Republic of Rwanda
Ministry of Education

RTB | RWANDA TVET BOARD

NITIS301

IoT SYSTEM INSTALLATION

INSTALL IoT SYSTEM

Competence

RQF Level: 3

Learning Hours
70

Credits: 7

Sector: ICT and Multimedia

Trade: Networking and Internet Technologies

Module Type: Specific

Curriculum: ICTNIT3001 - TVET Certificate III in Networking and Internet Technologies

Issue Date: August 2022

1200

Purpose statement	This specific module describes the skills, knowledge and attitude required to install IoT System. Upon completion of this module, the learner will be able to prepare IoT system installation, deploy IoT equipment, operate, test and maintain IoT system.					
Delivery modality	**Training delivery**		**100%**	**Assessment**		**Total 100%**
	Theoretical content		**30%**	Formative assessment	**30%**	50%
	Practical work:		70%		70%	
	Group project and presentation	**20%**				
	Individual project /Work	**50%**				
				Summative Assessment		**50%**

Elements of Competency and Performance Criteria

Element of competence	Performance criteria
1. Prepare IoT system installation	1.1. Installation manual is properly interpreted based on the installation design
	1.2. IoT components are properly identified based on the installation design
	1.3. Tools, materials, and equipment are correctly selected according to the installation requirements
	1.4. Tool, devices, and equipment are accurately calibrated as per manufacturer's standards
2. Deploy IoT equipment	2.1. The workplace is properly set according to the installation design
	2.2. IoT equipment are correctly assembled as per the manufacturer's guides
	2.3. Equipment settings are appropriately customized based on the installation requirements
	2.4. IoT system protection measures are properly applied as per the installation manual

	2.5. Functional testing is correctly performed according to the installation requirements
	2.6. IoT system installation is properly reported based on the installation requirements
3. Operate IoT system	3.1. Types of IoT system are properly identified according to the installation manual
	3.2. IoT system features are properly identified according to the IoT system requirements
	3.3. IoT system is properly monitored according to the IoT system requirements
	3.4. Data backup is correctly performed as per the backup guidelines
	3.5. IoT system status is properly interpreted as per the installation manual
	3.6. IoT system incidents are properly reported as per the monitoring results
4. Test IoT system	4.1.Types of testing are properly identified according to the installation requirements
	4.2.IoT Testing tools are correctly selected based on the type of testing
	4.3.Connectivity testing is correctly performed according to the installation requirements
	4.4.Functional testing is correctly performed according to IoT system installed
	4.5.Performance testing is correctly performed according the IoT system installed
	4.6.Testing report is correctly elaborated based on the test results
5. Maintain IoT system	5.1.Features updates are properly installed based on the manufacture's guidelines
	5.2.IoT system protection measures are properly checked in accordance with the installation manual
	5.3.Preventive Maintenance report is properly elaborated based on the work done

Course content

Learning outcomes	At the end of the module the learner will be able to: 1. Prepare IoT system installation 2. Deploy IoT equipment 3. Operate IoT system 4. Test IoT system 5. Maintain IoT system
Learning outcome 1: Prepare IoT system installation	**Learning hours: 20**

<table>
<tr><td colspan="2" align="center">Indicative content</td></tr>
</table>

- Introduction to IOT
  - ✓ Description of IoT Fundamentals
    - Definition
    - Benefits
    - Applications
    - Devices/Components
    - Platforms
    - Evolution
  - ✓ Identification of IoT components
    - Things
    - Internet
    - Connectivity
  - ✓ Identification of IoT Tools, Materials and equipment
    - Software
    - Hardware
  - ✓ Identification of IoT Technology Challenges
    - IoT Security
    - Data Privacy
    - IoT Devices Safety
    - Interoperability
    - Environmental Impact
- Identification of IoT Network Technologies
  - ✓ Low Range/Low Power
    - Zigbee
    - Wi-Fi6
    - Bluetooth/LE
    - NFC

