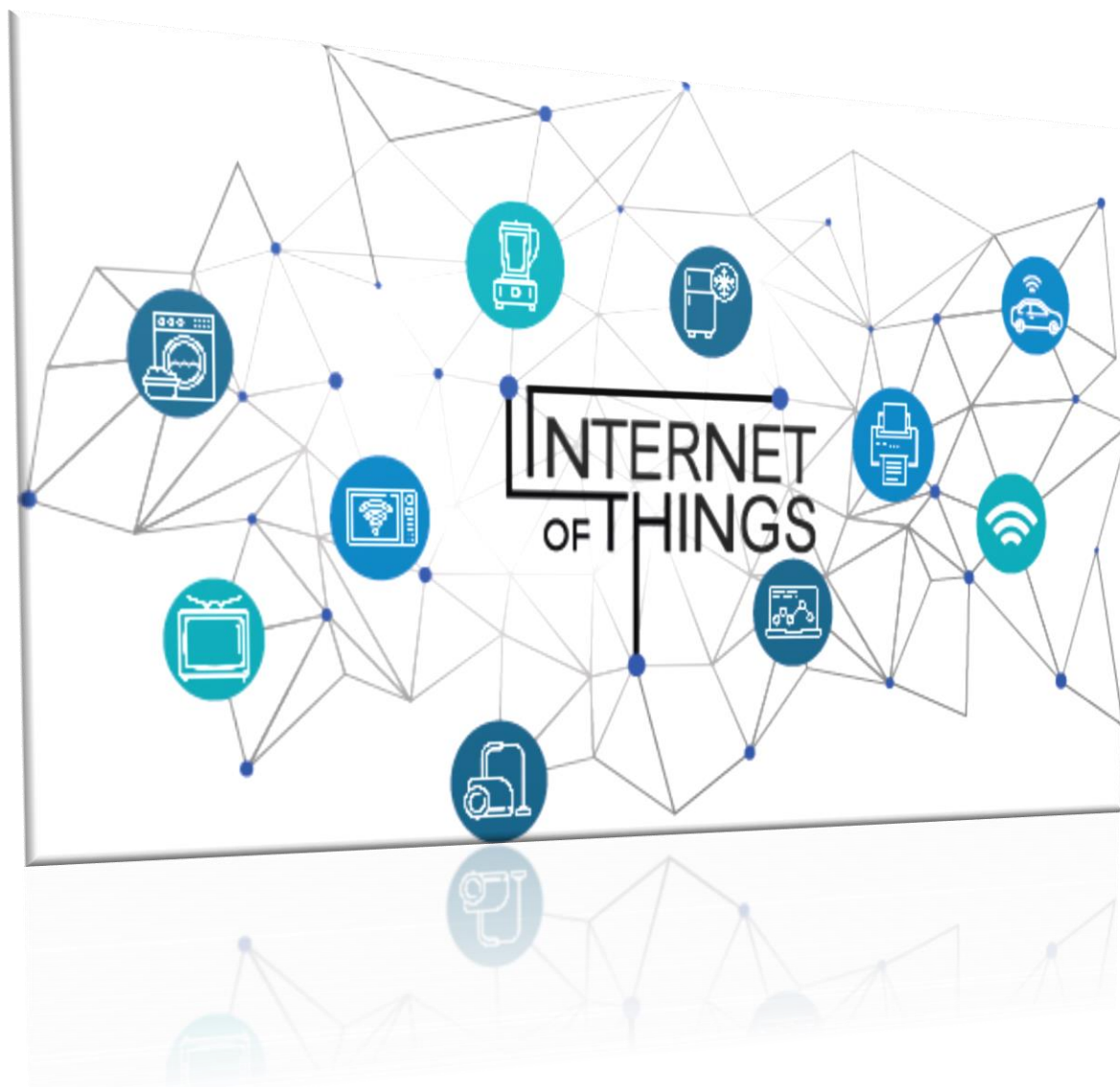




National Competency Standards for “Internet of Things (IoT)”



**National Vocational and Technical Training Commission (NAVTTTC),
Government of Pakistan**



ACKNOWLEDGEMENT

National Vocational and Technical Training Commission (NAVTTTC) extends its gratitude and appreciation to representatives of business, industry, academia, government agencies, provincial TEVTAs, sector skill councils and trade associations who spared time and extended their expertise for the development of National Vocational Qualifications for the trade of **Internet of Things (IoT)**. This work would not have been possible without the technical support of the above personnel.

NAVTTTC initiated development of CBT&A based qualifications for 200 traditional / hi-tech trades under the Prime **Minister’s Hunarmand Pakistan Program**, focusing on Development & Standardization of 200 Technical & Vocational Education & Training (TVET) Qualifications. NAVTTTC efforts have received full support from the Ministry of Federal Education and Professional Training which highly facilitated progress under this initiative.

It may not be out of place to mention here that all the experts of Industry, Academia and TVET experts of TEVTAs, BTEs and PVTC work diligently for making this qualification worthy and error free for which all credit goes to them. However, NAVTTTC accepts the responsibility of all the errors and omissions still prevailing in the Qualification document.

It is also noteworthy that development of Skill Standards is a dynamic and ongoing process, and the developed skill standards needs periodic review and updating owing to the constant technological advancements, development in scientific knowledge, and growing experience of implementation at the grass root level as well as the demand of industry. NAVTTTC will ensure to keep the qualifications abreast with the changing demands of both national and international job markets.

