CURRICULUM

Internet of Things Hardware Development
GRADE X
2021

GOVERNMENT OF PAKISTAN

Ministry Of Federal Education and Professional Training

ISLAMABAD

Contents

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.

Rationale

In a world dominated by digital technology, IoT has become the most important development of 21st century. IoT has come to play a prominent role in our lives by linking several systems to give smart performances in every task. It has created evolution of devices and applications impeccably integrated human communication in ways we never expected before. IoT as an emerging paradigm, will continue to pick up steam as more businesses realize the potential of connected devices to keep them competitive. IoT has been acknowledged as one of the foundation stones of Industry due to its potential to change the existing industrial and business processes. With the advent and growth of the IoT, physical environments are becoming smarter and more interconnected than ever before. This has changed the way we live by improving sustainability, efficiency, accuracy, and economy in almost every aspect of our lives. IoT has been leveraged in many industries such as healthcare systems, traffic management, energy management, education, environment monitoring, smart homes, and smart cities.

The Trade of Internet of Things is a profession that is increasingly getting attention in Pakistan because of the population growth and the resultant immense opportunities in this technology trade not only among the youth seeking to enter the industry but also among adults who wish to polish their skills to develop a career out of it.

This course aims to enable students to acquire a set of knowledge and concepts, and develop a range of technical, personal, interpersonal, organizational, and generic skills, that can be applied in various contexts, both within and related to trade of IoT domain. Furthermore, this course will stimulate the learners towards entrepreneurship in the industry.

Within this qualification relating to IoT interventions in schools, there are important interventions integrated within school settings. The purpose of this qualification is to strengthen connections between schools and trade and drawing on the concept of the socio technical network, theories the interactions between the relevant market and school contexts.

Internet of Things, Matric Tech (9th&10th)

Aims and Objectives

The specific aims of developing IoT qualification are:

- To Promote skills of the youth to maximize employment opportunities at national and international level.

- To provide skillful manpower for IoT based near future life.

- To mold students to develop skills about the use of IoT in daily life devices and make some new innovative devices.

- To recognize the factors contributing to the emergence and future trends of IoT within broader ICT industry.

- To examine the potential business opportunities that IoT can uncover.

- To capture and generate value from the application and use of IoT technologies.

- To provide students with a smooth transition to work.

- To enable students to construct a personal roadmap to gain strategic advantage from IoT.

Objectives

After completing this, the students will be able to:

- Explain Internet of Things in different contexts.

- Take account of the key components that make up an IoT system.

- Learn the concept and capabilities of smart thing and physical principles of sensing.

- Explore IoT enabling technologies, architectures, and standards.

- Acquire the basic competence of IoT Hardware and Software development

- Identify infrastructure for IoT developments.

- Apply IoT knowledge to implement small-scale IoT Project.

- Design, build and integrate IoT platforms, incorporating different types of sensors and actuators, micro-controllers, and devices.

- Understand IoT protocol stack and fundamentals of Social IoTs.

Grade-X –Internet of Things Hardware Development

Learning Themes and Students' Learning Outcomes Knowledge, Skills and Attitudes					
Chapter 01 (Combinational logic design)					
T = 11, P = 16, Total = 26					
Content	**Students' Learning Outcome**	**Activities/Practical**	**Duration**	**Tools**	**Workplace**

Digital gates	**The Students will be able to:**
	• understand the basics of digital systems
	• differentiate between analog and digital circuits
	• understand the working principle of digital gates
	• identify the symbol of logic gate, ic & logic function.
	• connect LED to the output pin of IC and apply different logics and input pins.
	• record & verify the output result against each given input.
		• Verify the truth table with the hardware setup of;
		  o AND gate
		  o OR gate
		  o NOT gate
		  o NAND gate
		  o NOR gate
		  o XOR gate
			4 Periods (T)
			6 Periods(P)
				• White board
				• Multimedia
				• Internet
				• AND gate IC
				• OR gate IC
				• NOT gate IC
				• NAND gate IC
				• NOR gate IC
				• XOR gate IC
				• Jumper Wires
				• Logic trainer
				• Computer system
					Classroom and Lab

