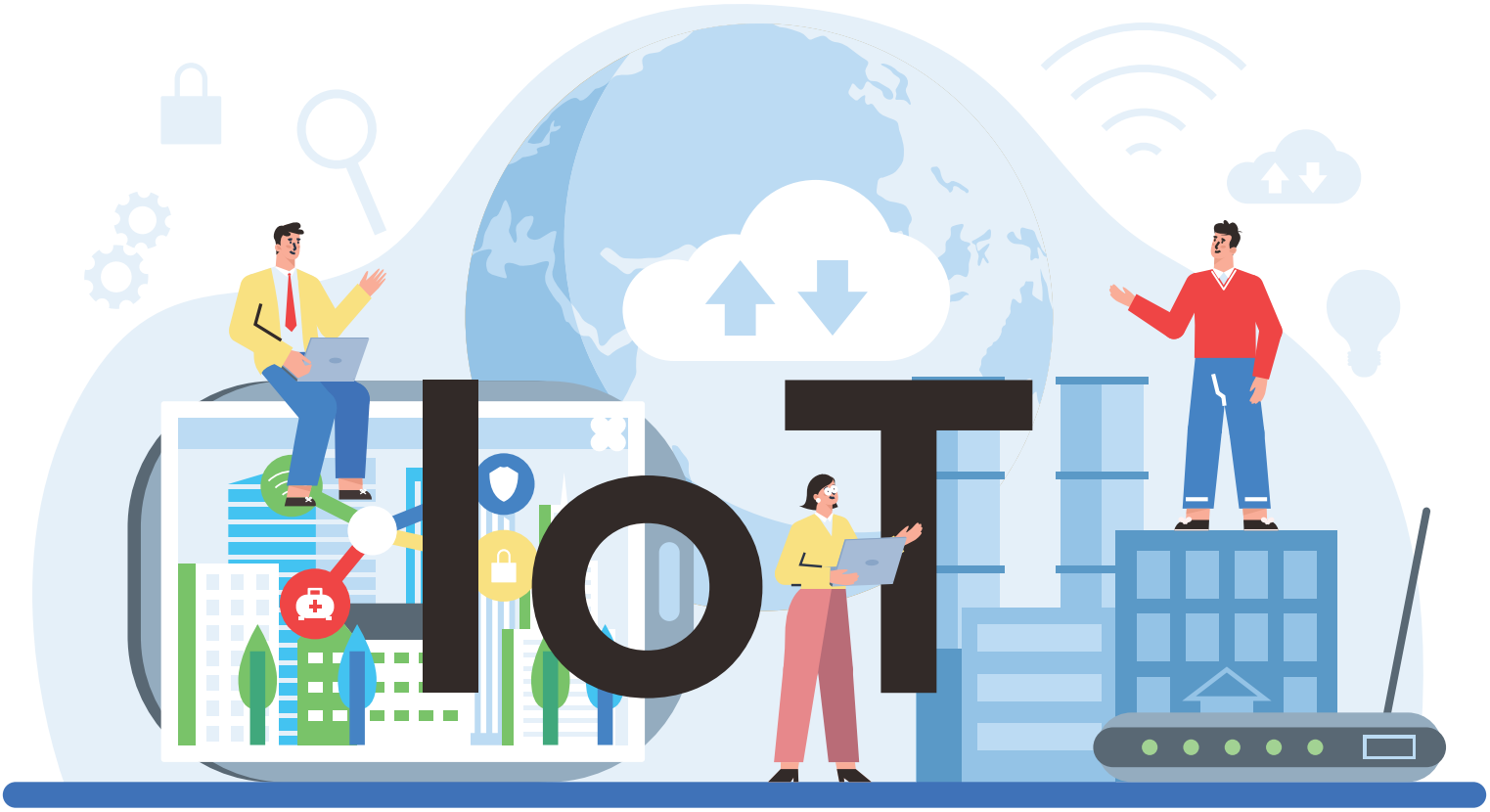
National Curriculum of Pakistan
2022-23

TECHNICAL EDUCATION

IOT & DATA CODING

IOT Fundamentals

Grades 9-10



NATIONAL CURRICULUM COUNCIL SECRETARIAT
MINISTRY OF FEDERAL EDUCATION AND
PROFESSIONAL TRAINING, ISLAMABAD
GOVERNMENT OF PAKISTAN

بسم الله الرحمن الرحيم

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It is with great pride that we, at the National Curriculum Council Secretariat, present the first core curriculum in Pakistan's 75-year history. Consistent with the right to education guaranteed by Article 25-A of our Constitution, the National Curriculum of Pakistan (2022-23) aspires to equip every child with the necessary tools required to thrive in and adapt to an ever-evolving globalized world.

