GUJARAT TECHNOLOGICAL UNIVERSITY (GTU)

Competency-focused Outcome-based Green Curriculum-2021 (COGC-2021)
Semester -VI

Fundamentals of IoT
(Course Code: 4360703)

Diploma programmer in which this course is offered	Semester in which offered
Computer Engineering	6th Semester

1.   RATIONALE

IoT (Internet of Things) is rooted in the transformative impact that IoT technologies are having on various industries and daily life. The course aims to provide students with a solid foundation in the principles, technologies, and applications of IoT, recognizing its significance as a key driver of technological innovation and societal advancement.

2.   COMPETENCY

The purpose of this course is to help the student to attain the following industry identified competency through various teaching-learning experiences:

- **Analyse and design the IoT System using the Sensor, the Actuator and Arduino board.**

3.   COURSE OUTCOMES (COs)

The student will develop underpinning knowledge, adequate design and programming skills competency for implementing various IoT applications using Arduino to attain the following course outcomes.

- Explain the basic concept of IoT

- Apply different Sensors and Actuators in IoT Application as required

- Develop sketch for the IoT application using the Arduino Uno board.

- Explain Messaging and Transport protocols for IoT communication used in the IoT Applications

- Illustrate the working of real world IoT applications.

4.   TEACHING AND EXAMINATION SCHEME

Teaching Scheme (In Hours)			Total Credits (L+T+P/2)	Examination Scheme				
				Theory Marks		Practical Marks		Total Marks
L	T	P	C	CA	ESE	CA	ESE	
3	-	2	4	30	70	25	25	150

Legends: *L*-Lecture; *T* – Tutorial/Teacher Guided Theory Practice; *P* -Practical; *C* – Credit, *CA* - Continuous Assessment; *ESE* -End Semester Examination.

5.   SUGGESTED PRACTICAL EXERCISES:

Sr. No.	Practical
1	Study of Arduino Uno board technical specifications and pins.
2	Study of various Sensors and actuators for IoT applications.
3	Develop IoT based application using Arduino board to blink the on-board LED at one second interval.
4	Develop IoT based application using Arduino board to turn ON and OFF the 3 LEDs (Red, Green, Blue) based on the 3 Pushbutton switches.
5	Develop IoT based application using Arduino board to implement automated traffic signal system using different colour LED.
6	Develop IoT based application using Arduino board to read analog input from a potentiometer and control the brightness of an LED.
7	Develop IoT based application using Arduino board from DHT sensor to measure temperature and humidity.
8	Develop IoT based application using Arduino board and ultrasonic sensor to measure distance and display it on the Serial Monitor.
9	Develop IoT based application using Arduino board and PIR sensor to detect presence/movement and turn on an LED automatically.
10	Develop an IoT based application using Arduino board to control servo motors back and forth across 180 degrees.
11	Develop an IoT based application using an Arduino board to print "Hello IoT" on a 16x2 LCD display.
12	Develop IoT based application using Arduino board and relay to implement smart appliance control.

* Some assignments/presentations for different topics can be arranged to attain other COs for Continuous Assessment for Practical Components.

6.   MAJOR EQUIPMENT/ INSTRUMENTS REQUIRED

Sr. No.	Equipment Name with Broad Specifications	PrO. No.
1	Computer system with operating system: Windows 7 or higher Ver., macOS, and Linux, with 4GB or higher RAM, Python versions: 2.7.X, 3.6.X	All PrOs
2	Arduino Uno, clock speed of 16 MHz,14 digital I/O pins, 6 analog input pins, UART for serial communication, voltage regulator (7v to 12v), USB connector with RESET Button.	
3	LEDs, Humidity and Temperature Sensor, Ultrasonic Sensor, Light Sensor, Servo motor, 16x2 LCD display, PIR Sensor, Potentiometer, relay etc. ESP8266 (Wi-Fi) board	

7. AFFECTIVE DOMAIN OUTCOMES

The following *sample* Affective Domain Outcomes (ADOs) are embedded in many of the above-mentioned COs and PrOs. More could be added to fulfil the development of this competency.

a. Understanding of IoT concepts.
b. Hardware and sensor knowledge
c. Follow ethical practices.