Half adder	**The Students will be able to:** • describe working of half adder • understand construction of half adder on the bread board using digital gates • construct, and test a half-adder circuit. • record & verify the output result against each given input	• Construct half adder and verify its truth table.	3 Periods (T) 5 Periods(P)	• White board • Multimedia • AND gate IC • OR gate IC • NOT gate IC • NAND gate IC • NOR gate IC • XOR gate IC • Jumper Wires • Logic trainer • Internet • Computer system	Classroom and Lab
Full adder	**The Students will be able to:** • describe working of full adder • understand construction of full adder on the breadboard using digital gates • construct, and test a full-adder circuit • record & verify the output result against each given input	• Construct full adderand verify its truth table	4 Periods (T) 5 Periods(P)	• White board • Multimedia • AND gate IC • OR gate IC • NOT gate IC • NAND gate IC • NOR gate IC • XOR gate IC • Jumper Wires • Logic trainer • Internet	Classroom and Lab

				• Computer system	

Chapter 02 (Sequential logic design)

T = 9, P = 14, Total = 23

Content	Students' Learning Outcome	Activities/Practical	Duration	Tools	Workplace

Introduction to sequential logic design
• flipflops
	The students will be able to:
	• understand sequential logic design.
	• differentiate between combinational and sequential logic design.
	• differentiate between synchronous and asynchronous sequential circuits
	• introduce flipflop.
	• understand basic function of flipflops.
	• use flipflops in applications of digital systems.
		• Verify the truth table with the hardware setup of;
		  ○ SR flipflop
		  ○ JK flipflop
		  ○ T flipflop
		  ○ D flipflop
			5 Periods (T)
			8 Periods(P)
				• D-Flipflop
				• JK Flipflop
				• T Flipflop
				• SR flipflop
				• Logic trainer.
				• Jumper wires
				• White board
				• Multimedia
				• Internet
				• Computer system
					Classroom and Lab

4-bit shift register	**The students will be able to:** • understand 4-bit shift register • explain the working principle of 4-bit shift register. • construct 4-bit shift register using D-flipflops. • recode the output according to the input.	• Construct 4-bit shift register and verify its truth table with the hardware setup..	4 Periods (T) 6 Periods(P)	• D-Flipflops • Logictrainer. • Jumper wires • Scales • White board • Multimedia • Internet • Computer system	Classroom and Lab

Chapter 03 (IoT Networking & Interfacing of Sensors & Actuators)

T = 10, P = 18, Total = 28

Content	Students' Learning Outcome	Activities/Practical	Duration	Tools	Workplace

Interfacing of temperature and humidity sensor with Arduino	**The Students will be able to:**
	• understand:
	  ○ interfacing process
	  ○ sensors
	• differentiate between active and passive sensors
	• differentiate between analog and digital sensors.
	• understand the working of temperature and humidity sensor
	• identify the communication interface of sensor
	• interface temperature and humidity sensor with Arduino.
		• Record Temperature values on Serial Monitor
		• Record Humidity values on Serial Monitor using Arduino IDE
			6 Periods (T)
			12 Periods(P)
				• Temperature Sensor
				• Arduino UNO
				• USB mini cable
				• Jumper Wires
				• White board
				• Multimedia
				• Internet
				• Computer system
				• Humidity sensor
				• Breadboard
					Classroom and Lab

Content	Students' Learning Outcome	Activities/Practical	Duration	Tools	Workplace
	• program Arduino to read the value of temperature and humidity sensors				

Drive Relay with Arduino	The Students will be able to:
	• understand:
	  o actuators
	  o relay
	• understand the working principle of relay
	• identify control pins
	• identify normally open (NO) and normally connected (NC) pins.
	• construct a relay driver circuit using transistor.
	• develop an arduino program to drive relay.
		• Turn on/off a light bulb connected with relay.	4 Periods (T)
			6 Periods(P)
				• Relay
				• Arduino UNO
				• USB mini cable
				• Jumper Wires
				• White board
				• Multimedia
				• Internet
				• Computer system
					Classroom and Lab

Chapter 04 (IoT networking & interfacing of communication module)

T = 19, P = 30, Total = 49

Content	Students' Learning Outcome	Activities/Practical	Duration	Tools	Workplace
Interface ESP8266 with Arduino	The Students will be able to: • understand Wi-Fi protocol • understand ESP8266 module • connect ESP8266 with Arduino • program the Arduino to connect to available Wi-Fi Access Point.	• Make Arduino a Wi-Fi hotspot	7 Periods (T) 10 Periods(P)	• ESP8266 • Arduino UNO • Usb mini cable • Header wires • Scales • White board • Multimedia • Internet • Computer system	Classroom and Lab
Configuring Wi-Fi Station	The Students will be able to: • differentiate between Wi-Fi station and Wi-Fi access point • understand the process of configuring ESP8266 as a Wi-Fi station without using Arduino • write a program to connect ESP8266 to an available Wi-Fi access point	• Configure a Wi-Fi station using ESP8266 and connect it to a Wi-Fi access point	6 Periods (T) 10 Periods(P)	• ESP8266 based NodeMCU • USB mini cable • Header wires • Scales • White board • Multimedia • Internet • Computer system	
ESP32 as a Bluetooth device	The Students will be able to: • understand the difference between Wi-Fi and Bluetooth protocol • understand the difference between ESP 8266 and ESP32 • understand the process of configuring Bluetooth in ESP32 • develop a program to connect ESP32 to the Bluetooth of mobile	• Configure and connect Bluetooth of ESP32 with mobile phone	6 Periods (T) 10 Periods(P)	• ESP32 based NodeMCU • USB mini cable • Header wires • Scales • White board • Multimedia • Internet • Computer system	

