![Republic of Rwanda emblem] **Republic of Rwanda**
Ministry of Education

RTB | RWANDA TVET BOARD

DIGITAL ELECTRONICS FUNDAMENTALS

GENDE501

APPLY DIGITAL ELECTRONICS FUNDAMENTALS

Competence

RQF Level: 5

Learning Hours

70

Credits: 7

Sector: Energy

Trade: Renewable energy

Module Type: General

Curriculum: ENGREN 5001-TVET Level 5 in Renewable Energy

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1200
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Purpose statement	This general module describes the skills, knowledge and attitudes required to apply digital electronics fundamentals. The learner will be able to describe basic concepts of digital electronics, and apply digital number systems, digital arithmetic, digital codes, digital integrated circuit, combinational, sequential circuits, and programmable logic devices as well.			
Learning assumed to be in place	N/A			

Delivery modality	Training delivery		100%	Assessment		Total 100%
	Theoretical content		30%		30%	
	Practical work:		70%	Formative assessment	70%	50%
	• Group work and presentation	30%				
	• Individual work	40%				
				Summative Assessment	50%	

Elements of Competency and Performance Criteria

Elements of competency	Performance criteria
1. Apply digital numbers	1.1. The Digital number systems are described according to their types
	1.2. The Digital codes are identified according to their types
	1.3. The Digital arithmetic are applied according to the type of operators
2. Apply logic gates	2.1. The Logic gates are applied according to their types
	2.2. The Logic families are identified according to their categories
	2.3. The Digital ICs are classified according to their size, technology & applications
	2.4. the Logic circuits are simulated and applied according to work to be done
3. Apply Boolean algebra	3.1. The Theorems of Boolean Algebra are identified according to their types
	3.2. The Boolean expressions are formed based on the standard forms
	3.3. The Boolean expressions are simplified according to the simplification tech
4. Apply Fixed logic devices	4.1. The types of Combinational logic circuits are identified according to their working and applications
	4.2. The parts of Sequential logic circuits are identified according to its design
	4.3. The types of Sequential logic circuits are identified according to their working and applications

5. Apply Programmable Logic Devices (PLD)	5.1. The PLD's working principle is described according to its applications
	5.2. The PLD types are classified according to their architecture, logic capacity and programmability
	5.3. The PLD's Programming Languages are identified according to their types
	5.4. the PLD's programming devices are applied according to their types

Intended Knowledge, Skills and Attitude		
Knowledge	**Skills**	**Attitudes**
✓ Safety precautions, and security ✓ Technical Symbols and diagrams ✓ Interpret circuit diagrams ✓ Industrial codes and standards ✓ Basic of electronic fundamentals ✓ Basic of arithmetical operation	✓ Computer skills ✓ Proper use of measurement tools ✓ Computer-aided design ✓ Creating circuit diagram ✓ Analytical skills ✓ Diagnostic skills ✓ Communication skills ✓ Collaborative skills ✓ Task management skills	✓ Honest ✓ Accountability ✓ Self-motivated ✓ Gender sensitive ✓ Customer care oriented ✓ Decisive ✓ Time management ✓ Humble ✓ Creative ✓ Patient ✓ Responsible ✓ Innovative ✓ Flexible ✓ integrity ✓ Goal oriented ✓ Self-confident ✓ Motivated ✓ Good common sense ✓ Self-confident ✓ Task oriented ✓ Honest ✓ Customer focused ✓ Energetic ✓ Able to work independently ✓ Integrity ✓ Strong moral character ✓ Personal hygiene/grooming ✓ Time management ✓ Open minded ✓ Organized ✓ Maintain health ✓ Positive work ethics

		✓ Gender sensitivity ✓ Flexible ✓ Problem solver ✓ Goals oriented ✓ Teamwork and Collaboration ✓ Professionalism ✓ Strong Work Ethic ✓ Adaptability ✓ Safety Consciousness ✓ Customer Service Orientation

Course content

Learning outcomes	At the end of the module the learner will be able to: 1. Apply digital numbers 2. Apply Boolean algebra 3. Apply logic gates 4. Apply Fixed logic devices 5. Apply Programmable Logic Devices (PLD)
Learning outcome 1: Apply digital numbers	**Learning hours: 15**