- RFID
- Ethernet
- ✓ Large Range
  - LPWAN
  - Cellular
  - LoRa
  - SigFox
  - WiFi HaLow
  - 5G
  - LTE
  - Satellite
- Description of IoT Architecture and protocols
  - ✓ Physical model of IoT
  - ✓ Logical model of IoT
  - ✓ IoT Protocols
- Calibration of tools, equipment and materials
  - ✓ Description of calibration
    - Definition
    - Purpose
  - ✓ Calibration techniques
  - ✓ Calibration procedures
- Interpretation of Manual/Datasheet

Resources required for the learning outcome	
Equipment	Wireless Router, Gadgets, Appliances, Arduino Board
Materials	Arduino Starter Kit, IoT Device Datasheet
Tools	Calibration software, Simulators, Screw drivers, Pliers, Multi-meter
Facilitation techniques	Demonstration and simulation Individual and group work Trainer guided Group discussion
Formative assessment methods /(CAT)	Written assessment Oral presentation

Learning outcome 2: Deploy IoT equipment	Learning hours: 10
Indicative content	

- Performance of workplace Setup
  - ✓ Study the workplace environment
    - ⬛ Distance
    - ⬛ Physical obstacles
    - ⬛ Existing systems (Source of power)
  - ✓ Selection of requirements
    - ⬛ Tools
    - ⬛ Equipment
    - ⬛ Materials
  - ✓ Mapping the workplace
  - ✓ Setup network connectivity
- Identification of IoT deployment levels
  - ✓ Level-1
  - ✓ Level-2
  - ✓ Level-3
  - ✓ Level-4
  - ✓ Level-5
  - ✓ Level-6
- Assembling of IoT equipment
  - ✓ Manufacturer's guide interpretation
  - ✓ Fixing of IoT equipment
- Configuration of IoT devices
  - ✓ Selection of IoT platform
    - ⬛ On-premise
    - ⬛ Cloud based
  - ✓ Installation of IoT applications
    - ⬛ IoT Device provisioning
    - ⬛ IoT Management (Future Ready device management eg: remote configuration, Unified Device Management)
  - ✓ Functional testing
    - ⬛ Speed
    - ⬛ Latency
    - ⬛ Jitter
    - ⬛ QoS
- Implementation of IoT system Security
  - ✓ Setup the security measures
    - ⬛ Physical
    - ⬛ Logical
  - ✓ Perform IoT device firmware Update

- Firmware versioning
- Firmware control
- Documentation of IoT installation report
    - ✓ Data and facts recording
    - ✓ Report generation

Resources required for the indicative content	
Equipment	Modem, Access Point, Computer, microcontrollers, Arduino Starter Kit
Materials	Internet connectivity, pipes, cable trunks, electrical tapes, screws, Labelling tags
Tools	Software platforms, simulation software, tape measure, multi-meter, screwdrivers, drilling machine, hammer, ladder, pliers,
Facilitation techniques	Demonstration and simulation Individual and group work Practical exercise Individualized Trainer guided
Formative assessment methods /(CAT)	Written assessment Oral presentation Performance assessment Product based assessment

Learning outcome 3: Operate IoT system	Learning hours: 20

Indicative content

- Identification of IoT systems Types
    - ✓ Consumer IoT
    - ✓ Commercial IoT
    - ✓ Industrial IoT
    - ✓ Infrastructure IoT (IIoT)
    - ✓ Internet of Military Things (IoMT)
- Implementation of IoT system Backup and restoration
    - ✓ Identification of backup types
        - Full backup
        - Differential backup
        - Incremental backup
    - ✓ Creation of backup
        - Automatic
        - Manual
    - ✓ Restoration of IoT system
- Identification of IoT features
    - ✓ Connectivity
    - ✓ Sensing

- ✓ Active Engagements
- ✓ Scale
- ✓ Dynamic Nature
- ✓ Intelligence
- ✓ Energy
- ✓ Safety
- ✓ Integration
- Management of IoT device service
  - ✓ Event triggering
  - ✓ Conditional actions
  - ✓ Conditional configurations
- Monitoring of IoT system
  - ✓ Monitoring software
  - ✓ Monitoring parameters
  - ✓ IoT system status interpretation
  - ✓ Monitoring results interpretation
  - ✓ Incident management
    - ✦ Definition
    - ✦ Lifecycle