	phone			• Mobile phone	

Chapter 05 (Project)

T = 11, P = 21, Total = 32

Content	Students' Learning Outcome	Activities/Practical	Duration	Tools	Workplace
7-segment display with Arduino	**The Students will be able to:** • understand the working of 7-segment display. • understand the TM1637 module. • use the libraries in Arduino IDE. • connect TM1637 with Arduino. • display decimal numbers on TM1637 using Arduino	• Display decimal numbers from 1 to 100 with a delay of 1 second on TM1637. • Display hex numbers on TM1637.	5 Periods (T) 10 Periods(P)	• Arduino UNO • TM1637 • USB mini cable. • Header wire. • Scales • White board • Multimedia • Internet • Computer system	Classroom and Lab
Findingdistance using ultrasonic sensor	**The Students will be able to:** • understand the working of ultrasonic sensor. • find distancing using speed and time. • interface ultrasonic sensor with arduino. • record distance readings on serial monitor.	• Find water level in a tank using ultrasonic sensor • Detect motion using ultrasonic sensor.	6 Periods (T) 11 Periods(P)	• Ultrasonic sensor • Arduino UNO • USB mini cable • Header wires • Water jar • White board • Multimedia • Internet • Computer system	Classroom and Lab

Chapter 06 (Freelancing)

T = 4, P = 7, Total = 11

Content	Students' Learning Outcome	Activities/Practical	Duration	Tools	Workplace
Freelancing and Setup Profile	**The Students will be able to:** • define freelancing • know different freelance platforms • know the difference between seller and buyer freelancing • explain the terminologies related to the freelancing platform like (gig, profiles, rating, review, revision and a bid etc.) • set up a seller profile • add personal and professional information on your profile • link up social media and other professional accounts to seller profile	• Presentation on freelancing and process involve in it • Create profile on freelancing platforms	1 Periods (T) 2 Periods(P)	• Internet • Laptop/Computer • Freelance platforms	Classroom and Lab
Create the Gigs	**The students will be able to:** • find your ideal category and	• Design a powerful gig	1 Periods (T) 1 Periods(P)	• Internet • Laptop/Comput	Classroom and Lab

	services • check out the competition • create an appealing title for the gig • choose subcategory and tags • create and price gig packages • win buyers with gig description • boost gig success with visuals • choose a suitable gig package among basic, standard and premium options			er • Freelance platforms	
Find work/Submit proposals	**The students will be able to:** • understanding of niche and projects lie in those niche • difference of hourly based and fixed price projects • find the right project according to your niche • understand the requirements by reading the project description and demands with great attention/ get clear understanding of the project • ask questions to clarify the ambiguities. • offer a mockup • setup a competitive fee for the project • review your bid proposal to remove any spelling or grammatical mistakes • submit the bid proposal	• Discussion on the niche and finding right project according to niche. • Presentation on process of finding work	1 Periods (T) 2 Periods(P)	• Internet • Laptop/Computer • Freelance platforms • MS Office	Classroom and Lab
Complete projects &Get paid.	**The students will be able to:** • ask for feedback form the client • keep in touch with buyers/customers • use the contacts page to maintain close coordination with the potential buyers/customers • request customer to recommend you to other clients and work circles • understand payment methods for freelance platforms • communicate with the client by using the freelance platform messaging service only • know about use of payment protection methods to get your reward secure	• Setup a personal deadline to finish the project • Make close consultation with your client during the development of the project •	1 Periods (T) 2 Periods(P)	• Internet • Laptop/Computer • Freelance platforms • MS Office	Classroom and Lab