**Dr. Nasir Khan,
Executive Director,
NAVTTTC**



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1. Introduction

The Internet of Things (IoT) is a network of resource constrained nodes being capable of automating an existing manual procedure. This IoT network is also connected to the internet to enable ease of access and user friendly configuration and monitoring. An IoT developer is an expert who completely understands the IoT network, its different components and their working. IoT developer is capable of programming sensor and hardware devices. IoT developer is capable of developing a hardware and software for IoT edge devices. He is also trained of sending the data to the cloud server. IoT developer is a specialist in utilizing resource constrained devices. IoT cloud developer is an expert who can install and configure Virtual machines on the cloud. While IoT Data scientist is the one who utilizes the data received on the cloud and saves it efficiently in the databases to train Machine Learning algorithms. IoT security is one of the hot research topic nowadays which will create many skill based jobs in the near future. An IoT developer is incomplete without the understanding and hands on experience of security protocols. In a nutshell, IoT is the start of art technology to automate the industrial, commercial and domestic procedures and there is a need to develop the resources with the required IoT skills which will not only benefit the industry but also create job opportunities for the individuals.

IoT is an ever changing field. The number of IoT nodes are increasing each day and hence their monitoring, upgrading and security needs. Therefore, industry requirement for skilled workforce is increasing which can only be managed through setting relevant competency standards in collaboration with the leading industries.

Being cognizant of this fact, National Vocational & Technical Training Commission (NAVTTTC) developed competency standards for IoT system development under National Vocational Qualifications Framework (NVQF). These competency standards have been developed by a Qualifications Development Committee (QDC) and validated by the Qualifications Validation Committee (QVC) having representation from the leading IoT development houses and research labs of the country.



2. Purpose of the Qualification

The competency based NVQ has been developed to train the unskilled men and women of Pakistan on the technical and entrepreneurial skills to be employed / self-employed and inevitably set sustainable impact on their lives by enhancing their livelihood income.

The purpose of these qualifications is to set highly professional standards for IoT Experts in order to complete local and international job market. Who will serve as key elements enhancing quality of Pakistan’s IoT development sector. The specific objectives of developing these qualifications are as under:

- Improve the professional competence of IoT Hardware and Software development
- Capacitate the local community and trainers in modern CBT trainings, methodologies and processes as envisaged under NVQF
- Provide flexible pathways and progressions in IoT development houses
- Enable the trainees to perform their duties in efficient manner
- Establish a standardized and sustainable system of training in IoT industry in Pakistan
- Enabling the youth with greater employment opportunities



3. Date of Validation

The level 5 IoT qualification has been validated on 20th – 24th July 2020 at PITAC, Lahore, by the qualification validation committee (QVC) members.

4. Date of Review

The level 5 IoT qualification has been reviewed on _____, by the qualification validation committee (QVC) members.

5. Codes of Qualifications

The International Standard Classification of Education (ISCED) is a framework for assembling, compiling and analyzing cross-nationally comparable statistics on education and training. ISCED codes for these qualifications are assigned as follows:

ISCED Classification	
Code	Description
0714-E&A(1)	1 st Level National Certificate of level-5, in “ Internet of Things”
0714-E&A(2)	2 nd Level National Certificate of level-5, in “ Internet of Things”
0714-E&A(3)	3 rd Level National Certificate of level-5, in “ Internet of Things”
0714-E&A(4)	4 th Level National Certificate of level-5, in “ Internet of Things”



6. Members of Qualification Development Committee

The following members participated in the qualification development process of the IoT qualification at PITAC, Lahore.

Date:08 to 12 June 2020

S#	Name	Designation
1.	Dr. Adnan Noor Mian	Associate Professor – ITU, Lahore
2.	Ali Hammad	Associate Professor – UET, Lahore
3.	Sanaullah Manzoor	Research Associate & PHD Fellow – ITU, Lahore
4.	Muhammad Anghus Jamil	Managing Partner – Techno Desert
5.	Mughees Butt	Co-founder – Techno Desert
6.	Salman Shahid	Embedded Developer – Techno Desert
7.	Amir Amin	HOD – City Polytechnic
8.	Muhammad Umair	Lecturer, UET Lahore
9.	Hina Khalid	Assistant Professor – UET, Lahore
10.	Muhammad Yasir	Deputy Director - NAVTTC
11.	Muhammad Hassaan	Daccum Facilitator / BCS



7. Members of Qualification Validation Committee

The following members participated in the qualification validation process of **IoT** at PITAC, Lahore.

Date: 20th -24th July, 2020

S#	Name	Designation
1.	Dr. Ahmad Mustafa	Chief Instructor, GSTC, Murree
2.	M. Abbas Khan Abbasi	HOD, KP Tevta, GPI, Mansehra
3.	Hina Khalid	Assistant Professor, UET, Lahore
4.	Danish Khan	Calibration & Testing Engineer, PCSIR, Islamabad
5.	Muzammil Hassan	AM Research, KICS-UET, Lahore
6.	Muhammad Umair	Lecturer, UET, Lahore
7.	Sanaullah Manzoor	Research Associate, PHD Fellow, ITU, Lahore
8.	Faisal Sarwar	PBTE Representative
9.	Muhammad Nouman	
10.	Muhammad Yasir	Deputy Director, NAVTTC
11.	Muhammad Hassaan	Daccum Facilitator



8. Entry Requirements

The entry requirement for this qualification would be Matric with science.

