GUJARAT TECHNOLOGICAL UNIVERSITY (GTU)

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

Course Title: Wireless Sensor Networks and IoT
(Course Code :) 4353201

Diploma programmer in which this course is offered	Semester in which offered
Information & Communication Technology	Fifth

1. RATIONALE

In today's world smart grid, smart homes, smart water networks, intelligent transportation, smart infrastructure systems etc. Connect our world more than we ever thought possible. The common vision of such systems is usually associated with one single concept, the Internet of Things (IoT), where through the use of sensors, the entire physical infrastructure is closely coupled with information and communication technologies; where intelligent monitoring and management can be achieved via the usage of networked embedded devices. In this course the students will learn and explore the use and evolution of WSNs within the wider context of IoT and provide a review of WSN architecture framework, standards and IoT based Applications.

2. COMPETENCY

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

- Describe the fundamental principles of WSN and design application specific real-world IoT systems.

3. COURSE OUTCOMES (COs)

1. To demonstrate the fundamental architecture and key design issues in wireless sensor networks.
2. To enlist the various protocols and its differences with traditional protocols in WSNs.
3. To familiarize with conceptual framework of IoT.
4. To demonstrate architecture and design principle of IoT for real time applications.
5. To design and develop real time application specific IoT systems.

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	0	2	4	30*	70	25	25	150

(*): Out of 30 marks under the theory CA, 10 marks are for assessment of the micro-project to facilitate integration of COs and the remaining 20 marks is the average of 2 tests to be taken during the semester for the assessing the attainment of the cognitive domain UOs required for the attainment of the COs. Legends: L-Lecture; T – Tutorial/Teacher Guided Theory Practice; P - Practical; C – Credit, CA - Continuous Assessment; ESE - End Semester Examination.

5. SUGGESTED PRACTICAL EXERCISES:

The following practical outcomes (PrOs) are the subcomponents of the Course Outcomes (Cos). Some of the PrOs marked '*' are compulsory, as they are crucial for that particular CO at the 'Precision Level' of Dave's Taxonomy related to 'Psychomotor Domain'.

Sr. No	Practical Outcomes (PrOs)	UNIT	Approx. Hrs. Required
1*	To Simulate Wireless sensor network using open source educational simulation software.	I	2
2 *	To simulate and demonstrate LEACH protocol for WSN using open source educational simulation software.	II	2
3 *	Getting started with NodeMCU, Arduino with ESP8266 and ESP32 in the Arduino IDE.	III	4
4 *	GPIO Interfacing and programming (LED, Switch, Motor)	IV	2
5	Digital on/off sensor (PIR and IR) Interfacing programming.	IV	2
6 *	Controlling devices remotely using Bluetooth link.	IV	2
7 *	Controlling devices remotely using Wi-Fi link.	IV	2
8 *	Web based device control (Perform the practical to build a web server and control device from a local web server).	IV	2
9 *	Getting started with different cloud system.	IV	2
10	Analog sensor programming and uploading sensor data on cloud.	IV	2
11	Interfacing and programming of actuators, Control devices remotely using cloud.	IV	2
12*	Introduction to raspberry pi and installing operating system for raspberry pi	IV	4
13 *	Controlling relay state based on input from IR sensors using raspberry pi	IV	2
14	Interfacing stepper motor with Raspberry Pi	IV	2
15 *	Advanced burglar alarm security system with the help of PIR sensor, buzzer and keypad using raspberry pi. (Alarm gets disabled if correct keypad password is entered)	V	4
16 *	Automated LED light control based on input from PIR (to detect if people are present) and LDR (ambient light level)	V	4

Note :

i. More Practical Exercises can be designed and offered by the respective course teacher to develop the industry relevant skills/outcomes to match the COs. The above table is only a suggestive list.

6. MAJOR EQUIPMENT/ INSTRUMENTS REQUIRED

This major equipment with broad specifications for the PrOs is a guide to procure them by the administrators to use in uniformity of practical's in all institutions across the state.

Sr.No.	Suggested 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, MATLAB	All PrOs
2	Arduino Uno, Node MCU ESP32 & ESP8266,Raspberry Pi 3 Model B, HC05 Bluetooth module etc.	
3	LEDs, Humidity and Temperature Sensor, Ultrasonic Sensor, Light Sensor, Servo motor, 16x2 LCD display, PIR Sensor, Potentiometer, relay etc.,	

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. Understand the choice and application of Wireless Sensor Network
b. Describe the fundamental architecture and design principles for IoT.
c. Adhere to ethical practices

8. UNDERPINNING THEORY

The major underpinning theory is given below based on the higher level UOs of Revised Bloom's taxonomy that are formulated for development of the COs and competency. If required, more such UOs could be included by the course teacher to focus on attainment of COs and competency.

