CURRICULUM

Internet of Things Hardware Development
GRADE IX
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 (9^{th}&10^{th})

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-IX –Internet of Things Hardware Development

Learning Themes and Students' Learning Outcomes Knowledge, Skills and Attitudes					
Chapter 01 (Basic Electrical Theory)					
T = 9, P = 13, Total = 22					
Content	**Students' Learning Outcome**	**Activities/Practical**	**Duration**	**Tools**	**Workplace**

Basic principle of electricity	**The Students will be able to:**
	• define electricity.
	• understand electrical quantities and their units:
	  ○ voltage
	  ○ current
	  ○ resistance
	• explain characteristics of conductors, insulator, semiconductor
	• describe power and energy and its difference
	• apply instruments to measure current, voltage, resistance
	• use oscilloscope to plot wave form
		• Carryout Orientation Visit of Electrical Lab/ workshop and record the observation.
		• Recognize Electrical symbols with fixed component and equipment (in workshop/lab)
		• Draw electrical symbols
		• Measure AC & DC voltage, currentand resistance using digital multimeter (DMM)
		• Calibrate the given oscilloscope
			4 Periods (T)
			4 Periods(P)
				• PVC cable
				• Lamp
				• Resistor
				• Fluorescent lamp
				• Avometer
				• Ohm meter
				• Digital multimeter
				• Multimeter
				• power supply
				• Oscilloscope
					Classroom and Lab

Ohm's law	**The Students will be able to:** • define ohm's law • applyohm's law for measuring current, voltage and resistance	• Apply Ohm's law for measuring Current, Voltage and Resistance • Verify your theoretical results on the actual setup using multimeter	2 Periods (T) 4 Periods(P)	• Multimeter • Resistor • power supply	Classroom and Lab
Cells & Batteries	**The Students will be able to:** • define cell and batteries • describe the importance of cell and batteries • explain the types of cell and batteries • explain the charging procedure/principle of battery • use cell and battery as a series and parallel source • describe the components/parts of cell and battery • explain the construction and working principles of cells and batteries • explain the procedure for maintaining a battery.	• Check gravity of battery with the help of hydrometer • Perform testing of cell and battery by DC ammeter. • Calculate the size of different type of batteries for a specific circuit	3 Periods (T) 5 Periods(P)	• DC ammeter • Gravity checker • Cell • Battery • power supply	Classroom and Lab

	• describe the importance of electrolyte in the battery • explain the testing procedure of batteries. • explain the use of tools and equipment required for testing of batteries. • calculate the size of battery for a specific circuit through different techniques				
Chapter 02 (Electric Circuits)					
T =8 P = 14, Total = 22					
Content	**Students' Learning Outcome**	**Activities/Practical**	**Duration**	**Tools**	**Workplace**
Series and Parallel circuit	**The students will be able to:** • describe electric circuits and its basic components • explain the construction of series circuit for calculation of current, voltage and resistance. • explain the construction of parallel circuit for calculation of current, voltage and resistance • explain the construction of combinational circuit for calculation of current, voltage and resistance	• Construct a series circuit and measure Current, Voltage and Resistance • Construct parallel circuit and measure Current, Voltage and Resistance • Construct combinational circuit and measure Current, Voltage and Resistance	3 Periods (T) 6 Periods (P)	• Resistor, • Multi-meter • Lamp, lamp holder, power supply • Multimeter • Breadboard	Classroom and Lab
Kirchoff's voltage law (KVL)	**The students will be able to:** • define Kirchoff's voltage law • Solve combinational circuit using KVL • construct a series parallel combinational circuit to verify KVL	• Design combinational circuit, apply KVL and verify results with practical measurements	2 Periods (T) 4 Periods (P)	• Resistor • Wires • Multimeter • Breadboard • Battery • power supply	Classroom and Lab
Kirchoff's current law (KCL)	**The Students will be able to:** • define Kirchoff's current law • Solve combinational circuit using KCL • construct a series parallel combinational circuit to verify KCL	• Design combinational circuit, apply KCL and verify results with practical measurements	3 Periods (T) 4 Periods (P)	• Resistor • Wires • Multimeter • Breadboard • Battery • power supply	Classroom and Lab
Chapter 03 (Fundamental Electronics-1 for IoT)					
T =18, P =28, Total = 46					
Content	**Students' Learning Outcome**	**Activities/Practical**	**Duration**	**Tools**	**Workplace**
Diode and its application	**The Students will be able to:** • define PN junction	• Apply diodes as rectifier (half wave and full wave)	8 Periods (T) 13 Periods(P)	• Diode • Power supply	Classroom and Lab

