply.		fan using TRIAC.	• Guide the students to build and test a simple speed control circuits for a fan using TRIAC	• Capacitors
	GENERAL OBJECTIVE 4.0: Understand different types of Transistors.					
6-7	4.1 Discuss the term transistor. 4.2 Discuss different types of transistor. 4.3 Describe the basic structure of transistors. 4.4 Discuss the operating Principle of BJT and FET. 4.5 Discuss the operating Principle of JFET. 4.6 Discuss the I-V Characteristics of JFET. 4.7 Discuss biasing of BJT and FET. 4.8 Discuss the stability and	4.1 Explain the term transistors. 4.2 Explain different types of transistor. 4.3 Explain the basic structure of a transistor. 4.4 Explain the operating Principle of BJT and FET. 4.5 Discuss the	• Whiteboard • maker • Projector • Internet • Textbooks	• Build and test a switching circuit using BJT • Build and test a FET switching circuit • Measure the characteristics of BJT switching circuit	Guide the student to build and test a switching circuit using BJT	• Variable DC power supply • Multimeters • JFETs • Bread board • Resistors • Capacitors

	performance. 4.9 Discuss BJT and FET Amplifier Configurations.	operating Principle of BJT and FET. 4.6 Explain the I-V Characteristics of BJT and FET. 4.7 Explain the biasing of BJT and FET. 4.8 Explain the stability and performance. 4.9 Explain BJT and FET Amplifier Configurations				
	GENERAL OBJECTIVE 5.0: Understand Metal Oxide Field Effect Transistor (MOSFETS					
8-9	5.1 Describe the basic Structure of MOSFET. 5.2 Explain the operating Principle of MOSFET. 5.3 Discuss the I-V Characteristics of MOSFET. 5.4 Explain the biasing of MOSFET. 5.5 Discuss MOSFET as a Switch 5.6 Discuss the application of MOSFETs in power electronics.	5.1 Explain the basic Structure of MOSFET. 5.2 Discuss the operating Principle of MOSFET. 5.3 Explain the I-V Characteristics of MOSFET. 5.4 Explain the biasing of MOSFET. 5.5 Explain MOSFET as a Switch.	• Whiteboard • Whiteboard maker • Projector • Internet • Textbooks	Build and test a switching circuit using MOSFET	Guide the student to build and test a switching circuit using MOSFET	• Variable DC power supply • Multimeters • MOSFETs • Bread board • Resistors • Capacitors

		5.6 Explain the application of MOSFETs in power electronics.				
	GENERAL OBJECTIVE 6.0: Understand Thyristors					
10-11	6.1 Explain a thyristor. 6.2 Discuss the four-layer. structure of a thyristor. 6.3 State the types of thyristors. .	6.1 Explain what is Thyristor. 6.2 Explain the four-layer structure of a thyristor. 6.3 Discuss the types of thyristors.	• Whiteboard • Whiteboard maker • Projector • Internet • Textbooks			
	GENERAL OBJECTIVE 7.0: Describe Silicon Controlled Rectifiers.					
12-13	7.1 Discuss the structure of Silicon-controlled rectifiers (SCR). 7.2 Discuss the basic operation of SCR. 7.3 Explain the characteristics of SCR. 7.4 Discuss the applications of SCR in AC power control.	7.1 Explain the structure of Silicon-controlled rectifiers (SCR). 7.2 Explain the basic operation of SCR. 7.3 Explain the basic characteristics of SCR. 7.4 Explain the applications of SCR in AC Power Control (Phase-controlled rectifiers and motor speed control).	• Whiteboard • Whiteboard maker • Projector • Internet • Textbooks	• Build and test a Phase-controlled rectifier circuit using SCR. • Build and test a simple speed control circuits for a fan using TRIAC	• Guide the student to build and test a Phase-controlled rectifier using SCR. • Guide the student to build and test a simple speed control circuits for a fan using TRIAC	• Variable DC power supply • Multimeters • SCR • TRIAC • Bread board • Resistors • Capacitors