Resources required for the indicative content	
Equipment	Modem, Access Point, Computer, microcontrollers, Arduino Starter Kit
Materials	Internet connectivity, pipes, cable trunks, electrical tapes, screws, Labelling tags
Tools	Software platforms, simulation software, tape measure, multi-meter, screwdrivers, drilling machine, hammer, ladder, pliers,
Facilitation techniques	Demonstration and simulation Individual and group work Practical exercise Individualized Trainer guided
Formative assessment methods /(CAT)	Written assessment Oral presentation Performance assessment Product based assessment

Learning outcome 4: Test IoT system	Learning hours: 10
Indicative content	

- Identification of IoT Testing Types
  - ✓ Usability
  - ✓ Reliability
  - ✓ Data integrity
  - ✓ Security
  - ✓ Compatibility
  - ✓ Performance
- Performance of IoT Tests
  - ✓ Functional test
  - ✓ Security test
    - Identification of security testing tools
    - Perform Security test
  - ✓ Connectivity test
    - Identification of connectivity tools
    - Perform Connectivity test
  - ✓ Performance test
    - Identification of performance test
    - Perform Performance test
- Elaboration of testing report
  - ✓ Generation of report
  - ✓ Interpretation of report

Resources required for the indicative content	
Equipment	Computer, Multi-meter, Digital Storage Oscilloscope
Materials	Internet connectivity
Tools	Software platforms, JTAG Dongle, Software-defined radio (SDR)
Facilitation techniques	Demonstration and simulation Individual and group work Practical exercise Individualized Trainer guided
Formative assessment methods /(CAT)	Written assessment Oral presentation Performance assessment Product based assessment

Learning outcome 5: Maintain IoT system	Learning hours: 10

Indicative content
- Identification of IoT Maintenance types   ✓ Predictive   ✓ Preventive   - Application of IoT Software upgrade   ✓ Automatic   ✓ Manual   - Performance of IoT system security maintenance   ✓ Perform IoT action repairs   ✓ Perform IoT system protection checks   - Documentation of IoT maintenance report   ✓ Data analysing and facts recording   ✓ Report generation

Resources required for the indicative content	
Equipment	Computer, Multi-meter, Digital Storage Oscilloscope
Materials	Internet connectivity,
Tools	Software platforms, JTAG Dongle, Software-defined radio (SDR)
Facilitation techniques	Demonstration and simulation Individual and group work Practical exercise Individualized Trainer guided
Formative assessment methods /(CAT)	Written assessment Oral presentation Performance assessment Product based assessment

| Integrated/Summative assessment |
|---|

Integrated situation

HH Media Ltd is a networking company located in Kigali City. They provide internet services to public and private institutions.

Institution that works with them have declared a problem concerning how to prevent their premises to be burnt without notice.

After being presented this problem, HH Media Ltd hired an IoT Engineer to develop for them a Fire Alarm IoT Solution that can handle that problem and after developing this

solution he presented this diagram as installation design to be followed whenever it is going to be deployed to the institutions.