9. Regulation of the Qualification and Schedule Of Units

Not Applicable



10. Summary of Competency Standards

Sr No	Competency Standards	Occupation	NVQF Level	Category	Estimated Contact Hours			Cr Hr
					Th	Pr	Total	

Level 4 IoT Programmer

1	Interface Sensors and Actuators		Level 4	Technical	28	69	97	9.7
2	Apply Microcontroller interfacing protocols		Level 4	Technical	18	69	87	8.7
3	Configure ADC and PWM of a Controller		Level 4	Technical	15	42	57	5.7
4	Interface Short Range Wireless Technologies (Wifi, Bluetooth, BLE, Zigbee,) with the microcontrollers		Level 4	Technical	22	96	118	11.8
5	Program Basic Building blocks using C/C++		Level 4	Technical	52	246	298	29.8
6	Program different applications in Arduino, Raspberry Pi and NodeMCU		Level 4	Technical	22	81	103	10.3
7	Perform Arduino, Raspberry Pi and NodeMCU Interfacing with Sensors		Level 4	Technical	26	90	116	11.6
8	Perform Socket Programming		Level 4	Technical	19	87	106	10.6
9	Develop mobile apps using MIT APP Inventor		Level 4	Technical	19	96	115	11.5
10	Develop a smart home based project		Level 4	Technical	7	66	73	7.3
11	Work in a team		Level 4	Generic	12	18	30	3
Total					240	960	1200	120



11. Detail of Qualification and its Competency Standards

LEVEL 4: IOT PROGRAMMER

0714-E&A-1. Interface Sensors and Actuators

Overview: This competency unit covers the skills and required knowledge to interface (connect physically) different sensors and actuators in the given circuit.

Competency Unit	Performance Criteria
CU1. Interface Temperature Sensor	P1: Select sensor according to specification P2: Download the datasheet to configure pins P3: Configure sensor according to datasheet P4: Connect the sensor in given circuit
CU2. Interface Humidity Sensor	P1: Select sensor identification number P2: Download the datasheet to configure pins P3: Configure sensor according to datasheet P4: Connect the sensor in given circuit
CU3. Interface Occupancy Sensor	P1: Select sensor identification number P2: Download the datasheet to configure pins P3: Configure sensor according to datasheet P4: Connect the sensor in given circuit
CU4. Interface IR Sensor	P1: Select sensor identification number P2: Download the datasheet to configure pins P3: Configure sensor according to datasheet P4: Connect the transmitter in the circuit P5: Connect the receiver in the circuit
CU5. Interface Ultrasonic Sensor	P1: Select sensor identification number P2: Connect the Vcc and GND with respective pins of circuit P3: Connect ECHO pin with RX pin of your circuit P4: Connect TRIG pin with TX pin of circuit.
CU6. Interface RFID	P1: Select the sensor according to specifications P2: Download the datasheet to configure pins P3: Configure sensor according to datasheet



	P4: Connect the sensor in the given circuit
CU7. Interface NFC	P1: Select the sensor according to specifications P2: Download the datasheet to configure pins P3: Configure sensor according to datasheet P4: Connect the sensor in the given circuit
CU8. Interface Actuators	P1: Select actuator according to specifications P2: Download the datasheet to configure pins P3: Configure actuator according to datasheet P4: Connect the actuator with corresponding digital/analog pin

Knowledge & Understanding

The trainee must be able to demonstrate knowledge and understanding required to carry out tasks covered in this competency standards which includes the knowledge of:

- Basic electronics (resistance, capacitors, inductors, diodes, SCR, TRIAC etc)
- Understanding of sensor identification number
- Knowledge about different sensors
- Analog Inputs and outputs, their conversions, different base systems etc.
- Understand Active and passive elements/sensors
- Understanding of microcontrollers
- Basic understanding of circuits
- Understanding of NFC and NFC tags
- Understanding to interface / connect temperature sensor
- Differentiate power, communication and control pins
- Understanding of communication protocols for sensors
- Knowledge of measurement system specifications
- Knowledge about active and passive sensor
- Understanding of transmitter and receiver

Tools and Equipment

The tools and equipment required for this competency standard are given below:

S. No.	Items
1	Temperature Sensor
2	Humidity Sensor
3	Occupancy Sensor
4	IR Sensor
5	Ultrasonic Sensor



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6	Relay
7	Transistor
9	Solenoid Valve
10	Datasheets
11	Power Supply
12	Arduino
13	Raspberry pi
14	Seven segment display
15	Smartphone
16	NFC Tags
17	Actuator
18	DC motor

Critical Evidence(s) Required

The candidate needs to produce following **Critical Evidence(s)** in order to be competent in this competency standard:

- Implement circuit diagrams being performed



0714-E&A-2. Apply Microcontroller Interfacing Protocols

Overview: This competency unit covers the skills and required knowledge to use different interfaces of a microcontroller and interface sensors with microcontrollers in C programming language.