	• N type and P type materials. • Majority charge carrier • Minority charge carrier. • define diode • understand working principle of diode • identify current voltage and power rating of diode. • understand forward and reverse biasing • apply diodes as rectifier (half wave, full wave)	• Verify theoretical readings with practical results		• Resistance • Wires • Oscilloscope • Multimeter • Breadboard • 12V AC adapter	
Zener diode	**The Students will be able to:** • define Zener diode • explain characteristics of Zener diode. • current voltage and power rating of Zener diode • understand the voltage and current regulation • differentiate between load and line regulation • understand the application Zener diode in a circuit	• Apply Zener diode as a voltage stabilizer and note readings in data sheet	4 Periods (T) 6 Periods(P)	• Zener Diode • Power supply • Resistance • Wires • Oscilloscope • Multimeter • Breadboard • Push Button	Classroom and Lab
Bipolar junction transistor (BJT)	**The Students will be able to:** • introduce to transistor • define bipolar junction transistor • construct transistor and its working principle • explain application of transistor	• Apply BJT as a switch • Verify theoretical readings with practical results	6 Periods (T) 9 Periods(P)	• BJT • Power supply • LED • Resistance • Wires • Multimeter • Breadboard • Push Button	Classroom and Lab
Chapter 04 (Electronics-2 for IoT)					
T = 14, P = 20, Total = 34					
Content	**Students' Learning Outcome**	**Activities/Practical**	**Duration**	**Tools**	**Workplace**
Field effect transistor (FET)	**The Students will be able to:** • define FET • understand the power rating of FET and its datasheet • understand working principle of FET • compare JFETs and MOSFETs. • construct JFETs and MOSFETs. • identify symbols used for JFET and MOSFETs. • use multimeter/ datasheet to	• Presentation on differences between BJT & FET • Apply FET in a switching circuit	9 Periods (T) 11 Periods(P)	• FET • Power supply • LED • Resistance • Connecting Wires • Multimeter • Breadboard • Push Button	Classroom and Lab

	identify the Gate Source & Drain of FET. • understand biasing of FET (JFET, MOSFET) • draw characteristic curve of FET.				
Thyristors	**The Students will be able to:** • define Thyristor • introduce UJT • understand construction of UJT • understand the biasing of UJT • understand characteristic curve of UJT • comprehend intrinsic stand-off ratio &RC time constant	• Presentation on differences between FET & UJT • Apply UJT in a switching circuit	5 Periods (T) 9 Periods(P)	• UJTT • Power supply • LED • Resistance • Connecting Wires • Multimeter • Breadboard • Push Button	Classroom and Lab
Chapter 05(Introduction to Microcontrollers)					
T = 18, P = 21, Total = 39					
Content	**Students' Learning Outcome**	**Activities/Practical**	**Duration**	**Tools**	**Workplace**
Introduction to Microcontroller	**The Students will be able to:** • define microcontroller • describe purpose of microcontroller • differentiate microcontroller and microprocessor • know common microcontroller • name some well-known microcontroller used specifically for IoT application. • know and understanding of Arduino. • understand pin configuration of Arduino	• Individual presentation on microcontroller and its application. • Discussion on Arduino pin configuration	7 Periods (T) 6 Periods(P)	• Computer system • Multimedia projector • Arduino microcontroller	Class room and Lab
Arduino IDE	**The Students will be able to:** • basic understanding of Arduino IDE. • process the installation of Arduino IDE. • know built-in libraries • add libraries in Arduino IDE.	• Download and install Arduino IDE in system. • Add a new board and library in IDE.	3 Periods (T) 5 Periods(P)	• Computer system • Multimedia projector • Arduino microcontroller • Arduino IDE	Class room and Lab
Connecting an Arduino with Computer System	**The Students will be able to:** • know about USB mini and USB micro • process of installing and updating USB to serial driver for Windows • select the relevant COM port on Arduino IDE	• Connect an Arduino board with computer system. • Select a connected board in Arduino IDE. • Install USB to serial driver • Configure the baud rate in USB to serial driver	4 Periods (T) 4 Periods(P)	• Computer system • Multimedia projector • Arduino microcontroller • Arduino IDE	Classroom and Lab

	• configure required baud rate of COM port in driver. • select relevant board in Arduino IDE				
Programming Arduino	**The Students will be able to:** • select the basic example Project in Arduino IDE • Burn the code on Arduino board. • Identify ifthe code isuploaded successfully. • Interface a LED with Arduino. • Upload the LED blinking program to the connected Arduino board.	• Configure the uploader's setting in Arduino IDE. • Test the sample program of blinking a LED on Arduino.	4 Periods (T) 6 Periods(P)	• Computer system • Multimedia projector • Arduino microcontroller • Arduino IDE • LED	Classroom and Lab
Chapter 06(Work Health and Safety)					
T = 8, P = 9, Total = 17					
Content	**Students Learning Outcome**	**Activities/Practical**	**Duration**	**Tools**	**Workplace**
Basics of work health and safety	**The Students will be able to:** • understand basic rules and principles of WHS • introduce Ergonomics • understandlegal obligations and work ethics regarding health and safety. • identify common workplace hazards • manage workplace hazards • followorganizational WHS and other relevant policies, procedures, processes	• Group presentation on WHS • Demonstrate basic principles of WHS	4 Periods (T) 4 Periods(P)	• Working • Computer • /Laptop • Internet	Class Room work place
Establishing WHS in IoT environments	**The Students will be able to:** • understandthe scope of project • identify techniques of the risk profile for all stake holders • identify Clients Health and safety specifications SOPs • understand development techniques of health and safety plan • implement techniques of health and safety plan.	• Identifying the risks involved in project assigned • Presentation on health and safety plan	4 Periods (T) 5 Periods(P)	• Working • Computer /Laptop • Internet	Class Room field work

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