8.   UNDERPINNING THEORY:

Unit	Unit Outcomes (UOs)	Topics and Sub-topics

Unit-I: Introduction to IoT	1.1 Explain definition and Characteristics of IoT
	1.2 Explain the IoT Architecture
	1.3 Explain the challenges involved in developing an IoT system.
		1.1 IoT Definition
		1.2 IoT Characteristics
		1.3 IoT Applications
		1.4 Key Components of IoT System
		    Things/Device, Gateway, Cloud/Server, Analytics, User Interface
		1.5 Architecture of IoT
		    1.5.1 Sensing Layer
		    1.5.2 Network Interface Layer
		    1.5.3 Data Processing Layer
		    1.5.4 Application Layer
		1.6 IoT Challenges
		    1.6.1 Design Challenges (Connectivity, Power Requirements, Complexity, Storage and Computational Capability, Data Extraction from complex environment)
		    1.6.2 Security Challenges (Security & Personal Safety, Privacy)

Unit-II: Sensors & Actuators	2.1 Distinguish the sensors and their working
	2.2 Distinguish the Actuators and their working
	2.3 Choose appropriate sensor based on the requirement
		2.1 Voltage Considerations for Sensors
		2.2 Sensors (working)
		    PIR Motion Sensor, Sharp IR Distance Sensor, LDR Sensor, Gyro Sensor, Ultrasonic Distance Sensor, DHT Sensor
		2.3 Need of ADC Chip while using Analog Sensors
		2.4 Actuators (working)
		    2.4.1 Servo Motor
		    2.4.2 Solenoid
		    2.4.3 Stepper Motor
		2.5 Need of Relay while using Actuators

Unit III:
Programming
with Arduino Uno
	3.1 Illustrate the Arduino Uno board
	3.2 Apply basic programming skills to develop the code for the Arduino Uno board.
	3.3 Practice the built-in, library and user defined functions in the program.
	3.4 Interface different sensors and actuators with Arduino board
		3.1 ARDUINO UNO board Block diagram
		3.2 Sketch Structure
		3.3 Data types & Built in Constants
		3.4 Operators: Arithmetic, Bitwise, Compound, Comparison, and Boolean
		3.5 Control statements and Loops
		3.6 Functions and library functions
		  3.6.1 User defined functions
		  3.6.2 Library functions:
		    I/O Functions: digitalRead, digitalWrite, pinMode, analogRead, analogWrite, analogReference.
		    Char functions: isAlpha, isAlphaNumeric, isDigit, isHexadecimalDigit, isSpace, isWhitespace, isUpperCase, isLowerCase.
		    Math Functions: abs, constrain, max, min, pow, sqrt
		3.7 LED Blinking using Arduino
		3.8 Serial Communication Functions: Serial, available, begin, end, print, println, write, read, readBytes, readString.

Unit-IV:
IoT
Communication
Protocols
	4.1 Explain the message passing protocols.
	4.2 Paraphrase transport protocols
	4.3 Differentiate different sensor network topologies
		4.1 Messaging Protocols
		  4.1.1 MQTT
		  4.1.2 CoAP
		  4.1.3 XMPP
		4.2 Transport Protocols
		  4.2.1 Introduction of BLE
		  4.2.2 Introduction to Li-Fi
		4.3 Basics of Sensor Network Topologies
		  4.3.1 Point to Point Topology
		  4.3.2 Mesh topology
		  4.3.3 Ring topology
		  4.3.4 Star Topology

Unit-V:
Applications of
IoT
	5.1 Recognize the need of IoT in real- world problems
	5.2 Apply various components of IoT to solve a real world problem.
		5.1 Overview, Block Diagram and Working of the
		    following real world IoT applications
		  5.1.1 Smart Home automation
		  5.1.2 Agricultural System
		  5.1.3 Smart Parking

9.   SUGGESTED SPECIFICATION TABLE FOR QUESTION PAPER DESIGN:

Unit No.	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
1	Introduction to IoT	8	6	8	0	14
2	Sensors and Actuators	9	4	10	0	14
3	Programming with Arduino Uno	10	0	7	10	17
4	IoT Protocols	10	6	12	0	18
5	Applications of IoT	5	0	0	7	7
Total		**42**	**16**	**37**	**17**	**70**

Legends: R=Remember, U=Understand, A=Apply and above (Revised Bloom's taxonomy)
Note: *This specification table provides general guidelines to assist students for their learning and to teachers to teach and question paper designers/setters to formulate test items/questions assess the attainment of the UOs. The actual distribution of marks at different taxonomy levels (of R, U and A) in the question paper may vary slightly from the above table.*

10.   SUGGESTED STUDENT ACTIVITIES

Other than the classroom and laboratory learning, following are the suggested student-related co-curricular activities which can be undertaken to accelerate the attainment of the various outcomes in this course: Students should conduct following activities in group

a) Undertake micro-projects in teams.

