GUJARAT TECHNOLOGICAL UNIVERSITY (GTU)

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

Course Title: Internet of Things
(Course Code: 4352404)

Diploma programmer in which this course is offered	Semester in which offered
Power Electronics	5th Semester

1. RATIONALE

The Internet of Things (IoT) has gained significant attention and popularity in recent years due to its potential to revolutionize various industries and aspects of our daily lives. The IoT enables seamless connectivity over the internet and interoperability between physical devices, machines, and systems to improve efficiency, productivity, and resource utilization. IoT holds immense potential to enhance our lives, transform industries, and drive innovation and economic growth. The IoT presents significant opportunities for innovation and economic growth. It enables the development of new products, services, and business models, fostering entrepreneurship and job creation.

2. COMPETENCY

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

- **Integrate various sensors and actuators with IoT devices.**

3. COURSE OUTCOMES (COs)

The practical exercises, the underpinning knowledge and the relevant soft skills associated with this competency are to be developed in the student to display the following COs:

1. **Explain the Importance and Role of IoT in new age world.**
2. **Describe communication and cloud technologies required for IoT.**
3. **Build various IoT applications using ESP32 and Arduino Cloud.**
4. **Build special IoT applications with the use of different cloud and web services.**
5. **Understand the Vehicular and Health care case studies with New IoT Paradigm.**

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

(*): 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

*Following practical outcomes (PrOs) that are thesub-components 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'.*

S. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. required
1	To study role and importance of IoT various fields.	1	2*
2	To study future prospective of IoT.	1	2
3	To study various non-cellular technologies used in IoT	2	2*
4	To study various cellular technologies used in IoT	2	2
5	To study cloud technology used for IoT.	2	2*
6	To study various hardware and software platforms available for IoT.	3	2*
7	Build IoT application to control 01 LED using ESP32 and Arduino Cloud.	3	2*
8	Build IoT application to control 02 and 03 color LED using ESP32 and Arduino Cloud.	3	2*
9	Build IoT application for interface LCD using ESP32 and Arduino Cloud.	3	2
10	Build IoT application for LED Matrix Display using ESP32.	3	4
11	Build IoT application to control DC Loads with relay card using ESP32.	3	2*
12	Build IoT application to control AC Loads with relay card using ESP32.	3	2*
13	Develop IoT application to receive SMS Alerts using Twilio.	4	4
14	Develop IoT application for Data Logging to Google Sheets with Google Scripts.	4	4
15	Develop IoT based Soil Moisture Monitoring System.	4	4*
16	Develop IoT based Surveillance Robot with camera.	4	4*
17	Develop IoT based Home Automation system for at least 03 loads using Blynk.	4	2
18	Prepare a case study on currently IoT used in vehicular application.	5	2*
19	Prepare a case study on currently IoT used in Health Care application.	5	2
20	To study various new paradigm of IoT.	5	2*
	Total		**28***

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.*

ii. *The following are some **sample** 'Process' and 'Product' related skills (more may be added/deleted depending on the course) that occur in the above listed **Practical Exercises** of this course required which are embedded in the COs and ultimately the competency.*

S. No.	Sample Performance Indicators for the PrOs	Weightage in %
1	Prepare of experimental setup	20
2	Operate the equipment setup or circuit	20
3	Follow safe practices measures	10

S. No.	Sample Performance Indicators for the PrOs	Weightage in %
4	Record observations correctly	20
5	Interpret the result and conclude	30
Total		**100**