Indicative content

- **Definitions and applications of digital electronics**
    - ✓ Define analog electronics
    - ✓ Define Digital electronics
    - ✓ Comparison between analogue and digital electronics

        ✚

        Examples of analogue and digital devices, signals, phenomena
    - ✓ Applications of digital electronics
- **Digital number systems**
    - ✓ Definitions
    - ✓ Describe digital number systems (types)
    - ✓ Number systems' bases Conversion

- **Digital codes**
  - ✓ Introduction to digital codes
  - ✓ Digital codes types
  - ✓ Digital codes conversion
- **Digital arithmetic**
  - ✓ Introduction to digital arithmetic
  - ✓ Complement of a Number
    - ↓ 1's complement
    - ↓ 2's complement
  - ✓ Digital arithmetic operations
    - ↓ Addition
    - ↓ Multiplication
    - ↓ Subtraction
    - ↓ Division

Resources required for the learning outcome

Equipment	▪ Computer, projector, digital display, Analogue display
Materials	▪ Markers/ chalks, board, Internet
Tools	▪ Calculator, books
Facilitation techniques	▪ Brainstorming ▪ Group discussion ▪ Presentation
Formative assessment methods /(CAT)	▪ Written assessment

Learning outcome 2: Apply logic gates	Learning hours: 15

Indicative content

- **Introduction to logic gates**
- **Types of logic gates**
  - ✓ Truth table
  - ✓ Apply Logic gates
  - ✓ Universal logic gates
  - ✓ Applications of logic gates
- **Apply Logic families**
  - ✓ Types of logic families

- TTL
- ECL
- MOS
- ✓ Characteristic Parameters of Logic Families
- ✓ Comparison of main logic families
- ✓ Interpretation of user manual

- **Apply Digital ICs**
    - ✓ Advantages and limitations of ICs
    - ✓ Classification of digital ICs
        - Based on Technology
        - Based on number of active components
        - Based on applications
        - Based on manufacturing method
    - ✓ Applying digital ICs in electronic circuits
        - Logic gates (74HCXX, 74LSXX…)
        - CD4017
        - XX555 timer
    - ✓ Logic circuits simulation in software
        - Simulation software description
        - Design and run logic circuits
        - Construction of Logic circuits on breadboard

Resources required for the learning outcome

Equipment	▪ Computer, Projector, Multimeters, DC power supply,
Materials	▪ Markers/ chalks, Board, Internet, logic gates ICs, Breadboard, Jumper wires, Electronic components
Tools	▪ Books, Multisim software/ Proteus software
Facilitation techniques	▪ Brainstorming ▪ Trainer guided ▪ Group discussion ▪ Presentation
Formative assessment methods /(CAT)	▪ Written assessment ▪ Performance assessment

Learning outcome 3: Apply Boolean Algebra — Learning hours: 10

Indicative content

- **Introduction to Boolean algebra**
- **Theorems of Boolean Algebra**
    - ✓ Description of Boolean Algebra Laws
    - ✓ Demorgan's theorems
- **Standard Forms of Boolean Expressions**
    - ✓ Boolean Expressions
    - ✓ Standard Forms
- **Boolean expressions simplification techniques**
    - ✓ Using Boolean algebra laws
    - ✓ Using Karnaugh map (K-map)

Resources required for the learning outcome

Equipment	▪ Computer, projector
Materials	▪ Markers/ chalks, board, Internet
Tools	▪ Books
Facilitation techniques	▪ Brainstorming ▪ Group discussion ▪ Presentation
Formative assessment methods /(CAT)	▪ Written assessment

Learning outcome4: Apply Fixed Logic Devices — Learning hours: 15

Indicative content

- **Apply Combinational logic circuits**
    - ✓ Design and Working principle
    - ✓ Types of combinational logic circuits
        - ♦ Apply Adder and Subtractor
        - ♦ Apply Comparator
        - ♦ Apply Multiplexer and Demultiplexer
        - ♦ Apply Encoder and Decoder
    - ✓ Applications of combinational logic circuits
- **Multivibrators using ICs**
- **Apply Sequential logic circuits**