	GENERAL OBJECTIVE 8.0: Understand Triac.					
14-15	8.1 Discuss the structure of Triac. 8.2 Discuss the basic operation of Triac. 8.3 Explain the characteristics of Triac. 8.4 Discuss the applications of Triac in AC Power electronic systems.	8.1 Explain the structure of Triac. 8.2 Explain the basic operation of Triac. 8.3 Explain the characteristics of Triacs. 8.4 Explain the applications of Triac in AC Power electronic systems.	• Whiteboard • Whiteboard maker • Projector • Internet • Textbooks	• Build and test a Phase-controlled rectifier circuit using SCR. • Build and test a simple speed control circuits for a fan using TRIAC.	• Guide the student to build and test a Phase-controlled rectifier using SCR. • Guide the student to build and test a simple speed control circuits for a fan using TRIAC	• Variable DC power supply • Multimeters • SCR • TRIAC • Bread board • Resistors • Capacitors

<table>
<tr><td colspan="4">PROGRAMME: NATIONAL TECHNICAL CERTIFICATE IN INDUSTRIAL ELECTRONICS</td></tr>
<tr><td colspan="2">MODULE: Applications and Troubleshooting of Power Electronic Systems</td><td>COURSE CODE: CIE 236</td><td>CONTACT HOURS:</td></tr>
<tr><td>YEAR: 2</td><td>TERM: 3</td><td>PRE: REQUISITE: TERM 2 NTC 2</td><td>Theoretical: 24 Hours
Practical: 48 Hours</td></tr>
<tr><td colspan="4">GOAL: This module is designed to acquaint students with understanding of the applications and troubleshooting of power electronic systems</td></tr>
<tr><td colspan="4">GENERAL OBJECTIVES:

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

1.0 Understand low power transformers.
2.0 Understand common faults in power electronics.
3.0 Troubleshoot power electronic circuits.</td></tr>
</table>

PROGRAMME: NATIONAL TECHNICAL CERTIFICATE IN INDUSTRIAL ELECTRONICS						
MODULE: Applications and Troubleshooting of Power Electronic Systems				**COURSE CODE: CIE 236**		**CONTACT HOURS:**
YEAR: 2	**TERM:** 3	**PRE: REQUISITE: TERM 2 NTC 2**		**Theoretical:** 24 Hours **Practical:** 48 Hours		
GOAL: This module is designed to acquaint students with understanding of the applications and troubleshooting of power electronic systems						
Theoretical Content				**Practical Content**		
GENERAL OBJECTIVE 1.0: Understand low power transformers						
Week	**Specific Learning Outcome**	**Teachers Activities**	**Learning Resources**	**Specific Learning Outcome**	**Teachers Activities**	**Learning Resources**
1-5	1.1. Discuss the basic principles of transformers. 1.2. State the types of transformers. 1.3. Discuss the applications of low power transformers. 1.4. Discuss the basic transformer calculations.	1.1. Explain the basic principles of transformers. 1.2. Discuss the types of transformers. 1.3. Explain the applications of low power transformers. 1.4. Explain the basic transformer calculations.	• Whiteboard • Whiteboard maker • Projector • Internet • Textbooks			
GENERAL OBJECTIVE 2.0: Understand common faults in power electronics						
Week	**Specific Learning Outcome**	**Teachers Activities**	**Learning Resources**	**Specific Learning Outcome**	**Teachers Activities**	**Learning Resources**
6-10	2.1. Discuss the signs and symptoms of common faults in power electronics. 2.2. List common faults in power electronics. 2.3. Demonstrate solution to common faults in power electronics.	2.1 Explain the sign and symptoms of common faults in power electronics. 2.2 Discuss common faults in power	• Whiteboard • Whiteboard maker • Projector • Internet • Textbooks	• Carryout diagnosis of finding common fault in power electronic	Guide the students to carryout diagnosis of finding common fault in power electronic	

		electronics. 2.3 Explain solution to common faults in power electronics.				
GENERAL OBJECTIVE 3.0: Troubleshoot Power Electronic Circuits						
Week	**Specific Learning Outcome**	**Teachers Activities**	**Learning Resources**	**Specific Learning Outcome**	**Teachers Activities**	**Learning Resources**
11-15	3.1. Identify common faults in power electronic devices. 3.2. Gather information on the faulty components. 3.3. Isolate the faulty part of the power electronic device. 3.4. Replace or repair the faulty component or modify the circuit to resolve the issue. 3.5. List common power electronic faults.	3.1. Explain common faults in power electronic devices. 3.2. Discuss information on the faulty component. 3.3. Isolate the faulty part of the power electronic device. 3.4. Explain how to repair or replace the faulty component, or modify the circuit to resolve the issue. 3.5 List common power electronic fault	• Whiteboard • Whiteboard maker • Projector • Internet • Textbooks	• Carry out basic diagnosis on a circuit board that contains BJT,JFET, MOSFET and SCR • Illustrate how to isolate the faulty part of the power electronic device	• Guide the students to carry out basic diagnosis on a circuit board that contains BJT, JFET, MOSFET and SCR • Guide the students on how to isolate the faulty part of the power electronic device.	• power source • Multimeters • SCR • JFET • MOSFET • Motherboard • Oscilloscope