6. MAJOR EQUIPMENT/ INSTRUMENTS REQUIRED

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

S. No.	Equipment Name with Broad Specifications	PrO. No.
1	**IoT Trainer Kit** Product should have: Built in Cortex M3 32bit Microcontroller, WIFI module, wireless module, Bluetooth module, 4x16/4x20 LCD, I2C based 4-digit 7 segment display, 8 LEDs, POT for 12-bit ADC experiment, 12 bit DAC port, 7 push to on switches, SD MMC card, DS1307 RTC, I2C based EEPROM, Stepper Motor Driver with port for Stepper Motor, 4 POT for WIFI experiment, 4 Toggle switches for WIFI experiment, 3 PWM LED IOT, 4 LED for WIFI experiment, 3 relays, 12v &3.3v regulator, Power port, 4 sensor ports, I2C ports, JTAG ports.	7 to 17
2	**Arduino Nano (Compatible) and NodeMCU (Arduino-WiFi Compatible Board) Trainer Kit** Radio HC-12 433MHz Port, Bluetooth HC-05 Port, 10K Potentiometer, 16×2 LCD Display, DHT11 (Humidity and Temperature Sensor), Light Sensor, Real-Time Clock, Push Button, Light Emitting Diode (LEDs), LM35 (Analog Temperature Sensor), Small Breadboard and Arduino Shield Footprint, RGB LED (Red, Green, Blue), Passive Buzzer.	7 to 17
3	**IoT Trainer Kit using ESP32** 8 interfacing LED's, 1 * 4 Menu keypad, 4* 4 Matrix Keypad, RS232, RS485, USB communication port, 7 Segment Multiplexed Display, 16*2 LCD & OLED Display, ADC & DAC Card, 8 bit 4 port IO, On Board WiFi/Bluetooth Connectivity, 3.3 to 5V Level Converter, Power Supply 3.3V and 5V, SD CARD Interface, RTC & EEPROM Interface, DC Motor/ Stepper Motor Driver, Relay, Buzzer, Temperature Sensor, Analog Test POT.	7 to 17
4	**ESP 32 MCU Module**	7 to 17
5	**Multi Controller IoT Trainer Board** Trainer should contains Arduino Uno, Raspberry Pic, ESP32, STM32, Lora Module, Zigbee Module, Bluetooth Module, GSM Module, Display 1.8", DHT11 – Temp & Hum Sensor, RS232 converter, RS485 Converter, CAN Module, Buzzer, Relay, Potentiometer, Push Button, BMP280, RGB LED, Accelerometer & Gyroscope, PIR Sensor, Ultrasonic Sensor, Joystick Module, Servo Stepper Motor, Keyboard, Breadboard, RF Module, IR sensor, Gas Sensor, Pump, Sound Sensor, Light Sensor, Turbidity Sensor, Soil Moisture sensor, Reed Switch, Water level sensor, Load Cell, Vibration Sensor, Solenoid Valve, Hall Effect Sensor, Blood Pressure Sensor, Touch Sensor, PH Sensor, RFID Reader & Card	7 to 17
6	**LCD and LED Matrix Display**	9, 10
7	**4/8/16 Module AC/DC Relay Card**	11, 12
8	**ESP32 CAM Development Board WiFi + Bluetooth with AF2569 Camera Module**	16

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 fulfill the development of this competency.

a) Work as a leader/a team member.
b) Follow safety practices while using electrical instruments and tools.
c) Realize importance of sensors and transducers in electronic circuits.

The ADOs are best developed through the laboratory/field-based exercises. Moreover, the level of achievement of the ADOs according to Krathwohl's 'Affective Domain Taxonomy' should gradually increase as planned below:

i. 'Valuing Level' in 1st year
ii. 'Organization Level' in 2nd year.
iii. 'Characterization Level' in 3rd year.

8. UNDERPINNING THEORY

Only the major Underpinning Theory is formulated as higher level UOs of *Revised Bloom's taxonomy* in order development of the COs and competency is not missed out by the students and teachers. If required, more such higher level UOs could be included by the course teacher to focus on attainment of COs and competency.

Unit	Unit Outcomes (UOs) (4 to 6 UOs at Application and above level)	Topics and Sub-topics
Unit – I IoT Basics	1a. Explain significance of IoT.	1.1 Internet of Things (IoT): Introduction, IoT and Its Significance
	1b. Explain role of IoT in Sustainable Environment Management and Energy Management.	1.2 Role of the IoT: Sustainable, Environment Management, Energy Management.
	1c. What is importance of IoT in Industries, Smart Agriculture and Water Management Systems, Waste Management, Intelligent Cities and Smart Homes, Wildlife and Tourism, Marine Ecosystem Monitoring, Air Quality Management.	1.3 Importance of IoT: In Industries, Smart Agriculture and Water Management Systems, Waste Management, Intelligent Cities and Smart Homes, Wildlife and Tourism, Marine Ecosystem Monitoring, Air Quality Management.
	1d. Explain importance of Blockchain in IoT.	1.4 Importance of Blockchain Technologies in IoT.
	1e. Explain Future perspectives of IoT.	1.5 Future Perspectives of IoT.
Unit– II Communication Technologies and cloud for Internet of Things	2.a Describe various cellular and non-cellular communication technologies used for IoT.	2.1 Communication Technologies for IoT Networks; Non-Cellular Communication Technologies (Wi-Fi, Bluetooth, and ZigBee), Cellular Communication Technologies (3G, LTE, LTE-M); Specifications, Range, Data Rate, Application Area, Advantages and disadvantages
	2.b Describe cloud technologies used for IoT in Details.	2.2 Cloud Technology: Cloud computing, Types of Cloud services, Simple architecture, Characteristics, Need of