HH Media Ltd now needs an IoT Installer who will be in charge of assembling and deploying the system, and make sure that a maintenance plan is to be provided at the end. You are given the following diagram to help you install the developed IoT Solution and after the work you have to provide a detailed installation report as well as testing report.
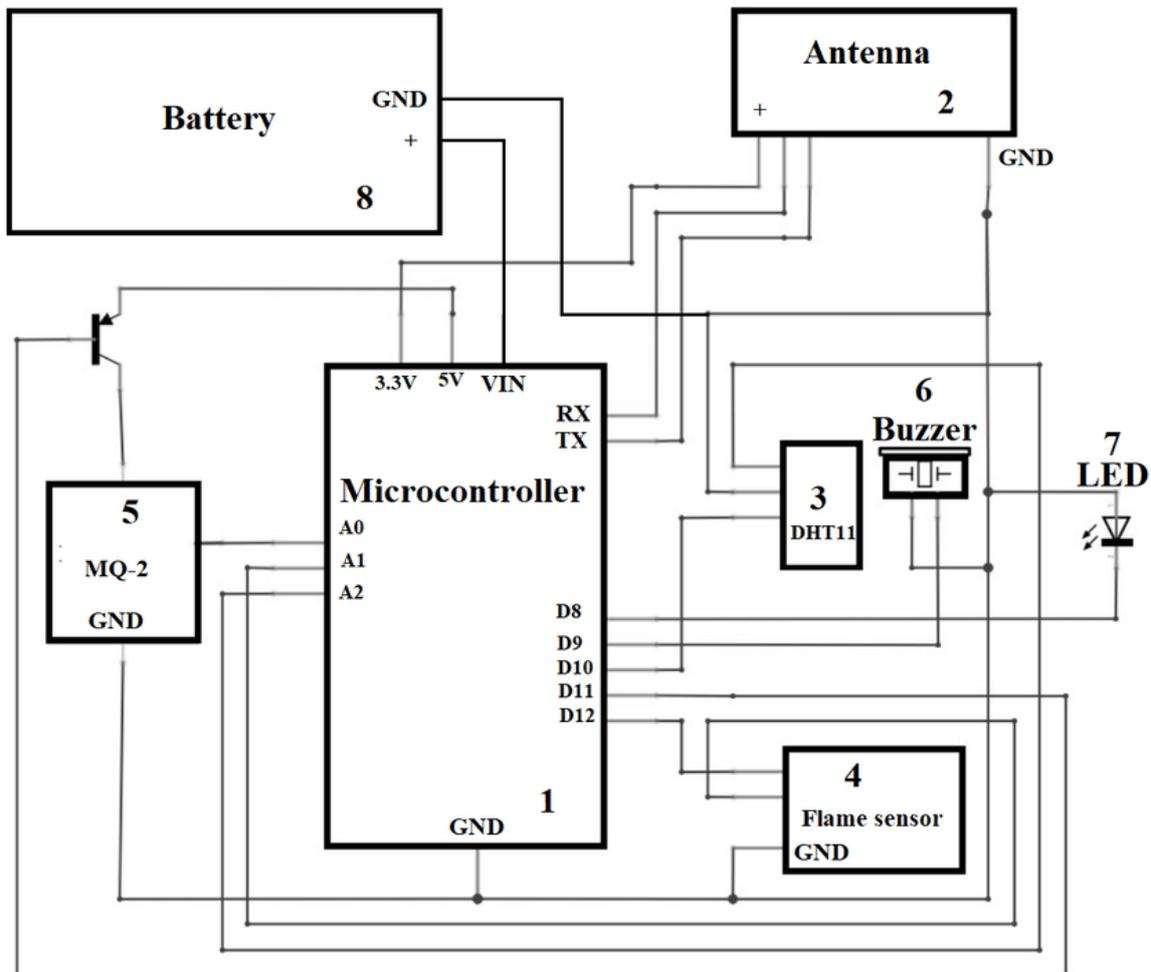
Current Consumption as follows:

Module	Current per hour	Current per second
DHT11 Sensor	0.3mA	0.00008333mA
MQ-2 Sensor	160mA	0.04444mA
Flame Sensor	0.4mA	0.0001111mA
Arduino's microprocessor (sleep-mode)	0.0001mA	0.000000027778mA
Arduino's microprocessor (active mode)	0.3mA	0.00008333mA
XBee ZigBee Antenna (send mode)	33mA	0.0091666mA
XBee ZigBee Antenna (receive mode)	28mA	0.00777778mA
XBee ZigBee Antenna (sleep-mode)	0.0001mA	0,0000002778mA

Device Specifications:

DHT11 Sensor: Temperature & Humidity Sensor (20-95%RH ; 0-50℃; 5V)
MQ-2 Sensor: Smoke/Gas Sensor with Concentration of 200 – 10000ppm
Flame Sensor: IR Based, KY-026
Arduino Board: Arduino Uno
XBee Antenna: ZigBee Antenna Module

This work has to be done within 7 hours. All tools, equipment and materials are provided.