<table>
<tr><td colspan="4">PROGRAMME: NATIONAL TECHNICAL CERTIFICATE IN INDUSTRIAL ELECTRONICS</td></tr>
<tr><td colspan="3">MODULE: Basic Instrumentation</td><td>COURSE CODE: CIE 317</td><td>CONTACT HOURS:</td></tr>
<tr><td>YEAR: 3</td><td>TERM: 1</td><td>PRE: REQUISITE: NTC 2</td><td colspan="2">Theoretical: 24 Hours
Practical: 48 Hours</td></tr>
<tr><td colspan="5">GOAL: This module is designed to introduce the trainees to Basic Instrumentation</td></tr>
<tr><td colspan="5">GENERAL OBJECTIVES:

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

1.0 Understand sensors.
2.0 Identify various types of sensors.
3.0 Conduct an experiment to show the operation of a sensor.
4,0 Understand basics of Instrumentation.
5.0 Demonstrate the calibration of a pressure gauge.
6.0 Understand basics of Microprocessor.</td></tr>
</table>

PROGRAMME: NATIONAL TECHNICAL CERTIFICATE IN INDUSTRIAL ELECTRONICS						
MODULE: Basic Instrumentation				**COURSE CODE: CIE 317**		**CONTACT HOURS:**
YEAR: 3	**TERM:** 1	**PRE: REQUISITE: NTC 2**		**Theoretical:** 24 Hours **Practical:** 48 Hours		
GOAL: This module is designed to introduce the trainees to Basic Instrumentation						
Theoretical Content				**Practical Content**		
GENERAL OBJECTIVE 1.0: Understand sensors.						
Week	**Specific Learning Outcome**	**Teachers Activities**	**Learning Resources**	**Specific Learning Outcome**	**Teachers Activities**	**Learning Resources**
1-6	1.1. Define a sensor. 1.2. Discuss basic sensor principles. 1.3. Discuss sensor application. 1.4. Discuss the types of sensors: analogue vs. digital sensors. 1.5. Differentiate between sensor and an actuator. 1.6. Discuss basic sensor principles. 1.7. Discuss the basic components of a sensor. 1.8. Discuss temperature sensors (Thermocouples, Thermistors, Resistance Temperature Detectors (RTDs). 1.9. Discuss pressure sensors (Strain gauges, Capacitive pressure sensors, Piezoelectric sensors). 1.10. Discuss Proximity Sensors (Inductive, capacitive, and ultrasonic sensors).	1.1 Explain a sensor. 1.2 Explain basic sensor principles. 1.3 Explain sensor application. 1.4 Explain the types of sensors: analogue vs. digital sensors. 1.5 Differentiate between sensor and an actuator. 1.6 Explain basic sensor principles. 1.7 Explain the basic components of a sensor. 1.8 Explain temperature sensors (Thermocouples, Thermistors, Resistance Temperature Detectors (RTDs) 1.9 Discuss Pressure Sensors (Strain	• Whiteboard • Whiteboard maker • Projector • Internet • Textbooks	• Identify different sensors. • Carry out a simple experiment to demonstrate the operation of any of the temperature sensors.	• Guide the student to identify different Sensors. • Guide the student to carry out a simple experiment to demonstrate the operation of any of the temperature sensors.	• DC power supply • Multimeters • Sensors • Bread board • Resistors • Capacitor • Connecting leads • Switch