Unit	Unit Outcomes (UOs)	Topics and Sub-topics
Unit-I: Introduction to Wireless Sensor Networks	Students will able to:- 1.a Describe the overview of wireless sensor networks and enabling technologies for wireless sensor networks. 1.b Discuss key challenges of designing application specific WSNs. 1.c List various applications of WSNs	1.1 Introduction to Wireless Sensor Networks 1.2 Single-Node Architecture 1.3 Hardware Components 1.3.1 The Sensing Subsystem 1.3.2 The Processor Subsystem 1.3.3 Communication Interfaces 1.3.4 Prototypes (IMote , XYZ & Hog throb Node Architecture) 1.4 Energy Consumption of Sensor Nodes 1.5 Operating Systems and Execution Environments 1.6 Network Architecture-Sensor Network Scenarios 1.7 Optimization Goals and Figures of Merit 1.8 Design principles for WSNs 1.9 Unique challenges and constraints in WSN 1.10Applications of WSNs.

Unit	Unit Outcomes (UOs)	Topics and Sub-topics
Unit-II: Communication Protocols & Network management in WSNs	Students will able to:- 2.a Apply the design principles of WSN architectures and operating systems for simulating environment situations. 2.b Apply various concepts for assignment of MAC addresses. 2.c Select the appropriate infrastructure, topology, routing and relevant parameters for desired QoS in WSNs.	2.1 Physical Layer and Transceiver Design Considerations 2.2 MAC Protocols for Wireless Sensor Networks, 2.2.1 classification of MAC protocols for WSNs 2.3 Low Duty Cycle Protocols And Wakeup Concepts i.e. S-MAC,IEEE 802.15.4. 2.4 Schedule based protocols (LEACH, SMACS, TRAMA) 2.5 Address and Name Management in WSNs 2.6 Assignment of MAC Addresses 2.7 Routing Protocols 2.7.1 Energy-Efficient Routing 2.7.2 Geographic Routing 2.7.3 Hierarchical networks by clustering. 2.8 Issues and Challenges in providing Quality of Service in WSNs
UNIT-III :Overview of Internet of Things	Students will able to:- 3.a Understand the basic concept of IoT 3.b Explain IoT Architecture and the major components of IoT 3.c Challenges and applications of IoT	3.1 IoT Conceptual Framework 3.2 IoT Architectural View 3.3 Technology Behind IoT 3.4 Sources of IoT 3.5 M2M communication 3.7 Modified OSI Model for the IoT/M2M Systems, 3.8 Major Components of IoT system 3.9 Popular IoT Development Boards 3.10 Examples of IoT applications

Unit	Unit Outcomes (UOs)	Topics and Sub-topics
Unit IV: Architecture and Design Principles for IoT	Students will be able to:- 4.a Understand the protocols and their need in IoT 4.b Able to interface with, controlling hardware, actuator, and sensors with NodeMCU/Raspberry Pi etc.	4.1 Types of Sensors and actuators for IoT applications, 4.2 IoT components and implementation 4.3 IoT Protocols: 4.3.1 Link layer protocols 4.3.2 Network/internet layer protocols 4.3.3 Transport layer protocols 4.3.4 Application layer protocols (HTTP, HTTPS,FTP, CoAP,MQTT,XMPP etc. 4.4 IoT Security issues & challenges 4.5 Prototyping and Designing Software for IoT Applications 4.6 Block diagram & pin configuration of NodeMCU and Raspberry PI. 4.7 Reading sensor data and transmit to cloud, Controlling devices through cloud using mobile application and web application
UNIT V :IoT Applications and case study	Students will be able to:- 5.a Classify IoT applications 5.b Demonstrate Real time IoT applications.	5.1 Broad categories of IoT applications: Consumer IoT, Commercial IoT, Industrial IoT, Infrastructure IoT, Military Things (IoMT) 5.2 Overview, Block Diagram and Working of the following real world IoT applications & case study : 5.2.1 Smart Home automation with IoT 5.2.2 IoT based Health care monitoring 5.2.3 Smart Parking system 5.2.4 Smart City Street light control & Monitoring system 5.2.5 Voice Apps on IoT device

9. SUGGESTED SPECIFICATION TABLE FOR QUESTION PAPER DESIGN:

Unit No.	Unit Title	Teaching Hour	Distribution of Theory Marks			
			R Level	**U Level**	**A Level**	**Total Marks**
I	Introduction to Wireless Sensor Networks	8	4	6	4	14
II	Communication Protocols & Network management in WSNs	10	4	6	6	16
III	Overview of Internet of Things	10	4	6	4	14
IV	Architecture and Design Principles for IoT	10	4	6	6	16
V	IoT Applications and case study	4	2	4	4	10
	Total	**42**	**18**	**28**	**24**	**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/Realtime applications.
d) Students are encouraged to register themselves in various MOOCs to further enhance their learning.