Unit	Unit Outcomes (UOs) (4 to 6 UOs at Application and above level)	Topics and Sub-topics
		cloud computing, Challenges, Popular platforms.
Unit– III IoT Hardware development	3a. List the selection criteria for IoT hardware platform. 3b. Compare various IoT boards. 3c. Build IoT application for LED (1,2,3), LCD, LED Matrix Display, Relay Card for AC and DC Loads using ESP32.	3.1 Hardware platform available for IoTs: Selection criteria, Classification, ESP32 specifications, comparison of various IoT ready Boards. 3.2 Interfacing using ESP32 and Arduino Cloud: LED (1,2,3), LCD, LED Matrix Display, Relay Card for AC and DC Loads.
Unit– IV Special Application Development	4a. Develop IoT applications for 1. SMS Alerts using Twilio, 2. Data Logging to Google Sheets with Google Scripts, 3. Soil Moisture Monitoring System, 4. CAM Based Surveillance Robot, 5. Home Automation using Blynk App.	4.1 SMS Alerts using Twilio. 4.2 Data Logging to Google Sheets with Google Scripts. 4.3 IoT based Soil Moisture Monitoring System. 4.4 CAM Based Surveillance Robot 4.5 Home Automation using Blynk App
Unit– V IoT Case Studies and new paradigm	5a. Explain role of IoT in vehicular application with its component, advantages. 5b. Take case study of Vehicular IoT for crime assistance support. 5c. Explain role of IoT in health care sector with its components, advantages, risk factors. 5d. Take case study of AmbuSens system. 5e. Discuss various new IoT paradigm.	5.1 Vehicular IoT: Components of vehicular IoT, Advantages of vehicular IoT, Crime assistance in a smart IoT transportation system. 5.2 Healthcare IoT: Components of healthcare, Advantages and risk of healthcare IoT, Case Studies on AmbuSens system. 5.3 Evolution of New IoT Paradigm: Internet of battlefield things (IoBT), Internet of vehicles (IoV), Internet of underwater things (IoUT), Internet of drones (IoD), Internet of space (IoSpace), Internet of services (IoS), Internet of people (IoP), Internet of nano things (IoNT), Internet of everything (IoE).

***Note**: The UOs need to be formulated at an 'Application Level' and above of Revised Bloom's Taxonomy' to accelerate the attainment of the COs and the competency.*

9. SUGGESTED SPECIFICATION TABLE FOR QUESTIONPAPER DESIGN

Unit No.	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
I.	**IoT Basics**	08	6	10	0	16

Unit No.	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
II.	**Communication Technologies and Cloud for Internet of Things**	06	4	6	0	10
III.	**IoT Hardware development**	12	0	6	14	20
IV.	**Special Application Development**	10	0	4	10	14
V.	**IoT Case Studies and new paradigm**	06	2	6	2	10

Legends: *R=Remember, U=Understand, A=Apply and above (Revised Bloom's taxonomy)*
Note*: This specification table provides general guidelines to assist student 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 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 and prepare reports of about 5 pages for each activity, also collect/record physical evidences for their (student's) portfolio which will be useful for their placement interviews:

a) **Compare and prepare chart of any four IoT Boards and Clouds.**
b) **Prepare case studies for use of IoT in Smart Agriculture and Water Management Systems, Waste Management, Intelligent Cities and Smart Homes, Wildlife and Tourism, Marine Ecosystem Monitoring, Air Quality Management and Industry 4.0.**

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/sub topics.
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 ***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***.
f) Use video/animation films to demonstrate various IoT Applications.
g) Guide students for selecting relevant IoT Board.