- ✓ Design and Working principle
- ✓ Types of Sequential logic circuits
  - ↓ Introduction
  - ↓ Clock Signal and Triggering
  - ↓ Asynchronous circuits
  - ↓ Synchronous circuits
- ✓ Apply Flip-Flops
  - ↓ Introduction
  - ↓ Latches
  - ↓ Set-Reset (SR) Flip-Flops
  - ↓ Toggle (T) Flip-Flops
  - ↓ Data (D) Flip-Flops
  - ↓ Jack Kilby (JK) Flip-Flops
- ✓ Apply Counters
  - ↓ Introduction
  - ↓ Up/Down counter
  - ↓ Decade counter
  - ↓ Ripple counter
  - ↓ Ring counter
  - ↓ Johnson counter
- ✓ Apply Shift Registers
  - ↓ Introduction
  - ↓ Serial In − Serial Out shift register
  - ↓ Serial In − Parallel Out shift register
  - ↓ Parallel In − Serial Out shift register
  - ↓ Parallel In − Parallel Out shift register
  - ↓ Universal shift Register

Resources required for the learning outcome

Equipment	▪ Computer, Projector, Multimeters, DC power supply
Materials	▪ Markers/ chalks, board, Internet, logic ICs, breadboard, jumper wires, electronic components
Tools	▪ Books, Multisim software/ Proteus software, universal plier
Facilitation techniques	▪ Brainstorming ▪ Trainer guided ▪ Group discussion

	• Presentation
Formative assessment methods /(CAT)	• Written assessment • Performance assessment

Learningoutcome5: **Apply Programmable Logic Devices**	**Learning hours: 15**

Indicative content

- **Introduction to Programmable Logic Devices (PLD)**
- **PLD Working principle**
- **Types of PLDs**
  - ✓ Based on size: simple and complex
  - ✓ Based on the type of array
- **Programming languages of PLDs**
  - ✓ Description of Programming languages
  - ✓ Programming process
  - ✓ Building a Logic Design
  - ✓ Functional Simulation
  - ✓ Timing Simulation
  - ✓ Device Programming (Downloading)
- **PLD programming logical devices**

Resources required for the learning outcome

Equipment	• Computer, Projector, Multimeters, DC power supply,
Materials	• Markers/ chalks, Board, Internet, logic ICs, PLDs, Breadboard, Jumper wires, electronic components
Tools	• Books, PLD programming software
Facilitation techniques	• Brainstorming • Trainer guided • Group discussion • Presentation
Formative assessment methods /(CAT)	• Written assessment • Performance assessment

List of abbreviations

1. **CAT:** Continuous Assessment Testing

2. **DC:** Direct Current

3. **ECL:** Emitter Coupled Logic

4. **IC:** Integrated Circuit

5. **MOS:** Metal Oxide Semiconductor

6. **PLD:** Programmable Logic Device

7. **TTL:** Transistor - Transistor Logic

8. **TVET:** Technical and Vocational Education and Training

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Glossary

Activity: Activities include releases, events, and deployment plans that you develop, start, and complete with the product.

Logic gate: a device that acts as a building block for digital circuits

Digital: electronic technology that generates, stores, and processes data in terms of two states: positive and non-positive. It is expressed as series of the digits 0 and 1, typically represented by values of a physical quantity such as voltage

Electronics: the branch of physics and technology concerned with the design of circuits using transistors and microchips, and with the behavior and movement of electrons in a semiconductor, conductor, vacuum, or gas.

Integrated circuit: An IC is the fundamental building block of all modern electronic devices. It's an integrated system of multiple miniaturized and interconnected components embedded into a thin substrate of semiconductor material (usually silicon crystal)

A programmable logic device: PLD is an electronic component used to build reconfigurable digital circuits.

Digital electronics: is the study of electronic circuits that are used to process and control digital signals.

Combinational logic circuit: is a circuit whose outputs only depend on the current state of its inputs. In mathematical terms, each output is a function of the inputs.

Sequential logic circuit: consists of a series of various inputs and outputs. Here, the outputs depend on a combination of both the present inputs as well as the previous outputs.