The National Curriculum is in line with international benchmarks, yet sensitive to the economic, religious, and social needs of young scholars across Pakistan. As such, the National Curriculum aims to shift classroom instruction from rote learning to concept-based learning.

Concept-based learning permeates all aspects of the National Curriculum, aligning textbooks, teaching, classroom practice, and assessments to ensure compliance with contemplated student learning outcomes. Drawing on a rich tapestry of critical thinking exercises, students will acquire the confidence to embark on a journey of lifelong learning. They will further be able to acknowledge their weaknesses and develop an eagerness to build upon their strengths.

The National Curriculum was developed through a nationwide consultative process involving a wide range of stakeholders, including curriculum experts from the public, private, and non-governmental sectors. Representatives from provincial education departments, textbook boards, assessment departments, teacher training departments, *deeni madaris*, public and private publishers, private schools, and private school associations all contributed their expertise to ensure that the National Curriculum could meet the needs of all Pakistani students.

The experiences and collective wisdom of these diverse stakeholders enrich the National Curriculum, fostering the core, nation-building values of inclusion, harmony, and peace, making the National Curriculum truly representative of our nation's educational aspirations and diversity.

I take this opportunity to thank all stakeholders, including students, teachers, and parents who contributed to developing the National Curriculum of Pakistan (2022-23)

Dr. Mariam Chughtai
Director
National Curriculum Council Secretariat
Ministry of Federal Education and Professional Training

IoT Fundamentals

Grades 11-12

Domain A: Introduction to IoT

Internet of Things is the field that tackles monitoring and controlling machines over the internet.

Standard: Analyze the importance and real world applications of IoT.

Grade 9	**Grade 10**
Benchmark I: Recognize the role of IoT in building technology of the future	**Benchmark I**: Describe best practices and challenges of building at scale.w
Student Learning Outcomes	
[SLO: IoTF-09-A-01]: Define the basic concept of IoT. [SLO: IoTF-09-A-02]: List various real world applications of IoT. [SLO: IoTF-09-A-03]:	[SLO: IoTF-10-A-01]: Describe the challenges and considerations for building a scalable IoT solution. [SLO: IoTF-10-A-02]: Explain the importance of securing the IoT architecture to protect devices, data, and communication from unauthorized access. [SLO: IoTF-10-A-03]:

Explain the importance and real world impact of IoT. [SLO: IoTF-09-A-04]: Identify ways in which IoT can solve real world problems. [SLO: IoTF-09-A-05]: Predict the future trends of IoT.	Demonstrate/Illustrate the working of an IoT system with examples
Benchmark II: Describe the key IoT components and understand system design by enlisting the layers in IoT architecture.	**Benchmark II**: Solve real life problems using IoT Systems and user interfa
Student Learning Outcomes	
[SLO: IoTF-09-A-06]: Explain the role of sensors in collecting data from the environment and providing input to IoT systems. [SLO: IoTF-09-A-07]: Understand protocols, standards, and technologies used for device-to-cloud communication. [SLO: IoTF-09-A-08]: Explain the role of the cloud layer to connect the device / perception layer to the application layer. [SLO: IoTF-09-A-09]:	[SLO: IoTF-10-A-04]: Identify the different communities of IoT developers. [SLO: IoTF-10-A-05]: Understand the importance of contributing to open source. [SLO: IoTF-10-A-06]: Develop a complete IoT system including hardware and user interface to solve real life problems. [SLO: IoTF-10-A-07]: Compose an IoT tutorial on Hackster.

Learn how the application layer is responsible for user interfaces, data management and application-specific functionalities based on the collected IoT data. [SLO: IoTF-09-A-10]: Understand building analytics and insights from data collected. [SLO: IoTF-09-A-11]: Identify how automations based on analytics and insights from the lower layers to optimize operations, improve efficiency, and enable new business models. [SLO: IoTF-09-A-12]: Design IoT systems with block diagrams.	
Benchmark III: Match concepts to real world applications.	
Student Learning Outcomes	
[SLO: IoTF-09-A-13]: Analyze the different applications of IoT in the real world. [SLO: IoTF-09-A-14]: Develop a complete IoT system including hardware and user interface to solve real life problems.	