Chapter 06(Entrepreneurship)					
T = 5, P =5, Total = 10					
Content	Students' Learning Outcome	Activities/Practical	Duration	Tools	Workplace
Introduction to Entrepreneurship	**The students will be able to:** • define entrepreneurship • know the key concepts of entrepreneurship • understand main component of entrepreneurship • learn types of entrepreneurship	• Group discussion on entrepreneurship	1 Periods (T) 1 Periods (P)	• Multimedia Presentation and virtual exposure	Classroom
Feasibility and Business Plan	**The students will be able to:** • know how to identify business opportunity. • know how to develop feasibility and business Plan.	• Design a business plan keeping in view requirements	2 Periods (T) 2 Periods (P)	• Multimedia Presentation and virtual exposure	Classroom
Marketing and Marketing Mix	**The students will be able to:** • understand about concept of marketing and marketing mix • understand 6 P's of marketing • apply costing and pricing	• Develop a marketing strategy for your business model developed in previous activity	2 Periods (T) 2 Periods (P)	• Multimedia and White Board	Classroom

Assessment and Evaluation

Assessment is the practice of collecting evidence of student learning. It aims at improving learning and teaching as well as recognizing the achievement of students. It determines students 'progression through their learning experiences and enables them to demonstrate that they have achieved the intended learning outcomes. The assessment is aligned with curriculum aims, design and learning processes.

Evaluation is an integral part of teaching-learning process. It involves gathering information through various assessment techniques, making valuable judgment and sound decisions. Assessment provides information and teaching about students' achievement in relation to learning objectives. With this information, the teacher makes informed decisions about what should be done to enhance the learning of students or to improve teaching methods. Assessment must be:

- Mainly open-ended, allowing for discussion and revision of new understanding.
- Tolerant of divergent thinking of students and promote the notion of no ''one right answer''.
- Presented in alternative mode, not just paper-and-pencil responses to limiting questions.
- Designed to foster analysis, comparison, generalization, prediction, and modification according to the grade and development level.
- Capable of promoting collaboration and team effort in demonstration of competence.
- Ongoing and cumulative, showing growth over time.

Formative (Internal) Assessment

Internal assessment refers to the assessment practices employed as part of the learning and teaching process. It is an ongoing process throughout the session and uses Test — Feedback — Adjust cycle repeatedly to improve students' performance and efficiency in learning and teaching. In designing internal assessment for the subject, teachers should maintain a proper balance between the formative and summative functions of assessment. It should be comprehensive to cover all the objectives as per curriculum. A diversity of assessment modes should be adopted so that students are given opportunities to develop and demonstrate the full range of learning outcomes of the curriculum, including those of knowledge, skills and values and attitudes.

Methods for Internal/Formative Assessment

Following tasks can help in formative assessment;

- Demonstration
- Practical exercises
- Group discussion
- Role play
- Oral/Multimedia presentation
- Test
- Assignment

- Quiz

Feedback on students work in all of the above tasks must be prompt, effective, and efficient. Assessment should have questions setting that specifically help in finding out knowledge, understanding and skills that can evaluate the competency of trainee.

Summative /External Assessment

Summative assessment will be managed by concerned Board of Intermediate and Secondary Education. It will be composed of two parts;

1) Theory Assessment /Written examination: The theory examination is suggested to consist of a wide variety of questions. Its overall weight age should be 40 %. It should be based on the curriculum rather than textbook. The assessment should be designed to examine the candidate's understanding of the whole syllabus and should test the range of abilities according to Bloom Taxonomy.

2) Practical Assessment/Practical examination: This is designed to test practical skills of students. Its overall weight age should be 60%. It will comprise of written exam (10%), practical (70 %) and viva/oral exam (20%).

A standards-referenced approach will be adopted for grading and reporting student performance. The purpose of this approach is to recognize what each student can do the in the subject at the end of the 2-year secondary school level education. The performance of each student will be matched against a set of performance standards, rather than comparing to the performance of other students. It makes the implicit standards explicit by providing specific indication of individual student performance. Descriptions will be provided for the set of standards.

Guidelines for Writing a Textbook

A textbook is an important teaching and learning resource and one of the most extensively used resources in classrooms. To reflect national needs and aspirations the needs and aspirations, the textbooks should be written in accordance with this curriculum. This curriculum meets not only the general aims and objectives but also fulfills the specific requirements of the individual subject. As the textbook serves as a framework for teaching, the author/authors should consider the following features:

- A textbook must include an introduction to the textbook, explaining how to use the textbook
- The textbook must be in line with the national curriculum, covering all SLOs of each content.
- Content and illustrations must be culturally, contextually and age appropriate.
- All text and material must be accurate, up-to-date and error-free.
- The continuity of the concepts, their integration and logical development should be ensured.
- Horizontal and vertical overlapping of the concepts should be avoided.
- The textbook should be informative and interactive with questions to be put at suitable intervals to provoke the students to think.
- The language used should be simple, clear, straight forward, unambiguous and easily comprehensible by the students of the particular level.

