Republic of Rwanda
Ministry of Education

RTB | RWANDA TVET BOARD

ETEDE401

# DIGITAL ELECTRONICS FUNDAMENTALS

## APPLY DIGITAL ELECTRONICS FUNDAMENTALS

## Competence

**RQF Level:** 4

**Learning Hours** 90

**Credits:** 9

**Sector:** Energy

**Trade:** Electrical Technology

**Module Type:** General

**Curriculum:** ENGELT 4001-TVET Level 4 in Electrical Technology



**Issue Date:** May 2023

| | |
|---|---|
| **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% | Formative assessment | 30% | 50% |
| Practical work: | | 70% | | 70% | |
| • 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 (this must be the** | 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<br>✓ Technical Symbols and diagrams<br>✓ Interpret circuit diagrams<br>✓ Industrial codes and standards<br>✓ Basic of electronic fundamentals<br>✓ Basic of arithmetical operation | ✓ Computer skills<br>✓ Proper use of measurement tools<br>✓ Computer-aided design<br>✓ Creating circuit diagram<br>✓ Analytical skills<br>✓ Diagnostic skills<br>✓ Communication skills<br>✓ Collaborative skills<br>✓ Task management skills | ✓ Honest<br>✓ Accountability<br>✓ Self-motivated<br>✓ Gender sensitive<br>✓ Customer care oriented<br>✓ Decisive<br>✓ Time management<br>✓ Humble<br>✓ Creative<br>✓ Patient<br>✓ Responsible<br>✓ Innovative<br>✓ Flexible<br>✓ integrity<br>✓ Goal oriented<br>✓ Self-confident<br>✓ Motivated<br>✓ Good common sense<br>✓ Self-confident<br>✓ Task oriented<br>✓ Honest<br>✓ Customer focused<br>✓ Energetic<br>✓ Able to work independently<br>✓ Integrity<br>✓ Strong moral character<br>✓ Personal hygiene/grooming<br>✓ Time management<br>✓ Open minded<br>✓ Organized<br>✓ Maintain health<br>✓ Positive work ethics |

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

## Course content

| **Learning outcomes** | At the end of the module the learner will be able to:<br>1. Apply digital numbers<br>2. Apply Boolean algebra<br>3. Apply logic gates<br>4. Apply Fixed logic devices<br>5. Apply Programmable Logic Devices (PLD) |
|---|---|
| **Learning outcome 1: Apply digital numbers** | **Learning hours: 30** |

**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<br>▪ Group discussion<br>▪ 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<br>▪ Trainer guided<br>▪ Group discussion<br>▪ Presentation |
| **Formative assessment methods /(CAT)** | ▪ Written assessment<br>▪ Performance assessment |

| **Learning outcome 3: Apply Boolean Algebra** | **Learning hours: 15** |
|---|---|

**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<br>▪ Group discussion<br>▪ Presentation |
| **Formative assessment methods /(CAT)** | ▪ Written assessment |

## Learning outcome4: Apply Fixed Logic Devices — Learning hours: 20

**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<br>▪ Trainer guided<br>▪ Group discussion |

| | |
|---|---|
| | ▪ Presentation |
| **Formative assessment methods /(CAT)** | ▪ Written assessment<br>▪ Performance assessment |
| **Learningoutcome5: Apply Programmable Logic Devices** | **Learning hours: 10** |
| **Indicative content** | |
| • **Introduction to Programmable Logic Devices (PLD)**<br>• **PLD Working principle**<br>• **Types of PLDs**<br>✓ Based on size: simple and complex<br>✓ Based on the type of array<br>• **Programming languages of PLDs**<br>✓ Description of Programming languages<br>✓ Programming process<br>✓ Building a Logic Design<br>✓ Functional Simulation<br>✓ Timing Simulation<br>✓ Device Programming (Downloading)<br>• **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<br>▪ Trainer guided<br>▪ Group discussion<br>▪ Presentation |
| **Formative assessment methods /(CAT)** | ▪ Written assessment<br>▪ 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, the 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.