		gauges, Capacitive pressure sensors, Piezoelectric sensors). 1.10 Discuss Proximity Sensors (Inductive, capacitive, and ultrasonic sensors).				
GENERAL OBJECTIVE 2.0: Understand basics of Instrumentation.						
Week	**Specific Learning Outcome**	**Teachers Activities**	**Learning Resources**	**Specific Learning Outcome**	**Teachers Activities**	**Learning Resources**
7-10	2.1 Define Instrumentation as its applies to industry. 2.2. State the importance of Instrumentation to the industry. 2.3. Summarise the applications of instrumentation systems in various industries. 2.4. State the types of Instruments 2.5. Discuss the general measurement process in Instrumentation. 2.6. Differentiate between accuracy and precision in Instrumentation. 2.7. Discuss calibration of instruments.	2.1 Describe Instrumentation as its applies to industry. 2.2. Discuss the importance of Instrumentation to the industry. 2.3. Explain the applications of instrumentation systems in various industries. 2.4. Discuss the types of Instruments. 2.5. Explain the general measurement process in Instrumentation. 2.6. Differentiate between accuracy and precision in	• Whiteboard • Whiteboard maker • Projector • Internet • Textbooks	• Demonstrate the calibration of a pressure gauge that has a calibrating nob on its transmitter	• Guide the student to demonstrate the calibration of a pressure gauge that has a calibrating nob on its transmitter	• Pressure gauge • Screwdriver

		Instrumentation. 2.7. Discuss calibration of instruments.				
GENERAL OBJECTIVE 3.0: Understand Basics of Microprocessor						
Week	**Specific Learning Outcome**	**Teachers Activities**	**Learning Resources**	**Specific Learning Outcome**	**Teachers Activities**	**Learning Resources**
10 - 15	3.1. Define microprocessors. 3.2. State types of microprocessors. 3.3. Discuss the applications of microprocessors in modern devices. 3.4. Describe the microprocessor architecture.	3.1. Explain microprocessors 3.2. Discuss types of microprocessors 3.3. Explain the applications of microprocessors in modern devices 3.4. Explain the Microprocessor Architecture	• Whiteboard • Whiteboard maker • Projector • Internet • Textbooks			

<table>
<tr><td colspan="4">PROGRAMME: NATIONAL TECHNICAL CERTIFICATE IN INDUSTRIAL ELECTRONICS</td></tr>
<tr><td colspan="3">MODULE: Microprocessors and PLCs in Industrial Automation</td><td>COURSE CODE: CIE 328</td><td>CONTACT HOURS:</td></tr>
<tr><td>YEAR: 3</td><td>TERM: 2</td><td>PRE: REQUISITE: TERM 1 NTC 3</td><td colspan="2">Theoretical: 36 Hours
Practical: 48 Hours</td></tr>
<tr><td colspan="5">GOAL: This module is designed to introduce the trainees to the applications of microprocessors and PLCs in industrial automation</td></tr>
<tr><td colspan="5">GENERAL OBJECTIVES:

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

1.0 Understand basics of programmable logic controllers (PLCs).
2.0 Identify components of PLC hardware.
3.0 Understand Basic Microprocessor Programming.
4.0 Design a simple digital clock using timers and counters.
5.0 Construct a simple digital clock designed in 4.0.</td></tr>
</table>

PROGRAMME: NATIONAL TECHNICAL CERTIFICATE IN INDUSTRIAL ELECTRONICS						
MODULE: Microprocessors and PLCs in Industrial Automation				**COURSE CODE: CIE 328**		**CONTACT HOURS:**
YEAR: 3	**TERM:** 2	**PRE: REQUISITE: TERM 1 NTC 3**		**Theoretical:** 36 Hours **Practical:** 48 Hours		
GOAL: This module is designed to introduce the trainees to the applications of microprocessors and PLCs in industrial automation						
Theoretical Content				**Practical Content**		
GENERAL OBJECTIVE 1.0: Understand basics of PLCs						
Week	**Specific Learning Outcome**	**Teachers Activities**	**Learning Resources**	**Specific Learning Outcome**	**Teachers Activities**	**Learning Resources**
1-7	1.1. Define PLCs. 1.2. State the applications of PLCs in industrial automation. 1.3. Differentiate between Compact and Modular PLCs. 1.4. Discuss the benefits of PLCs over mechanical relays. 1.5. Discuss PLC hardware components. 1.6. Discuss the basic PLC I/O Configuration and Interfacing. 1.7. Discuss the basic PLC operation and functions. 1.8. Describe the basic PLC programming languages.	1.1. Explain PLCs. 1.2. Discuss the applications of PLCs in industrial automation. 1.3. Differentiate between Compact and Modular PLCs. 1.4. Explain the benefits of PLCs over mechanical relays. 1.5. Explain PLC hardware components. 1.6. Explain the basic PLC I/O Configuration and Interfacing. 1.7. Explain the basic PLC Operation and	• Whiteboard • Whiteboard maker • Projector • Internet • Textbooks	• Identify each component of PLC hardware	• Guide the student to identify each component of PLC hardware	• PLC Module • Screwdriver

