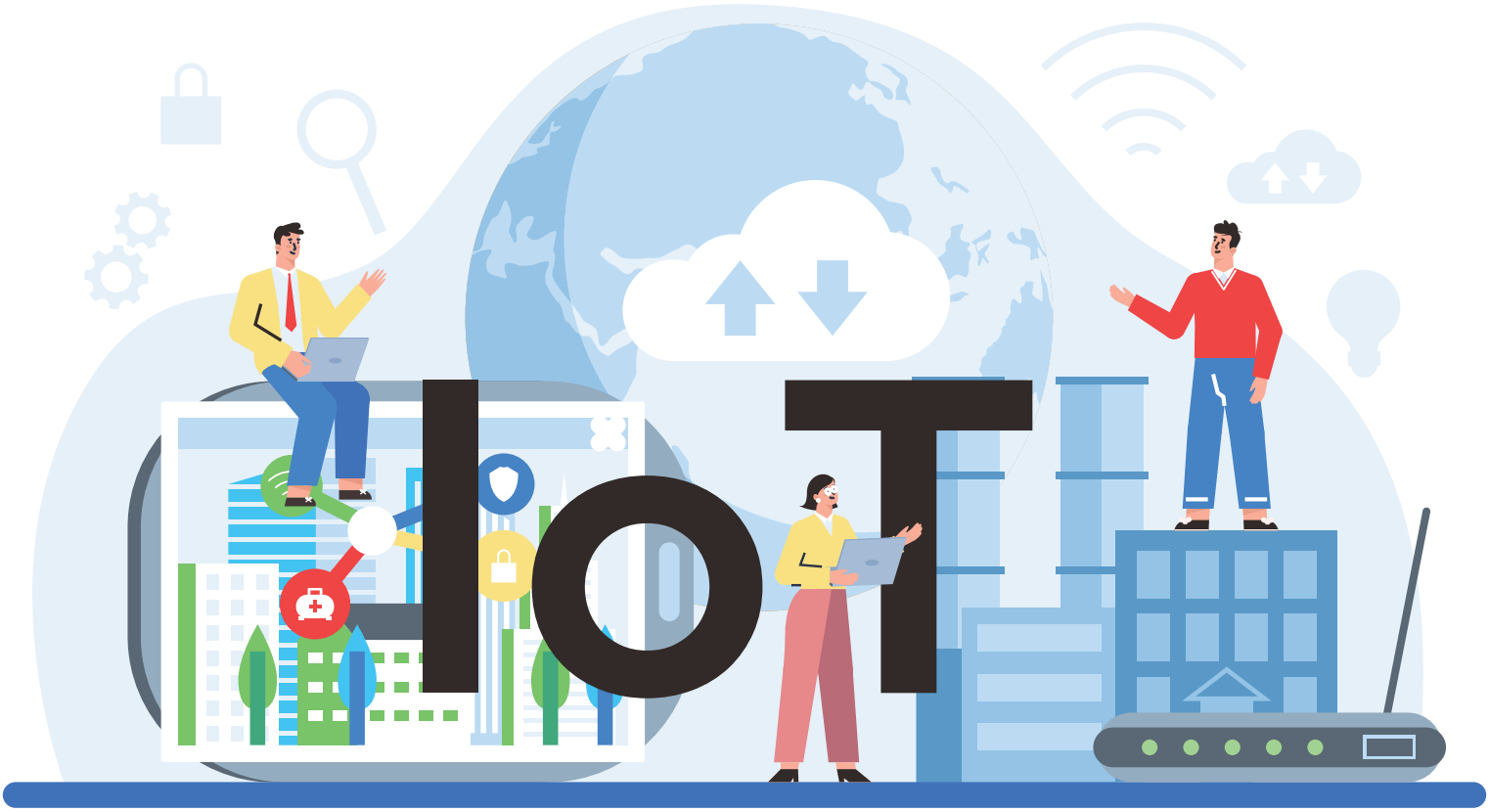
National Curriculum of Pakistan
2022-23

TECHNICAL EDUCATION

IOT & DATA CODING

IOT Advance Solutions

Grades 11-12



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 Advance Solutions

Grades 11-12

Domain A: Introduction to IoT Advanced Solutions

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

Standard: Design IoT systems with block diagrams

Grade 11	**Grade 12**
Benchmark I: Explain the importance and real world applications of IoT.	
Student Learning Outcomes	
[SLO:IoTF-11-A-01]: Define IoT and describe the basic concept of IoT. [SLO:IoTF-11-A-02]: Explain the importance and real world impact of IoT. [SLO:IoTF-11-A-03]: Identify the future trends of IoT.	