Domain B: Microcontrollers

A microcontroller is a small computer that you can use to programmatically interact with the environment, with sensors and actuators. A microcontroller in IoT also has a connectivity mechanism built in as well, so it can connect with the internet and can send sensor data and receive control signals from across the globe.

Standard: Program a microcontroller to take sensor readings.

Grade 9	**Grade 10**
Benchmark I: Analyze of microcontrollers architecture and features	**Benchmark I**: Categorize different types of actuators and sensors.
Student Learning Outcomes	
[SLO: IoTF-09-B-01]: Identify the basic features and applications of microcontrollers.	[SLO: IoTF-10-B-01]: Describe different types of sensors: analog sensors, digital sensors.
[SLO: IoTF-09-B-02]: List some common well-known microcontrollers used for IoT: ESP8266, ESP32, Raspberry Pi, etc.	[SLO: IoTF-10-B-02]: Identify different types of physical quantities and what corresponding sensors do you need to measure them.
[SLO: IoTF-09-B-03]: Understand the architecture of microcontrollers.	[SLO: IoTF-10-B-03]: Define actuators and identify different types of actuators.

[SLO: IoTF-09-B-04]: Describe different types of GPIOs and their purpose. [SLO: IoTF-09-B-05]: Describe different types of memory and their purpose: RAM, ROM. [SLO: IoTF-09-B-06]: Analyze the pin configuration of ESP8266	[SLO: IoTF-10-B-04]: Define ADC and describe how an analog pin translates analog readings to digital ones.
Benchmark II: Develop an Arduino program.	**Benchmark II**: Explain various protocols of interfacing sensors and actuators.
[SLO: IoTF-09-B-07]: Describe the role of an IDE in programming. [SLO: IoTF-09-B-08]: Demonstrate the process of installing Arduino IDE with an installer. [SLO: IoTF-09-B-09]: Define a board core and demonstrate the process of installing the ESP8266 core in Arduino IDE.	[SLO: IoTF-10-B-05]: List and describe different interface protocols: I2C, SPI, UART, etc. [SLO: IoTF-10-B-06]: Interface an I2C sensor with an ESP8266 and develop a program to read its value using OneWire library. [SLO: IoTF-10-B-07]: Define and explain PWM.

[SLO: IoTF-09-B-10]: Define a library and outline the key built-in libraries, like ESP8266WiFi, Arduino MQTT, etc. [SLO: IoTF-09-B-11]: Demonstrate the process of installing libraries in Arduino IDE. [SLO: IoTF-09-B-12]: Demonstrate the process of installing and updating USB to serial driver for ESP8266 for Windows. [SLO: IoTF-09-B-13]: Define port and demonstrate the process of selecting the relevant COM port on Arduino IDE. [SLO: IoTF-09-B-14]: Define baud rate and demonstrate the process of configuring required baud rate of COM port in Arduino IDE. [SLO: IoTF-09-B-15]: Demonstrate the process of selecting a board and its specific model in Arduino IDE.	[SLO: IoTF-10-B-08]: Interface an LED with ESP8266 and demonstrate controlling its brightness with PWM.

[SLO: IoTF-09-B-16]: Demonstrate the process of running the blink LED example sketch on ESP8266 in Arduino IDE. [SLO: IoTF-09-B-17]: Explain what the compile and upload buttons do. [SLO: IoTF-09-B-18]: Identify when the code is uploaded successfully from the printed logs. [SLO: IoTF-09-B-19]: Demonstrate the process of resolving compilation errors and upload errors in the code, from reading the logs (line numbers of the errors, etc). [SLO: IoTF-09-B-20]: Explain the use of the “Serial” class and demonstrate the process of working with the Serial Monitor to print debugging logs. [SLO: IoTF-09-B-21]: Explain the basics of C-language: declaring/initializing a variable, variable types, scope, defining/calling functions, operators (assignment, comparison, etc.), semicolon, conditions (if/else).	