		Functions. 1.8. Explain the basic PLC programming languages.				
GENERAL OBJECTIVE 2.0: Understand Basic Microprocessor Programming						
Week	**Specific Learning Outcome**	**Teachers Activities**	**Learning Resources**	**Specific Learning Outcome**	**Teachers Activities**	**Learning Resources**
8-15	2.1. Explain the basics of writing assembly codes for microprocessors. 2.2. Discuss the use programming tools and simulators for microprocessor programming. 2.3. Explain how input/output operations and interrupts work at the microprocessor level. 2.4 Describe how memory is organized and accessed in microprocessors.	2.1. Explain the basics of writing assembly code for microprocessors. 2.2. Explain the use programming tools and simulators for microprocessor programming 2.3. Explain how input/output operations and interrupts work at the microprocessor level. 2.4 Explain how memory is organized and accessed in microprocessors.	• Whiteboard • Whiteboard maker • Projector • Internet • Textbooks	• Implement a simple digital clock using timers and counters of a microprocessor	• Guide the student to implement a digital clock using timers and counters of a simple microprocess or	• DC power supply • Multimeters • Microprocessor module • Sensors • Bread board • Resistors • Capacitor • Connecting leads • Switch

<table>
<tr><td colspan="4">PROGRAMME: NATIONAL TECHNICAL CERTIFICATE IN INDUSTRIAL ELECTRONICS</td></tr>
<tr><td colspan="2">MODULE: Microprocessors and PLCs in Industrial Automation</td><td>COURSE CODE: CIE 329</td><td>CONTACT HOURS:</td></tr>
<tr><td>YEAR: 3</td><td>TERM: 2</td><td>PRE: REQUISITE: TERM 1 NTC 3</td><td>Theoretical: 24 Hours
Practical: 48 Hours</td></tr>
<tr><td colspan="4">GOAL: This module is designed to introduce the trainees to the applications of microprocessors and PLCs in industrial automation</td></tr>
<tr><td colspan="4">GENERAL OBJECTIVES:

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

1.0 Understand Basics of Variable Frequency Drives (VFDs)
2.0 Identify different types of VFD’s
3.0 Construct a fan controller by using a VFD</td></tr>
</table>

PROGRAMME: NATIONAL TECHNICAL CERTIFICATE IN INDUSTRIAL ELECTRONICS						
MODULE: Introduction to Variable Frequency Drives (VFDs)				**COURSE CODE: CIE 329**		**CONTACT HOURS:**
YEAR: 3	**TERM:** 2	**PRE: REQUISITE: TERM 1 NTC 3**		**Theoretical:** 24 Hours **Practical:** 48 Hours		
GOAL: This module is designed to introduce the trainees to the applications of variable frequency drives (VFDs).						
Theoretical Content				**Practical Content**		
GENERAL OBJECTIVE 1.0: Understand Basics of Variable Frequency Drives (VFDs)						
Week	**Specific Learning Outcome**	**Teachers Activities**	**Learning Resources**	**Specific Learning Outcome**	**Teachers Activities**	**Learning Resources**
1-15	1.1 Describe the function of VFDs. 1.2 State the key components of VFD systems (Rectifier, DC Bus, Inverter). 1.3 Discuss how VFDs are used in control motor speed and torque. 1.4 Discuss how VFDs are used in Frequency and voltage control.	1.1 Explain the function of VFDs. 1.2 Discuss the key components of VFD systems (Rectifier, DC Bus, Inverter). 1.3 Explain how VFDs are used in control motor speed and torque. 1.4 Explain how VFDs are used in Frequency and voltage control.	• Whiteboard • Whiteboard maker • Projector • Internet • Textbooks	• Identify different types of VFDs • Construct a fan controller using a VFD	• Guide the student to identify different types of VFDs • Guide the student to construct a fan controller using a VFD	• VFDs • power supply • Multimeters • Bread board • Connecting leads • Switch