Resources:

Tools	Internet Connectivity, Digital Multi-meter
Equipment	Programmed Microcontroller (Arduino Uno)
Materials/ Consumables	Arduino Starter Tool Kit, Flame Sensor, XBee

Assessable outcomes	Assessment criteria (Based on performance criteria)	Indicator	Observation		Marks allocation
			Yes	No	
Prepare IoT system installation: (20%)	Installation manual is properly interpreted based on the installation design	Installation manual is interpreted			3
		Installation design is interpreted			3
	IoT components are properly identified based on the installation design	IoT components are identified			2
		IoT components are selected			2
	Tools, materials, and equipment are correctly selected according to the installation requirements	Tools, materials, and equipment are selected			3
		IoT equipment are assembled			3
	Tool, devices, and equipment are accurately calibrated as per manufacturer's standards	Tool, devices, and equipment are calibrated			4
Deploy IoT equipment: (25%)	The workplace is properly set according to the installation design	Distance and physical obstacles are identified			3
		Existing system is analysed			3
		The workplace is set			3
	IoT equipment are correctly assembled as per the manufacturer's guides	Manufacturer's guide is interpreted			3
		IoT equipment are fixed			2

	IoT system protection measures are properly applied as per the installation manual	IoT system protection measures are applied			3
	Functional testing is correctly performed according to the installation requirements	Functional testing is performed			3
	IoT system installation is properly reported based on the installation requirements	IoT system installation is reported			4
Operate IoT system: (25%)	IoT system features are properly identified according to the IoT system requirements	IoT system features are properly identified			3
	IoT system is properly monitored according to the IoT system requirements	Monitoring software and parameters are identified			3
		Monitoring software parameters are selected			3
		IoT system is monitored			2
	Data backup is correctly performed as per the backup guidelines	Backup type is identified			2
		Backup is performed			4
	IoT system status is properly interpreted as per the installation manual	Event triggering is identified			2
		Conditional actions are interpreted			3
		IoT device services management are performed			3
Test IoT system: (15%)	Types of testing are properly identified according to the installation requirements	Types of testing are identified			1
	IoT Testing tools are correctly selected based on the type of testing	Testing tools are selected			2
	Connectivity testing is correctly performed	Connectivity tools are selected			1

	according to the installation requirements	Connectivity testing is performed			2
	Functional testing is correctly performed according to IoT system installed	Functional testing is performed			2
		Functional testing report is generated			2
	Performance testing is correctly performed according the IoT system installed	Performance testing tool is selected			1
		Performance testing is performed			2
	Testing report is correctly elaborated based on the test results	Testing report is generated			2
Maintain IoT system (15%)	Features updates are properly installed based on the manufacture's guidelines	Preventive Maintenance is performed			7
	IoT system protection measures are properly checked in accordance with the installation manual	Protection measures are performed			5
	Preventive Maintenance report is properly elaborated based on the work done	Preventive Maintenance report is elaborated			3
Total marks					**100**
Percentage Weightage					**100%**
Minimum Passing line % (Aggregate): **70%**					

References:

1. Chaouchi, H. (2010). *Getting Started with the Internet of Things.* California: Wiley.

2. Gilchrist, A. (2016). *Industry 4.0: The Industrial Internet of Things.* Bangken: APress.

3. Javed, A. (2016). *Building Arduino Projects for the Internet of Things: Experiments with Real-World Applications.* Illinois: APress.

4. Khan, J. Y., & Yuce, M. R. (2019). *Internet of Things (IoT): Systems and Applications.* Singapore: Jenny Stanford Publishing.

5. McEwen, A., & Cassimally, H. (2014). *Designing the Internet of Things.* West Sussex: Wiley.

6. Pfister, C. (2011). *Getting Started with the Internet of Things: Connecting Sensors and Microcontrollers to the Cloud.* California: Make: Community.

Abbreviations

5G: 5th Generation

BLE: Bluetooth Low Energy

DHT: Digital Temperature and Humidity

GND: Ground

IIoT: Infrastructure IoT

IoMT: Internet of Military Things

IoT: Internet of Things

JTAG: Joint Test Action Group

LoRa: Long Range

LPWAN: Low Power WAN

LTE: Long Term Evolution

M2M: Machine to Machine

MCU: Microcontroller

MQTT: Message Queuing Telemetry Transport

NFC: Near-Field Communication

PAN: Personal Area Network

QoS: Quality of Service

RFID: Radio Frequency Identification

RTOS: Real-Time Operating System

RX: Receive

SDR: Software-defined radio

TCP/IP: Transmission Control Protocol/Internet Protocol

TX: Transmit

Wi-FI: Wireless Fidelity

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