[SLO: IoTF-09-B-22]: Explain the basics of the Arduino framework: setup and loop functions, delay, serial, etc.	
Benchmark III: Interface sensors with ESP8266 and develop a program to read them via respective libraries and print the readings on Serial monitor.	**Benchmark III**: Demonstrate mastery in working with Single board computers like Raspberry Pi
[SLO: IoTF-09-B-23]: Demonstrate how to interface a DHT temperature sensor with ESP8266, with circuit diagram. [SLO: IoTF-09-B-24]: Develop a sketch using the DHT library to read DHT sensor readings and print them on the serial monitor.	[SLO: IoTF-10-B-09]: Outline the key libraries for working with a Raspberry Pi: gpio, time, etc. [SLO: IoTF-10-B-10]: Develop and run a sketch to blink an LED with Raspberry Pi. [SLO: IoTF-10-B-11]: Demonstrate the process of resolving errors in the code, from reading the console (line numbers of the errors, etc). [SLO: IoTF-10-B-12]: Explain the basics of Python-language: initializing a variable, variable scope, defining/calling functions, operators (assignment, comparison, etc.), indentation rules, conditions (if/else).

	[SLO: IoTF-10-B-13]: Demonstrate how to interface a DHT temperature sensor with Raspberry Pi, with circuit diagram. [SLO: IoTF-10-B-14]: Develop a sketch using the Adafruit_DHT library to read DHT sensor readings and print them on the console.

Domain C: Communication

Standard: Program an ESP8266 to connect with the internet and send data to the cloud.

Grade 9	**Grade 10**
Benchmark I: Explain the various connectivity layers and the role of cloud.	
Student Learning Outcomes	
[SLO: IoTF-09-C-01]: Identify different layers of internet connectivity in client and server communication.	

[SLO: IoTF-09-C-02]: Explain different connectivity protocols (MQTT, HTTP, CoAP, Zigbee, LPWAN) [SLO: IoTF-09-C-03]: Define fundamental concepts and principles of MQTT.	
Benchmark II: Connecting microcontroller to a broker	
Student Learning Outcomes	
[SLO: IoTF-09-C-04]: Develop program to connect ESP8266 microcontroller to WiFi. [SLO: IoTF-09-C-05]: Understand configuring a device cloud. [SLO: IoTF-09-C-06]: Demonstrate signing up for Arduino Cloud. [SLO: IoTF-09-C-07]: Understand the device management with Arduino Cloud.	

[SLO: IoTF-09-C-08]: Build an Arduino program to connect ESP8266 to Arduino Cloud over MQTT.	
Benchmark III: Send and receive messages	
Student Learning Outcomes	
[SLO: IoTF-09-C-09]: Develop an Arduino program to control an onboard LED of ESP8266 from Arduino Cloud. [SLO: IoTF-09-C-10]: Develop Arduino program to stream temperature sensor data from ESP8266 to Arduino Cloud.	

Domain D: User Interface

Standard: Give examples of data consumption in IoT applications and build user interfaces and reporting dashboards without code.

Grade 9	**Grade 10**

Benchmark I: Build an interface with no code	**Benchmark I**: Demonstrate using Grafana to build a dashboard to show temperature readings from ESP8266 via MQTT.
Student Learning Outcomes	
[SLO: IoTF-09-D-01]: Understand the use of various widgets of Arduino Cloud. [SLO: IoTF-09-D-02]: Use a switch widget to send data to ESP8266. [SLO: IoTF-09-D-03]: Use a chart widget to display the real time sensor value of ESP8266.	[SLO: IoTF-10-D-01]: List different types of visualization platforms. [SLO: IoTF-10-D-02]: Demonstrate signing up for Grafana and creating an instance. [SLO: IoTF-10-D-03]: Define data sources on Grafana and demonstrate installing and configuring the MQTT data source to receive data from the message broker that the ESP8266 is connected to. [SLO: IoTF-10-D-04]: Identify different Grafana widgets and their uses. [SLO: IoTF-10-D-05]: Use the display widget to show the live reading from the ESP8266.

	Benchmark II: Build automations and understand data consumption
Student Learning Outcomes	
	[SLO: IoTF-10-D-06]: List different types of automations platforms: IFTTT, Zapier, etc. [SLO: IoTF-10-D-07]: Understand connecting IFTTT with Arduino Cloud. [SLO: IoTF-10-D-08]: Set up IFTTT to tweet when temperature reading from ESP8266 is greater than a particular threshold. [SLO: IoTF-10-D-09]: Understand connecting IFTTT with Google Home.

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