<table>
<tr><td colspan="4">PROGRAMME: NATIONAL TECHNICAL CERTIFICATE IN INDUSTRIAL ELECTRONICS</td></tr>
<tr><td colspan="3">MODULE: Introduction to Industrial Control System</td><td>COURSE CODE: CIE 3110</td><td>CONTACT HOURS:</td></tr>
<tr><td>YEAR: 3</td><td>TERM: 3</td><td>PRE: REQUISITE: TERM 2 NTC 3</td><td colspan="2">Theoretical: 24 Hours
Practical: 0 Hours</td></tr>
<tr><td colspan="5">GOAL: This module is designed to introduce the trainees to basic Industrial Control System</td></tr>
<tr><td colspan="5">GENERAL OBJECTIVES:

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

1.0 Understand basics of Industrial Control System.</td></tr>
</table>

PROGRAMME: NATIONAL TECHNICAL CERTIFICATE IN INDUSTRIAL ELECTRONICS						
MODULE: Introduction to Industrial Control System				**COURSE CODE: CIE 3110**		**CONTACT HOURS:**
YEAR: 3	**TERM:** 1	**PRE: REQUISITE: TERM 2 NTC 3**		**Theoretical:** 24 Hours **Practical:** 0 Hours		
GOAL: This module is designed to introduce the trainees to basic Industrial Control System						
Theoretical Content				**Practical Content**		
GENERAL OBJECTIVE 1.0: Understand Basics of Industrial Control System						
Week	**Specific Learning Outcome**	**Teachers Activities**	**Learning Resources**	**Specific Learning Outcome**	**Teachers Activities**	**Learning Resources**
1-15	1.1. Define Industrial Control System. 1.2. Discuss the scope, and applications of Industrial Control System. 1.3. State the types of Industrial Control System. 1.4. Discuss the importance of Control Systems in Industry.	1.1. Discuss Industrial Control System. 1.2. Explain the scope, and applications of Industrial Control System. 1.3. Discuss the Types of Industrial Control System. 1.4. Explain the Importance of Control Systems in Industry.	• Whiteboard • Whiteboard maker • Projector • Internet • Textbooks			

LIST OF MINIMUM RESOURCES

S/N	Tools/Equipment	Maximum Quantity Required	Quantity Available	Additional Quantity Required
1	Multimeter	60		
2	Oscilloscope	5-6 units		
3	Function Generator	3-4 units		
4	Adjustable Power Supply (DC and AC)	2-3 each		
5	Breadboard	60		
6	Resistor, Capacitor, Inductor	various		
7	Wire Strippers	60		
8	Soldering Kit (for beginners)	60		
9	Prototyping Tools	3		
10	Transistors (BJT, FET)	various		
11	Operational Amplifiers (Op-Amps)	20-30		
12	Analog Signal Generators	4-Mar		
13	Capacitance Meter	3		
14	Potentiometers	5		
15	Multimeter (Analog and Digital)	various		
16	Logic Analyzer	1		
17	Microcontroller Kits	1		
18	Signal Generator	4-Mar		
19	Diodes (e.g., Schottky, Zener, Rectifier)	various		
20	Thyristors (SCRs)	10		
21	Heat Sinks	various		
22	Inductive Loads	20-30		
23	AC/DC Converter Circuit	5		
24	Triacs	10		
25	MOSFETs (Metal-Oxide-Semiconductor Field-Effect Transistors)	10		

26	Diode Bridge Rectifier	10		
27	Power Supply Test Equipment	2		
28	Load Banks	various		
29	Programmable Logic Controllers (PLCs)	3		
30	PLC Programming Software	1		
31	Microcontroller Kits	5		
32	Relay	20-30		
33	Switches	Various		
34	Sensors	Various		
35	Contactors	6		
36	VFD Unit	3		
37	AC Fan	3		
38	Cables and Connectors	(assorted for different circuits)		
39	Veroboard	60		
40	Microprocessor Kit	5		
41	First Aid box and basic contents	5		
42	Safety Glasses/Goggles	60		
43	Heat-resistant Gloves	60		
44	Fume mask	60		
45	Electrostatic Discharge Safety shoes	Several pairs		