Competency Unit	Performance Criteria
CU1. Connect and read data through SPI Interface	P1: Select number of pins as per requirement P2: Select number of packets and its format P3: Create the packets in sequence in C programming language P4: Connect the sensor in the circuit using SPI interface P5: Read value in C programming language
CU2. Connect and read data through I2C Interface	P1: Select number of pins as per requirement P2: Select number of packets and its format P3: Create the packets in sequence in C programming language P4: Connect the sensor in the circuit using I2C interface of microcontroller P5: Read value in C programming language
CU3. Connect and read data through Serial Communication (UART, USART)	P1: Select number of pins as per requirement P2: Select number of packets and its format P3: Create the packets in sequence in C programming language P4: Connect the sensor in the circuit using UART, USART interface of microcontroller P5: Read value in C programming language
CU4. Connect and read data through RS232	P1: Select number of pins as per requirement P2: Select number of packets and its format P3: Create the packets in sequence in C programming language P4: Connect the sensor in the circuit using RS232 interface P5: Read value in C programming language

Knowledge & Understanding

The trainee must be able to demonstrate knowledge and understanding required to carry out tasks covered in this competency standards which includes the knowledge of:

- Basic electronics (resistance, capacitors, inductors, diodes, transistors, TRIAC etc)
- Analog Inputs and outputs, their conversions, different base systems etc.
- Understand Active and passive elements/sensors



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- Programming Microcontrollers
- Understanding of communication interfaces of a microcontroller
- Differentiate data, clock and excitation pins
- Knowledge about C/C++ language
- Explain I2C clock speed, devices, baud rate and working voltage
- Define UART & USART interface
- Explain packet format
- Define RS232
- Explain RS232 clock speed, devices, baud rate and working voltage
- Define Synchronous and asynchronous communication

Tools and Equipment

The tools and equipment required for this competency standard are given below:

S. No.	Items
1	Temperature Sensor
2	Humidity Sensor
3	Occupancy Sensor
4	IR Sensor
5	Ultrasonic Sensor
6	Relay
7	Transistor
8	TRIAC
9	Solenoid Valve
10	Datasheets
11	Power Supply
12	Microcontroller
13	C IDE
14	UART transmitter
15	USART Transmitter
16	Trainer

Critical Evidence(s) Required

The trainee needs to produce following critical evidence (s) to be competent in this competency standard

- Program different interfaces of microcontroller



0714-E&A-3. Configure ADC and PWM of a Controller

Overview: This competency unit covers the skills and required knowledge to configure ADCs and PWM available on microcontrollers. This competency unit also covers the tools required to execute the performance criterion

Competency Unit	Performance Criteria
CU1. Configure ADC of Arduino and NodeMCU	P1: Download datasheet of required module P2: Select ADC pins P3: Calculate Resolution of ADC P4: Make one ADC pin as input using C/C++ programming language P5: Write and read value in C/C++ programming language
CU2. Configure PWM of Arduino/ NodeMCU	P1: Download datasheet of Arduino/NodeMCU P2: Select Analog pins P3: Calculate resolution of ADC P4: Make one ADC pin as output using C P5: Connect LED to this Pin P6: Examine LEDs brightness
CU3. Configure ADC of Raspberry Pi	P1: Download Pin Configuration of Raspberry Pi P2: Select PWM pins P3: Set identified pin as output in python P4: Set frequency of required signal P5: Apply this frequency on this output pin using python P6: Connect LED to identified pin P7: Examine LEDs brightness

Knowledge & Understanding

The trainee must be able to demonstrate knowledge and understanding required to carry out tasks covered in this competency standards which includes the knowledge of:

- Understanding of Analog Inputs and outputs
- Microcontrollers
- Explain ROM, EPROM, EEPROM
- Conversion of analog to digital signal and vice versa
- Different Number Systems
- Amplitude, frequency and duty cycle etc.
- Understanding of Analog and Inputs and outputs
- Programming Microcontrollers
- Conversion of analog to digital signal and vice versa
- Different Number Systems
- Knowledge of PWM, ADC.



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- Basic knowledge of C/C++ language about hardware configuration
- Amplitude, frequency and duty cycle etc.
- Knowledge of pulse width modulation
- Basic knowledge of basic python language

Tools and Equipment

The tools and equipment required for this competency standard are given below:

S. No.	Items
1	Temperature Sensor
2	Humidity Sensor
3	Occupancy Sensor
4	IR Sensor
5	Ultrasonic Sensor
6	Relay
7	Transistor
8	TRIAC
9	Solenoid Valve
10	Datasheets
11	Power Supply
12	Microcontroller
13	Raspberry pi
14	Jumper Wire
15	NodeMCU module
16	LED
17	Trainer

Critical Evidence(s) Required

The trainee needs to produce following critical evidence (s) to be competent in this competency standard

- Programs ADC of different microcontroller



0714-E&A-4. Interface short range wireless technologies (WiFi, Bluetooth, BLE, Zigbee,) with Micro-controller

Overview: This competency unit covers the skills and required knowledge to use different Short-Range Wireless Technologies such as (WiFi, Bluetooth, BLE, Zigbee,). This competency unit also covers the tools required to execute the performance criterion.