Benchmark II: Categorize IoT system into its key components and design a system from basic components.	
Student Learning Outcomes	
[SLO:IoTF-11-A-04]: Enlist the layers in IoT architecture. [SLO:IoTF-11-A-05]: Explain the role of sensors in collecting data from the environment and providing input to IoT systems. [SLO:IoTF-11-A-06]: List protocols, standards, and technologies used for device-to-cloud communication. [SLO:IoTF-11-A-07]: Explain the role of the cloud layer to connect the device / perception layer to the application layer. [SLO:IoTF-11-A-08]: Describe how the application layer is responsible for user interfaces, data management and application-specific functionalities based on the collected IoT data.	

[SLO:IoTF-11-A-09]: Explain building analytics and insights from data collected. [SLO:IoTF-11-A-10]: Identify how automations based on analytics and insights from the lower layers to optimize operations, improve efficiency, and enable new business models. [SLO:IoTF-11-A-11]: Design IoT systems with block diagrams.	

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 an ESP8266 and Raspberry Pi to interface with different sensors.

Grade 11	**Grade 12**
Benchmark I: Define the components in a microcontrollers architecture and their features.	
Student Learning Outcomes	
[SLO:IoTF-11-B-01]: Identify the basic features and applications of microcontrollers.. [SLO:IoTF-11-B-02]: List some common well-known microcontrollers used for IoT: ESP8266, ESP32, Raspberry Pi, etc. [SLO:IoTF-11-B-03]: Understand the difference between microcontrollers and single board computers.	

[SLO:IoTF-11-B-04]: Learn the different components and architecture of ESP8266 and Raspberry Pi	
Benchmark II: Program with Arduino and Python	
Student Learning Outcomes	
[SLO:IoTF-11-B-05]: Understand the role of a compiler [SLO:IoTF-11-B-06]: Learn setting up Arduino IDE [SLO:IoTF-11-B-07]: Identify the structure and syntax of Arduino programming language (based on C/C++) [SLO:IoTF-11-B-08]: Write Code for Arduino boards to control and interact with digital input/output [SLO:IoTF-11-B-09]: Set up the Raspberry Pi with the required operating system (e.g., Raspbian)	

[SLO:IoTF-11-B-10]: Use a programming language such as Python to write code for Raspberry Pi [SLO:IoTF-11-B-11]: Learn to initialize and control digital outputs using GPIO (General Purpose Input/Output) libraries or modules for Raspberry Pi	
Benchmark III: Interface different type of sensors and actuators	
Student Learning Outcomes	
[SLO:IoTF-11-B-12]: Describe different types of sensors: analog sensors, digital sensors. [SLO:IoTF-11-B-13]: Identify different types of physical quantities and what corresponding sensors do you need to measure them. [SLO:IoTF-11-B-14]: Define actuators and identify different types of actuators. [SLO:IoTF-11-B-15]: Define ADC and describe how an analog pin translates analog readings to digital ones.	

[SLO:IoTF-11-B-16]: List and describe different interface protocols: I2C, SPI, UART, etc.	

Domain C: Communication

Standard: Students will be able to:

- Explain different network topologies and their trade offs
- Building a sensor network
- Understand client server architecture and different communication protocols
- Deploy custom broker server

Grade 11	**Grade 12**
Benchmark I: Connect microcontroller to a broker.	**Benchmark I**: Deploy a custom MQTT broker
Student Learning Outcomes	
[SLO:IoTF-11-C-01]: Identify various layers of internet connectivity. [SLO:IoTF-11-C-0]: Develop program to connect ESP8266 microcontroller to WiFi.	[SLO:IoTF-12-C-01]: Understand the fundamental concepts of cloud computing. [SLO:IoTF-12-C-02]: Cloud virtual machines. [SLO:IoTF-12-C-03]:

[SLO:IoTF-11-C-03]: Understand configuring Arduino Cloud. [SLO:IoTF-11-C-04]: Develop a program to control a relay with ESP8266 over the internet. [SLO:IoTF-11-C-05]: Build a program to send temperature data to Arduino Cloud..	Networking on the cloud with virtual private networks. [SLO:IoTF-12-C-04]: Configure Railway platform. [SLO:IoTF-12-C-05]: Describe the core concept of version management with Github. [SLO:IoTF-12-C-06]: Build an MQTT server with python. [SLO:IoTF-12-C-07]: Add a database to store messages.
Benchmark II: Analyze different connectivity topologies and describe their tradeoffs.	
Student Learning Outcomes	
[SLO:IoTF-11-C-06]: Enlist different connectivity topologies [SLO:IoTF-11-C-07]: Understand connecting to Internet with Cellular or WiFi	

[SLO:IoTF-11-C-08]: Build sensor mesh with Zigbee or BLE or nRF24 radios. [SLO:IoTF-11-C-09]: Long range radio communication with LPWAN [SLO:IoTF-11-C-10]: Explain different internet communication protocols [SLO:IoTF-11-C-11]: Describe fundamental concepts and principles of MQTT [SLO:IoTF-11-C-12]: Describe Client Server topology for CoAP [SLO:IoTF-11-C-13]: Distinguish between d ifferent cloud platforms • Arduino Cloud • Blynk • Grandeur • AWS IoT • Particle • Helium	

• Things Stack	

Domain D: Application layer

Standard: Analyze IoT data with Machine Learning to create predictions and detect anomalies.

Grade 11	**Grade 12**
Benchmark I: Analyze IoT data using visualization platforms.	**Benchmark I**: Data science and ml
Student Learning Outcomes	
[SLO:IoTF-11-D-01]: Illustrate visualization techniques and tools specifically tailored for IoT data analytics. [SLO:IoTF-11-D-02]: Explain the use of Grafana to create custom dashboards [SLO:IoTF-11-D-03]: Use the display widget to show the live reading from the ESP8266.	[SLO:IoTF-12-D-01]: Provide an overview of data analytics techniques [SLO:IoTF-12-D-02]: Apply descriptive analytics techniques (e.g., summary statistics, data visualization) to gain insights into the data patterns and trends. [SLO:IoTF-12-D-03]:

	Apply a predictive analytics technique (e.g., regression, time series forecasting) to build a model and make predictions.
Benchmark II: Understand building custom user interface	**Benchmark II**: Understand building a data pipeline
Student Learning Outcomes	
[SLO:IoTF-11-D-04]: Explain the purpose and benefits of using a Web/Mobile Dashboard. [SLO:IoTF-11-D-05]: List the web technologies to create custom web pages. [SLO:IoTF-11-D-06]: Describe the RESTful architecture for communicating with servers [SLO:IoTF-11-D-07]: Use Arduino Cloud API with Postman	[SLO:IoTF-12-D-04]: Apply predictive analytics technique to detect anomalies in real time.

Domain E: Building for scale

Standard: Apply all the IoT concepts at edge.

Grade 11	Grade 12
	Benchmark I: Explain Edge computing and its modern topologies.
Student Learning Outcomes	
	[SLO:IoTF-12-E-01]: Explain the purpose of edge computing. [SLO:IoTF-12-E-02]: Describe the components of an edge computing architecture. [SLO:IoTF-12-E-03]: Explore real-world use cases of edge computing. [SLO:IoTF-12-E-04]: Use modern smart home protocols like Matter and Thread
	Benchmark II: Demonstrate real-time decision-making at Edge

Student Learning Outcomes	
	[SLO:IoTF-12-E-05]: Explain how edge computing enables data processing and analytics at the edge of the network. [SLO:IoTF-12-E-06]: Using Edge Impulse for Edge machine learning with Raspberry Pi
	Benchmark III: Explain the fundamental concepts of continuous delivery.
Student Learning Outcomes	
	[SLO:IoTF-12-E-07]: Understand the importance of security in production. [SLO:IoTF-12-E-08]: Sending software patches with different platforms [SLO:IoTF-12-E-09]: Using Arduino Cloud for Arduino based controllers [SLO:IoTF-12-E-10]:

	Using AWS Greengrass for Raspberry Pi [SLO:IoTF-12-E-11]: Using Particle for cellular

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