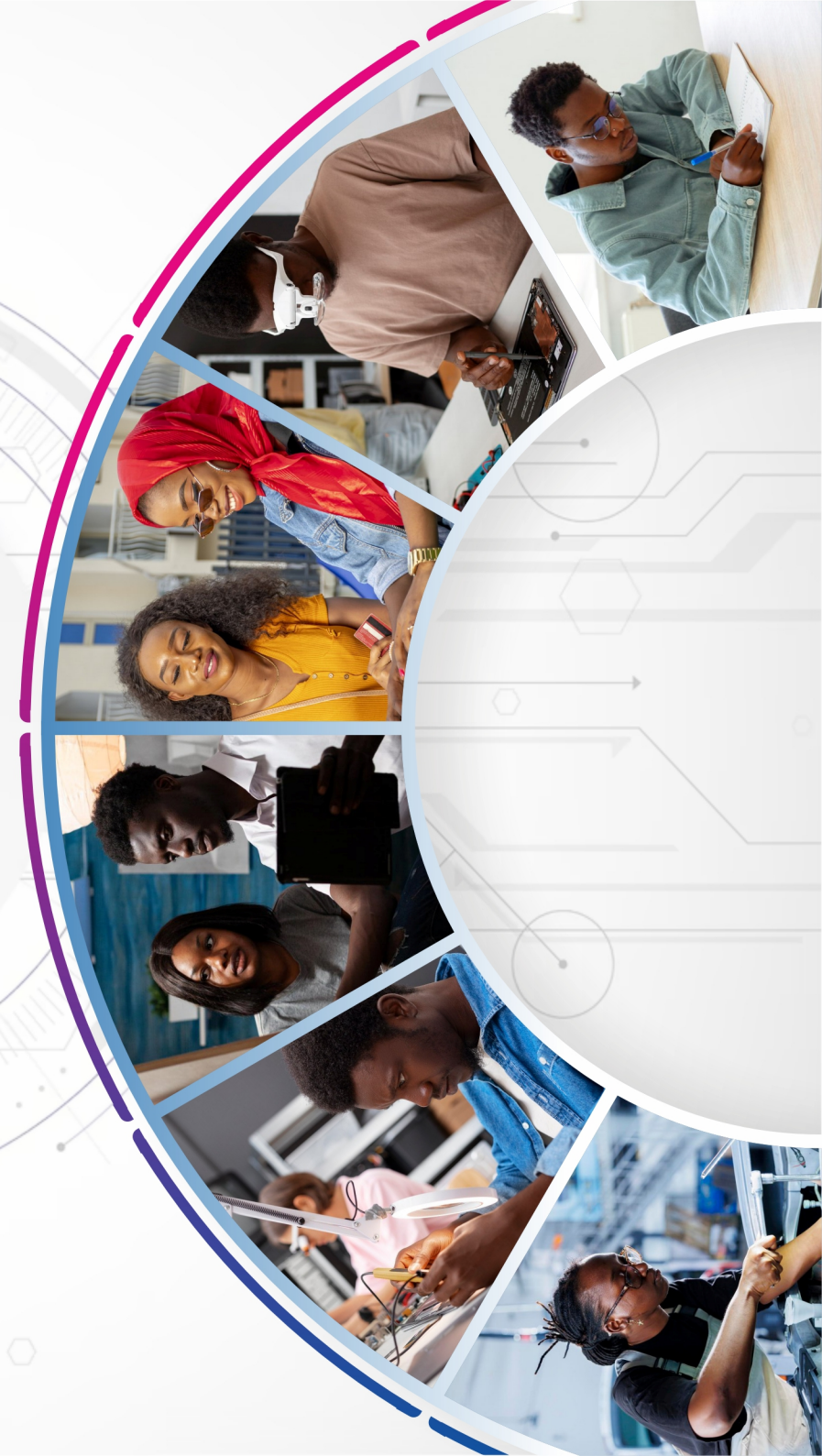
List of Resources Material

- **"Fundamentals of Electrical Engineering" by U.A. Odi**
  A comprehensive text covering the foundational principles of electrical engineering with a focus on both theoretical and practical aspects of electrical systems.
- **"Electrical Principles and Practice" by O.O. Onibere**
  This textbook introduces electrical principles, suitable for students starting their electrical engineering journey.
- **"Introduction to Analog Electronics" by Adebisi A. Afolabi**
  A useful resource for learning about analog electronics and its practical applications in electrical engineering, with an emphasis on real-world examples.
- **"Basic Electronic Circuits: Principles and Application" by O.O. Oyebade**
  Focuses on the design, analysis, and application of analog electronic circuits, targeted at both beginners and advanced students**.**
- **"Digital Electronics: Principles and Applications" by Akin A. Akinsola**
  A textbook covering the principles of digital electronics, including logic gates, Boolean algebra, and sequential logic circuits, suited for undergraduate students in electrical engineering.
- **"Digital Logic and Computer Design" by A.O. Adewole**
  A comprehensive textbook that provides students with theoretical foundation and practical knowledge of digital electronics, logic circuits, and design systems.
- **"Power Electronics: Principles and Applications" by S.O. Omojola**
  Focuses on the devices and circuits used in power electronics, covering topics such as rectifiers, inverters, and DC-DC converters, with a focus on practical applications.
- **"Fundamentals of Power Electronics" by I.O. Akintoye**
  A textbook that provides an in-depth understanding of power electronics devices, their applications, and characteristics.
- **"Power Semiconductor Devices and Circuits" by O.O. Fashina**
  Covers power semiconductor devices and their role in power electronic circuits, from basic concepts to advanced applications.
- **"Semiconductor Power Devices" by J.A. Adebayo**
  This book discusses the fundamentals and applications of power semiconductors, such as MOSFETs, IGBTs, and SCRs, providing a Nigerian perspective on the subject.
- **"Troubleshooting and Repair of Power Electronics" by S.A. Babalola**
  A practical guide to troubleshooting power electronic systems, from component failure analysis to full system repair strategies, with a focus on real-world scenarios**.**

- **"Applications of Power Electronics in Industrial Systems" by K.O. Olusola**