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. About 10% 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.

12. SUGGESTED MICRO-PROJECT LIST

Only **one micro-project** is planned to be undertaken by a student that needs to be assigned to him/her in the beginning of the semester. In the first four semesters, the micro-projects are group-based (group of 3 to 5). However, in the fifth and sixth semesters, the number of students in the group should not exceed three. The micro-project could be industry application based, internet-based, workshop-based, laboratory-based or field-based. Each micro-project should encompass two or more COs which are in fact, an integration of PrOs, UOs and ADOs. Each student will have to submit one-two page report also.

- IOT based Smart Agriculture System
- IOT based Weather Reporting System
- IOT based Home Automation System
- IOT based Face Recognition Bot
- IOT based Smart Garage Door
- IOT based Smart Alarm Clock
- IOT based Air Pollution Monitoring System
- IOT based Smart Parking System
- IOT based Smart Traffic Management System
- IOT based Smart Cradle System
- IOT based Smart Gas Leakage Detector Bot
- IOT based Streetlight Monitoring System
- IOT based Smart Anti-Theft System

- IOT based Liquid Level Monitoring System
- IOT based Night Patrol Robot
- Automatic Street Lighting system using IoT
- IOT based Smart Building Project using PIR
- Smart Water Monitoring System using IoT
- Cloud-ready temperature sensor with the Arduino Uno
- An IoT Temperature Monitor for Balcony Garden
- Smart Irrigation System using IoT
- Temperature & Humidity Sensing using IoT
- IoT Remote Soil Moisture Monitor
- IoT based smart alert system for Heart Patients

13. SUGGESTED LEARNING RESOURCES

No	Title	Authors	Publisher	Year
1	Fundamentals of Wireless Sensor Networks Theory & Practice	Waltenegus Dargie & Christian Poellabauer	A John Wiley and Sons, Ltd., Publication	2010
2	Internet of Things: Architecture and Design Principles	Rajkamal	McGraw Hill Education	2017
3	Protocols And Architectures for Wireless Sensor Networks	Holger Karl & Andreas Willig	John Wiley	2005
4	Wireless Sensor Networks- An Information Processing Approach	Feng Zhao & Leonidas J. Guibas	Elsevier	2007

14. SOFTWARE/LEARNING WEBSITES

- **https://www.nsnam.org/about/** (free network simulation software, licensed under the GNU GPLv2 license, and is publicly available for educational & research purpose)
- NPTEL online course on IoT
- IoT Tutorial point www.tutorialspoint.com
- https://www.microsoft.com/en-us/internet-of-things/
- https://play.google.com/store/apps/details?id=cc.arduino.cloudiot
- https://www.scnsoft.com/blog/iot-architecture-in-a-nutshell-and-how-it-works
- https://mrcet.com/downloads/digital_notes/CSEIOT/WIRELESS%20SENSOR%20NETWORKS.pdf

15. PO-COMPETENCY-CO MAPPING:

Semester V	**Information & Communication Technology Wireless sensor Network & IoT (Course Code:4353201)**						
	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	**Describe the fundamental principales of WSN and designe application specific real-world IoT systems.**						
Course Outcomes CO1 To demonstrate the fundamental architecture and key design issues in wireless sensor networks	1	-	2	-	3	-	2
CO2 To enlist the various protocols and its differences with traditional protocols in WSNs.	-	2	3	2	-	-	2
CO3 To familiarize with conceptual framework of IoT.	3	-	1	2	-	-	1
CO4 To demonstrate architecture and design principle of IoT for real time applications.	1	2	3	3	-	2	1
CO5 To design and develop real time application specific IoT systems	-	2	3	3	2	3	3

*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

Sr. No.	Name and Designation	Institute	Contact No.	Email
1	DR. Monali Prajapati	Government Polytechnic Gandhinagar	74900 52256	monalimandli79@gmail.com
2	Mr. T. P. Chanpura	Government Polytechnic for Girls,Ahmedabad		
3	Mrs. Manisha Mehta	Government Polytechnic Himatnagar		