- Simple questions may be asked within the chapter, which requires students to recall, think, and apply what they have just learnt as well as to reinforce the learning of the concepts and principle.
- The examples and applications should be from everyday life and be supportive of our cultural values.
- Photographs and illustrations should be clear, labeled and supportive of the text. Tables, flow charts and graph may be given wherever needed.
- Key points at the end of each chapter should provide a summary of the important concepts and principles discussed in the chapter.
- End-of-the-chapter exercises must include a variety of assessment styles based on levels of Bloom's Taxonomy. These should encourage students to think, develop skills, and use information for a variety of purposes.
- Textbooks should be free from all kinds of biases including, gender, religion, occupation, social background etc.
- To make the students self-learner use of IT based resources may be encouraged. Relevant internet links and other online resources may be included.
- Glossary of the new vocabulary must be included.

Guideline for planning and writing a chapter

The textbook author may decide the titles of each chapter and can choose to cover students' learning outcomes (SLOs) from any themes in developing the content of the chapter. The textbook author must also keep in mind that a number of SLOs cannot be addressed in the text (as if this is done it would lead students to simply memorize the text and not serve the realization of the curriculum). These SLOs could be realized through questions and practical activities within and at the end of the chapter exercises.

- Learning outcomes must be given at beginning of each chapter.
- Decide on key ideas, facts, concepts, skills and values that can be developed.
- Illustrations must clearly convey the desired concept.
- Activities must demand from students to do inquiry and problem solving according to grade level.
- Ensure that the content is up to date, accurate and developmentally appropriate.
- Contents must be in line with chapter outcomes.
- Language must be consistent, culturally appropriate and grammatically correct (as if talking to a group).
- Language must engage and hold reader's attention.
- Recall previous learning, where possible.
- Structure the writing so that the sentence is simple, paragraphs deal with single ideas etc.
- Interesting information in the form of tidbits, fact file, point to ponder etc. must be given.
- Write a summary/concept map at end of each chapter, reviewing key knowledge and skills.
- End-of-chapter exercises
- Recall and integrate previous learning
- Engage students and develop their creativity
- Move from lower to higher order thinking
- Focus on multiple intelligences
- Keep the text contextually relevant in line with local teaching and learning.

- Provide website links for further research

Guidelines for Writing Learner Workbook

Workbooks are books that contain writing activities and exercises that build upon each chapter in the textbook. Workbook exercises help students to develop conceptual understanding of the concepts dealt with in the text, to develop skills and to apply knowledge to new situations. Basic features of a workbook A workbook should have:

- Various exercises and activities for each chapter, topic, subtopic.
- Exercises and activities that will enable student to develop and practice the content knowledge, skills and higher order thinking.
- Accurate and variety of exercises.
- Clear illustrations/ examples/ explanations to show what students are supposed to do, and/or what product looks like.
- Exercises and activities with a variety of purposeful, stimulating, challenging and innovative items to encourage students to review and practice the knowledge and skills they have learnt.
- Exercises that include both constructed and restricted response items.
- Activities, which requires readily available, acceptable, and affordable materials and resources.

Basic Requirements for Lab (Tools/Equipment)

SR#	Tools & Equipment
1.	AND gate IC
2.	Arduino microcontroller
3.	Arduino UNO
4.	Avometer
5.	Battery
6.	BJT
7.	Breadboard
8.	Cell
9.	Computer /Laptop
10.	Connecting Wires
11.	D Flipflop
12.	DC ammeter

13.	Diode
14.	ESP8266 12E
15.	FET
16.	Fluorescent lamp
17.	Freelance platforms
18.	Gravity checker
19.	Header wire.
20.	Humidity Sensor
21.	Internet
22.	JK Flipflop
23.	LED
24.	Logic trainer.
25.	MS Office
26.	Multimedia projector
27.	Multimeter
28.	NAND gate IC
29.	NOR gate IC
30.	NOT gate IC
31.	ESP32 based NodeMCU
32.	Ohm meter
33.	OR gate IC
34.	Oscilloscope
35.	Power supply
36.	Push Button
37.	PVC cable

38.	Relay
39.	Resistance
40.	Resistor
41.	T Flipflop
42.	Temperature sensor
43.	Humidity sensor
44.	Jumper wire
45.	SR flipflop
46.	12V AC adapter
47.	TM1637
48.	UJT
49.	Ultrasonic sensor
50.	USB mini cable
51.	Water jar
52.	White board
53.	XOR gate IC
54.	Zener Diode