  A textbook focusing on the application of power electronics in industrial systems, with case studies and troubleshooting tips.
- **"Principles of Electrical Measurement and Instrumentation" by E.A. Nwokeji**
  A textbook that covers the fundamental concepts of electrical measurements and instrumentation, explaining the operation and application of various instruments.
- **"Electrical Instrumentation and Measurement Systems" by O.A. Alabi**
  Provides insights into various measurement techniques and instrumentation systems used in electrical engineering, with practical applications.
- **"Microprocessor and Microcontroller Systems" by A.O. Ajayi**
  A useful text for understanding the fundamentals of microprocessors and microcontroller systems, including programming and interfacing with various devices.
- **"Programmable Logic Controllers: Concepts and Applications" by O.T. Olaniyan**
  Covers the principles of PLCs, programming, and applications in industrial automation, ideal for students and professionals working with automation systems.
- **"Industrial Automation and Control Systems" by A.B. Jiboye**
  A comprehensive textbook focusing on industrial automation, control systems, and the application of PLCs in manufacturing and other industrial processes.
- **"Electric Motor Drives and VFD Applications" by K.O. Daramola**
  This textbook introduces electric motor drives and the application of VFDs in controlling motor speed, along with practical examples.
- **"Variable Frequency Drives: Principles and Applications in Power Systems" by M.A. Ayodele**
  Focuses on the theory and applications of VFDs in power systems, covering topics such as speed control, power management, and system integration.

LIST OF DEVELOPMENT TEAM			
S/N	**Name of the Resource Personnel**	**Address**	**E-Mail**
1	Engr. Jaafaru Garba	NBTE Kaduna	jaafargarba2@gmail.com
2	Engr. Dr. Yunusa Ali Said	Kaduna Polytechnic	yunusaalisaid@yahoo.com
3	Engr. Adamu Gidado	Dangote Academy Obajana	Adamu.gidado.ag@gmail.com

LIST OF CRITIQUE TEAM			
S/N	**Name of the Resource Personnel**	**Address**	**E-Mail**
1	Engr. Jaafaru Garba	NBTE Kaduna	jaafargarba2@gmail.com
2	Engr. Yakubu Rabiu	Center for Innovation and Creativity, NDA Kaduna	yakuburabiu05@gmail.com
3	Musa Bulus Garkida	Dangote Academy Obajana	bulus.garkida@gmail.com



World Bank – National Board
for Technical Education, Nigeria
Project on Innovation Development
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of Skills (IDEAS)

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