Competency Unit	Performance Criteria
CU1. Interface WiFi module with a Controller	P1: Integrate WIFI module with the controller P2: Configure WIFI settings P3: Establish WIFI communication between two different modules P4: Transmit and receive Application data P5: Rectify the issues in connectivity of the device.
CU2. Interface Bluetooth module with a controller	P1: Integrate Bluetooth module with the controller P2: Configure Bluetooth settings P3: Establish Bluetooth communication between two different modules P4: Transmit and receive Application data P5: Rectify the issues in connectivity of the device
CU3. Interface ZigBee with a controller	P1: Select module identification number P2: Download the datasheet P3: Select coordinator, router and endnode P4: Configure Zigbee node as End Node P5: Configure Zigbee Node as Coordinator P6: Create Zigbee network P7: Receive the data from the Zigbee Network

Knowledge & Understanding

The trainee must be able to demonstrate knowledge and understanding required to carry out tasks covered in this competency standards which includes the knowledge of:

- Knows basics of wireless communication and various protocols for wireless communication.
- Understanding of network topologies: Star, mesh and hybrid networks
- Able to identify infrastructure-based and ad-hoc networks
- Able to identify different components of a network
- Knowledge of ZigBee
- Basic understanding of the Short-range protocols
- I/O interfacing and microcontroller programming
- Understanding of network topologies: Star, mesh, bus, ring and hybrid networks



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- Able to identify infrastructure and adhoc networks
- Able to identify different components of a network
- I/O interfacing and microcontroller programming
- Microcontrollers
- Able to choose the best topology as per the application
- Able to understand components and communication protocols of WSNs
- I/O interfacing and microcontroller programming
- Able to choose the best network topology as per the application requirements

Tools and Equipment

The tools and equipment required for this competency standard are given below:

S. No.	Items
1	WiFi Shield for Arduino
2	Microcontroller - Arduino
3	ZigBee Module
4	Bluetooth Module
5	BLE Module
6	Jumper wires
7	Built-in software libraries for communication
8	Datasheets
9	Power Supply
10	DMM for testing hardware connections
11	Laptop
12	Working internet connection
13	Temperature sensor
14	LoRa Module
15	Microcontroller – Arduino
16	Raspberry pi
17	IoT Devices

Critical Evidence(s) Required

The trainee needs to produce following critical evidence (s) to be competent in this competency standard

- Establish communication between two devices for each of the wireless technologies (WIFI, Bluetooth, RFID, Zigbee)



0714-E&A-5. Program Basic Building Blocks using C/C++

Overview: This competency unit covers the skills and required knowledge to demonstrate the understanding of basic programming. It provides a detailed grasp on basic programming skills required for program development.

Competency Unit	Performance Criteria
CU1. Develop Basic program with Arithmetic Computations	P1: Install the IDE for coding P2: Create basic program structure P3: Declare variables according to the requirements P4: Implement arithmetic expression in program P5: Debug the code in case of error numeric values P6: Run the code to display the correct answer
CU2. Develop Basic program with Decision control	P1: Create basic program structure P2: Use decision statement as per the requirement of problem P3: Debug the code in case of error P4: Run the code to display the correct answer
CU3. Develop Basic programs using loop	P1: Create basic program structure P2: Initialize loop control variable P3: Set loop condition P4: Set loop invariant P5: Write the loop as per the requirement of the problem P6: Run the code to display the correct answer
CU4. Develop programs with arrays	P1: Create basic program structure P2: Declare and initialize array P3: Define loop to access array P4: Access elements of array to perform actions as per requirement of the problem P5: Debug the code in case of error P6: Run the code to display the correct answer
CU5. Develop programs using pointer	P1: Create basic program structure P2: Declare and initialize pointer P3: Assign an address value to pointer P4: Access different memory indices through this value P5: Access elements of an array using pointers
CU6. Develop program with functions	P1: Create basic program structure P2: Initialize the function header, with parameters and return type



	<p>P3:Declare the function, to perform the assigned task.</p> <p>P4:Call the user created function as per requirement of problem</p> <p>P5:Call multiple functions with different parameters and display results.</p> <p>P6:Debug the code in case of error</p> <p>P7:Run the code to display the correct answer</p>
CU7. Develop a program using built-in libraries	<p>P1:Create basic program structure</p> <p>P2:Include the header file as required by the problem</p> <p>P3:Call the functions instructed by task from the built-in library.</p> <p>P4:Perform the task as per requirement of problem</p> <p>P5:Debug the code in case of error</p> <p>P6:Run the code to display the correct answer</p>
CU8. Develop programs using basic classes	<p>P1:Declare member functions and variables of the class</p> <p>P2:Create the objects of that class</p> <p>P3:Initialize the object</p> <p>P4:Access the functions and data of particular objects.</p> <p>P5:Debug the code in case of error</p> <p>P6:Run the code to display the correct answer</p>
CU9. Develop programs using encapsulation	<p>P1:Initialize the function header, with parameters and return type</p> <p>P2:Declare member functions and variables of the class</p> <p>P3:Apply encapsulation (private, public) on the classes</p> <p>P4:Create the objects of that class</p> <p>P5:Initialize the object</p> <p>P6:Access the functions and data of particular objects.</p> <p>P7:Debug the code in case of error</p> <p>P8:Run the code to display the correct answer</p>
CU10. Develop program using classes with inheritance	<p>P1:Declare parent and child class</p> <p>P2:Declare member functions and variables of required classes</p> <p>P3:Create an objects of child classes</p> <p>P4:Access parent class function using child class objects</p> <p>P5:Initialize the objects</p> <p>P6:Access the functions and data of declared objects as per the requirement of the problem</p> <p>P7:Debug the code in case of error</p> <p>P8:Run the code to display the correct answer</p>