b) Give a seminar on any relevant topics.

c) Visit any Industry with IoT in your area and learn the IoT systems used in Industry.

d) Students are encouraged to register themselves in various MOOCs such as: Swayam, edx, Coursera, Udemy etc to further enhance their learning.

e) Undertake Swayam MOOC online course: "Introduction to Internet of Things": https://onlinecourses.nptel.ac.in/noc24_cs35/preview

11.   SUGGESTED SPECIAL INSTRUCTIONAL STRATEGIES (if any)

These are sample strategies, which the teacher can use to accelerate the attainment of the various outcomes in this course:

a. Massive open online courses (***MOOCs***) may be used to teach various topics/subtopics.

b. Guide student(s) in undertaking micro-projects.

c. ***'L' in section No. 4*** means different types of teaching methods that are to be employed by teachers to develop the outcomes.

d. About ***15-20% of the topics/sub-topics*** which are relatively simpler or descriptive in nature is to be given to the students for ***self-learning***, but to be assessed using different assessment methods.

e. With respect to ***section No.10***, teachers need to ensure to create opportunities and provisions for ***co-curricular activities***.

12. SUGGESTED PROJECT LIST
1. Smart Agriculture System
2. Weather Reporting System
3. Home Automation System
4. Face Recognition Bot
5. Smart Garage Door
6. Smart Alarm Clock
7. Air Pollution Monitoring System
8. Smart Parking System
9. Smart Traffic Management System
10. Smart Cradle System
11. Smart Gas Leakage Detector Bot
12. Streetlight Monitoring System
13. Smart Anti-Theft System
14. Liquid Level Monitoring System
15. Night Patrol Robot
16. Internet of Things with Android and Arduino
17. Automatic Street Lighting system using IoT
18. Smart Building Project using PIR
19. Smart Water Monitoring System using IoT
20. Cloud-ready temperature sensor with the Arduino Uno
21. An IoT Temperature Monitor for Balcony Garden
22. Smart Irrigation System using IoT
23. Temperature & Humidity Sensing using IoT
24. IoT Remote Soil Moisture Monitor
25. IoT based smart alert system for Heart Patients

13. SUGGESTED LEARNING RESOURCES

Sr	Title	Authors	Publisher	Year
1	Internet of Things: Architecture and Design Principles	Rajkamal	McGraw Hill Education	2017
2	IoT Fundamentals Networking Technologies, Protocols and Use Cases for Internet of Things	David Hanes, Gonzalo salgueiro	Cisco Press	2017
3	Designing the Internet of Things	Adrian McEwen, Hakim Cassimally	John Wiley and Sons, Ltd.	2014

14. SOFTWARE/LEARNING WEBSITES
- Swayam MOOC online course for the introduction to internet of Things:
  https://onlinecourses.nptel.ac.in/noc24_cs35/preview
- Tutorials point online learning portal:
  https://www.tutorialspoint.com/internet_of_things/index.htm
- Arduino tutorial: https://www.arduino.cc/reference/en/

● Online Simulator for Arduino: https://www.tinkercad.com/dashboard

15. PO-COMPETENCY-CO MAPPING:

Semester VI	Fundamentals of IoT (Course Code: 4360703)						
	POs						
Competency & Course Outcomes	PO1 Basic & Discipline specific knowledge	PO2 Problem Analysis	PO3 Design/ development of solutions	PO4 Engineering Tools, Experimentation and Testing	PO5 Engineering practices for society, sustainability & environment	PO6 Project Management	PO7 Life-long learning
**Competency**	Analyse and design the IoT System using the Sensor, the Actuator and Arduino board.						
Course Outcomes: CO1: Explain the basic concept of IoT	2	2	-	-	-	-	1
CO2: Apply different Sensors and Actuators in IoT Application as required	3	3	3	3	1	-	1
CO3: Develop sketch for the IoT application using the Arduino Uno board.	3	3	3	3	2	2	1
CO4: Explain Messaging and Transport protocols for IoT communication used in the IoT Applications.	2	1	1	1	-	-	1
CO5: Illustrate the working of real world IoT applications.	2	2	2	2	1	1	1

Legend: '**3**' for high, '**2**' for medium, '**1**' for low and '**-**' for no correlation of each CO with PO.

16. COURSE CURRICULUM DEVELOPMENT COMMITTEE
GTU Resource Persons

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