CU11. Develop program using classes with polymorphism	P1: Declare parent and child class P2: Declare member functions and variables of these classes P3: Create objects of both classes parent and child P4: Initialize the objects P5: Access the functions and data of declared objects to show polymorphic behavior P6: Debug the code in case of error P7: Run the code to display the correct answer
CU12. Develop program using files	P1: Write the code to open file from program P2: Declare member functions and variables of the classes P3: Write data in that file from the program. P4: Write code to open another file from program P5: Read data from that file and display it P6: Debug the code in case of error P7: Run the code to display the correct answer

Knowledge & Understanding

The trainee must be able to demonstrate knowledge and understanding required to carry out tasks covered in this competency standards which includes the knowledge of:

- Understanding the basic problem to be solved.
- Identification of programming concept required in it.
- Understanding of IDE being used for the selected language.
- Understanding of basic Data Types, Variables and Constants basic input and output statements.
- Understanding of decision control statements.
- Understanding of Repetition (Loops) statements.
- Understanding of Arrays
- Understanding of Functions
- Understanding of commonly used built-in libraries
- Define Pointer and address handling
- Understanding of object-oriented programming (OOP).
- Differentiation between objects and classes
- Basic Understanding of Encapsulation and data abstraction
- Basic Understanding of Inheritance

Tools and Equipment

The tools and equipment required for this competency standard are given below:

S. No.	Items
1	IDE for C++ / Python (Py charm / Dev C++)
2	Laptop/Desktop



Critical Evidence(s) Required

The trainee needs to produce following critical evidence (s) to be competent in this competency standard

1. Programs developed by the student



0714-E&A-6. Program different applications in Arduino, Raspberry pi and NodeMCU

Overview: This competency unit covers the skills and required knowledge to start programming on Arduino, Raspberry pi and NodeMCU. It also provides an introduction to the main syntax required for Arduino programming.

Competency Unit	Performance Criteria
CU1. Develop applications on Arduino	P1: Setup environment for Arduino IDE P2: Perform LED blink with basic digital wire P3: Perform multiple LED handling with loops and arrays P4: Control digital input and output P5: Test LED Fader with Analog Input handling P6: Control Serial communication P7: Perform interfacing with accelerometer P8: Interrupt handling with button
CU2. Develop applications on Raspberry Pi	P1: Setup environment for Raspberry Pi P2: Perform LED blink with Basic digital write P3: Handle multiple LEDs with loops and arrays P4: Control digital input and output P5: Control LED's glow with Analog Input handling P6: Interface with accelerometer sensor P7: Control Interrupts with push button
CU3. Develop applications on NodeMCU	P1: Setup environment for NodeMCU P2: Perform LED blink with Basic digital write P3: Handle multiple LEDs with loops and arrays P4: handle digital input and output P5: Fade LED's glow with Analog Input handling P6: Handle serial communication P7: Perform interfacing with accelerometer P8: Interrupt handling with button

Knowledge & Understanding

The trainee must be able to demonstrate knowledge and understanding required to carry out tasks covered in this competency standards which includes the knowledge of:

- Understanding of basic programming
- Understanding of basic Arduino board
- Understanding of basic Sensors and their interfaces
- Understanding of interrupts
- Understanding of Digital analog communication



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- Understanding of serial communication
- Understanding of Transmitter and Receiver Phenomenon
- Understanding of basic Raspberry-Pi board
- Understanding of NodeMCU

Tools and Equipment

The tools and equipment required for this competency standard are given below:

S. No.	Items
1	Arduino UNO
2	Arduino IDE
3	Laptop/Desktop
4	LED Bulb
5	Mini USB Cable
6	Internet Connection
7	Jumper Wires
8	Infrared Sensor, Ultrasonic Sensor, Current Sensor, Voltage Sensor
9	Bluetooth Module, WIFI Module, RFID Module, Relay Module
10	NodeMCU
11	Raspberry pi

Critical Evidence(s) Required

The trainee needs to produce following critical evidence (s) to be competent in this competency standard.

1. Programs developed by students
2. Circuit footprints/diagrams



0714-E&A-7. Perform Arduino, Raspberry Pi and NodeMCU interfacing with sensors

Overview: This competency unit covers the skills and required knowledge to interface Arduino, Raspberry pi and NodeMCU with various sensors and modules. It provides an introduction to the main theories and activities associated with Arduino, Raspberry pi and NodeMCU with various sensors and modules being applied in industry

Competency Unit	Performance Criteria
CU1. Perform Arduino interfacing with sensors	P1: Program Arduino with Infrared Sensor for outputs P2: Program Arduino with Current Sensor for output P3: Program Arduino with Voltage Sensor for Outputs P4: Program Arduino with Ultrasonic Sensor P5: Program Arduino with Bluetooth Module P6: Program Arduino with WIFI Module P7: Program Arduino with RFID module P8: Program Arduino with Relay module
CU2. Perform Raspberry Pi interfacing with sensors	P1: Interface Raspberry PI with Infrared Sensor P2: Interface Raspberry PI with Current Sensor P3: Interface Raspberry PI with Voltage Sensor P4: Interface Raspberry PI with Ultrasonic Sensor P5: Interface Raspberry PI with Bluetooth Module P6: Interface Raspberry PI with WIFI Module P7: Interface Raspberry PI with RFID module P8: Interface Raspberry PI with Relay module
CU3. Perform NodeMCU interfacing with sensors	P1: Interface NodeMCU with Infrared Sensor P2: Interface NodeMCU with Current Sensor P3: Interface NodeMCU with Voltage Sensor P4: Interface NodeMCU with Ultrasonic Sensor P5: Interface NodeMCU with Bluetooth Module P6: Interface NodeMCU with WIFI Module P7: Interface NodeMCU with RFID module P8: Interface NodeMCU with Relay module

Knowledge & Understanding

The trainee must be able to demonstrate knowledge and understanding required to carry out tasks covered in this competency standards which includes the knowledge of:

- Understanding of Infrared Sensor
- Understanding of Ultrasonic Sensor



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- Understanding of Bluetooth Module
- Understanding of WIFI Module
- Understanding of RFID Module
- Understanding of Relay Module
- Understanding of Transmitter and Receiver Phenomenon
- Understanding of Raspberry Pi
- Understanding of NodeMCU
- Understanding of Arduino

Tools and Equipment

The tools and equipment required for this competency standard are given below:

S. No.	Items
1	Arduino UNO
2	Arduino IDE
3	Laptop/Desktop
4	LED Bulb
5	Mini USB Cable
6	Internet Connection
7	Jumper Wires
8	Infrared Sensor, Ultrasonic Sensor, Current Sensor, Voltage Sensor
9	Bluetooth Module, WIFI Module, RFID Module, Relay Module
10	NodeMCU
11	Raspberry pi

Critical Evidence(s) Required

The trainee needs to produce following critical evidence (s) to be competent in this competency standard.

1. Programs developed by students
2. Circuit footprints/diagrams



0714-E&A-8. Perform Socket Programming

Overview: This competency unit covers the skills and required knowledge to demonstrate the understanding of basic socket programming using TCP and UDP. It provides a hands-on grasp on client server communication using sockets.

Competency Unit	Performance Criteria
CU1. Develop the code to communicate between client and server side	<p>P1: Write code to open a socket.</p> <p>P2: Write code to open an input stream and output stream to the socket.</p> <p>P3: Read from and write to the stream according to the server's protocol.</p> <p>P4: Listen for the connection on server side</p> <p>P5: Close the streams.</p> <p>P6: Close the socket.</p> <p>P7: Perform communication between client and server using socket programming</p> <p>P8: Perform socket troubleshooting</p>
CU2. Develop the code for multi-client server	<p>P1: Write code to open a socket.</p> <p>P2: Write code to open an input stream and output stream to the socket.</p> <p>P3: Listen for the connection on server side</p> <p>P4: Start an independent thread for multiple clients</p> <p>P5: Close the streams.</p> <p>P6: Close the socket in case of exception</p> <p>P7: Perform socket troubleshooting</p>

Knowledge & Understanding

The trainee must be able to demonstrate knowledge and understanding required to carry out tasks covered in this competency standards which includes the knowledge of:

- Understanding of the detailed language of interest
- Basic understanding of client server communication
- Basic understanding of DNS servers
- Basic understanding of ports and network addressing
- Understanding of TCP and UDP
- Knowledge of operating system ports and how to unblock them.



Tools and Equipment

The tools and equipment required for this competency standard are given below:

S. No.	Items
1	IDE
2	Laptop/Desktop

Critical Evidence(s) Required

- The trainee needs to produce following critical evidence (s) to be competent in this competency standard
1. Programs of server and client side



0714-E&A-9. Develop mobile apps using MIT APP inventor

Overview: This competency unit covers the skills and required knowledge to demonstrate the understanding of Android App development using MIT App Inventor. It provides a detailed grasp on basic programming skills required for App Inventor usage

Competency Unit	Performance Criteria
CU1. Transfer app to mobile device via USB and WIFI	P1: Open the IDE for coding P2: Code a simple hello world program P3: Compile a code P4: Debug the code (in case of error) P5: Run a code on emulator P6: Create a hello world app using app inventor P7: Connect to mobile while WiFi and transfer app to mobile and run it. P8: Connect to mobile via USB and transfer app to mobile and run it.
CU2. Develop Basic app with user interface	P1: Make basic app structure with single activity/screen P2: Use some basic user interface controls as required by the problem P3: Transfer the code to mobile and execute
CU3. Develop app with multi-screen	P1: Make basic app structure with two activities/screens P2: Use some basic user interface controls as required by the problem P3: Switch from one screen to next P4: Transfer the code to mobile and execute
CU4. Develop app to interact with phone Call	P1: Make user interface with a phone dialer P2: Write the code to Initialize call on selected number P3: Transfer the code to phone and check if the call gets connected
CU5. Develop app to interact with location sensor	P1: Make user interface to show location data P2: Write code to get the location data from sensor whenever the location changes and display P3: Transfer the code to phone and check if the call gets connected



CU6. Develop app to transmit data to local Database	P1: Make basic app to take some data from user. P2: Store that data to the local DB P3: Make another app to read data from local DB P4: Extract data for the same DB used in first app and display it P5: Transmit both app to mobile P6: Run both apps in set order P7: Ensure coordination among both apps
CU7. Install App Inventor support for Arduino	P1: Set up Arduino IDE P2: Install App Inventor support for Arduino P3: Interface Arduino with computer P4: Transfer AIM-for-Things-Arduino101.ino to board P5: App inventor should be able to access Arduino

Knowledge & Understanding

The trainee must be able to demonstrate knowledge and understanding required to carry out tasks covered in this competency standards which includes the knowledge of:

- Understanding the basic problem to be solved.
- Knowledge of basic programming skills.
- Basic understanding of block-based programming environments.
- Basic knowledge of Arduino.
- Basic handling of circuit board and cables.

Tools and Equipment

The tools and equipment required for this competency standard are given below:

S. No.	Items
1	IDE
2	Laptop/Desktop
3	Arduino
4	Android based mobile
5	Basic wires and jumpers

Critical Evidence(s) Required

The trainee needs to produce following critical evidence (s) to be competent in this competency standard.

1. Develop a mobile application to control switches



0714-E&A-10. Develop a Smart Home Project

Overview: In this competency standard trainee will develop a Smart Home Project System using imperative tools and applications, he learned throughout this course.

Competency Unit	Performance Criteria
CU1. Control Lights and Fans through Android Application	<p>P1. Interface Relay Driving Circuit with Nodemcu.</p> <p>P2. Connect a bulb/fan with the relay.</p> <p>P3. Write a C/C++ application on Nodemcu to trigger relay.</p> <p>P4. Apply code to connect Nodemcu to available Wi-Fi router / access point.</p> <p>P5. Apply code to connect to any public MQTT broker.</p> <p>P6. Create this topic on the broker.</p> <p>P7. Add in the code (Nodemcu program) to subscribe to this topic.</p> <p>P8. Build a Simple Android application with a button / switch and MQTT client.</p> <p>P9. Add functionality in the Android app that whenever switch is on, send a MQTT message on the same topic.</p> <p>P10. Add functionality in the Nodemcu code that whenever this message is received, turn on the relay.</p> <p>P11. Execute the code on Nodemcu and control relay from android app.</p>
CU2. Receive Indoor sensor's value on android app	<p>P1. Interface temperature / humidity sensor with Nodemcu.</p> <p>P2. Write a code to read its value in C/C++.</p> <p>P3. Add in this code to connect to a Wi-Fi router.</p> <p>P4. Add MQTT client functionality in this code.</p> <p>P5. Create a topic on any public MQTT broker</p> <p>P6. Add in Nodemcu code to connect and send sensor's value to this broker on the created topic.</p> <p>P7. Build a Simple Android application with a Textview and MQTT client.</p> <p>P8. Subscribe the mqtt client in android app to the same topic and display the received message on textview.</p> <p>P9. Execute the code on Nodemcu and check received value on android app.</p>

Knowledge & Understanding

The candidate must be able to demonstrate underpinning knowledge and understanding required to carry out tasks covered in this competency standard. This includes:

- Building Android application
- Programming Nodemcu for different applications.
- Working on MQTT protocol.

Tools and Equipment



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The tools and equipment required for this competency standard are given below:

S. No.	Items
1.	Computer System
2.	Internet Connection with an accessible Wi-Fi router.
3.	Nodemcu
4.	Relay driver circuit
5.	Android studio
6.	Android phone
7.	Temperature sensor
8.	Humidity sensor
9.	Resistances

Critical Evidence(s) Required

The candidate needs to produce following **Critical Evidence(s)** in order to be competent in this competency standard:

- Develop an IoT enabled smart home project.



0714-E&A-11. Work in a Team Environment

Overview: This unit covers the knowledge, skills and attitudes required to gather, interpret and convey information in response to workplace requirements. It also identifies role and responsibility as a member of a team. Your underpinning knowledge will be sufficient to provide you the basis for your work.

Competency Unit	Performance Criteria
CU1. Obtain and convey Workplace information	<p>P1. Assess the specific and relevant information from the appropriate sources</p> <p>P2. Convey the information using the appropriate medium and ideas</p> <p>P3. Use appropriate non- verbal communication</p> <p>P4. Identify appropriate lines of communication with supervisors and colleagues</p> <p>P5. Use the defined workplace procedures for storage of information</p> <p>P1: Inform co-workers and superiors about any deviation</p>
CU2. Participate in workplace meetings and discussions	<p>P1. Express your own opinions</p> <p>P2. Listen other’s point of view without interruption</p> <p>P1: Prepare simple questions about workplace procedures</p>
CU3. Identify own role and responsibility within team	<p>P1. Identify the individual role and responsibilities within the team environment.</p> <p>P2. Recognize the roles and responsibility of other team members.</p> <p>P3. Report relationships within team and external to team</p> <p>P2: Share report with co-workers.</p>
CU4. Support the co-workers	<p>P1. Hand over the required materials and tools timely to interfacing team</p> <p>P2. Work together with co-workers in an effective manner</p> <p>P3. Address the problems of co-worker effectively</p> <p>P3: Report to immediate boss</p>

Knowledge & Understanding

The candidate must be able to demonstrate underpinning knowledge and understanding required to carry out tasks covered in this competency standard. This includes the knowledge of:

- Importance of effective communication



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- Different mode of communication
- Types of non-verbal communication
- Mode of communication while operating machines
- Importance of creating cooperative work environment
- Role and objective of team.
- Different Sources of information
- Risk of failure in team work on the project.
- Importance of resolving the co-worker's problems
- Plan work and organize required resources in coordination with team
- 7Cs of communications

Critical Evidence(s) Required

The candidate needs to produce following critical evidence(s) in order to be competent in this competency standard:

- Prepare minutes of meeting
- Prepare questions for meeting
- Prepare a report about daily workplace tasks