12. SUGGESTED MICRO-PROJECTS

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-project

is group-based. However, in the fifth and sixth semesters, it should be preferably be ***individually*** undertaken to build up the skill and confidence in every student to become problem solver so that s/he contributes to the projects of the industry. In special situations where groups have to be formed for micro-projects, 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 maintain dated work diary consisting of individual contribution in the project work and give a seminar presentation of it before submission. The total duration of the micro-project should not be less than ***16 (sixteen) student engagement hours*** during the course. The student ought to submit micro-project by the end of the semester to develop the industry oriented COs.

A suggestive list of micro-projects is given here. This has to match the competency and the COs. Similar micro-projects could be added by the concerned course teacher:

a) Build any IoT application for Sustainable Development.
b) Build any IoT application for Environmental Pollution Monitoring.
c) Build any IoT application for AC Load Controlling.
d) Build any IoT based Robotic Application.
e) Build any IoT based Drone Application.
f) Build any Health Care and Hospital Management application using IoT.

13. SUGGESTED LEARNING RESOURCES

S. No.	Title of Book	Author	Publication with place, year and ISBN
1	Internet of Things Applications for Sustainable Development	Niranjan Lal Shamimul Qamar Sanyam Agarwal Ambuj Kumar Agarwal Sourabh Singh Verma	CRC Press ISBN 978-1-032-12898-6 (hbk) ISBN 978-1-003-22688-8 (ebk)
2	Introduction to IoT	Sudip Misra Anandarup Mukherjee Arijit Roy	Cambridge University Press ISBN 978-1-108-95974-2 (hbk) ISBN 978-1-108-91356-0 (ebook)
3	Internet of Things	Jain V. K.	Khanna Publishers ISBN 819-5-20752-9
4	Internet of Things for Smart Cities Technologies, Big Data and Security	WaleedEjaz, AlaganAnpalagan	Springer Nature Switzerland AG ISBN 978-3-319-95036-5 ISBN 978-3-319-95037-2 (eBook)
5	ESP8266 Robotics Projects	Pradeeka Seneviratne	Packt Publishing ISBN 978-1-78847-461-0

14. SOFTWARE/LEARNING WEBSITES

a) https://www.educba.com/data-science/data-science-tutorials/iot-tutorial/
b) https://www.youtube.com/watch?v=LIhmzVL5bm8&list=RDQMmTsukyHmUOE&start_radio=1
c) https://www.youtube.com/watch?v=n6iWPsWIGhQ&list=PLHq_wPEVVWy35jTVJpuHdcuXI72phAAxm
d) https://www.youtube.com/watch?v=b7GC4Zr74M0
e) https://www.youtube.com/watch?v=Ic63-yf-zuc&list=PL3uLubnzL2Tm5PAw88N1jR9MLTJpuPEnX
f) https://www.youtube.com/watch?v=ahZYZPFoHq4&list=PLPIwNooIb9viDc9TZ4Kx206NDMmquLlGc

g) https://www.youtube.com/watch?v=unlPb-dfW7s&list=PLz8TdOA7NTzR1NxoC8yRIWfaO0Yrj9gVB
h) https://www.youtube.com/watch?v=APH6Nrar27w&list=PLYwpaL_SFmcB8fDd64B8SkJiPpEIzpCzC
i) https://www.youtube.com/watch?v=UrwbeOIlc68
j) https://www.youtube.com/watch?v=h0gWfVCSGQQ
k) https://www.electronicshub.org/getting-started-with-nodemcu/
l) https://electronicsworkshops.com/2020/08/02/introduction-to-nodemcu-esp8266/
m) https://www.intuz.com/guide-on-top-iot-development-boards
n) https://iotdesignpro.com/esp32-projects?page=1
o) https://github.com/myinvent/Myduino-IoT-Training-Kit/tree/main
p) https://www.instructables.com/IOT-for-Beginners-with-Node-Mcu/
q) https://maker.pro/arduino/projects/introduction-to-iot-with-node-mcu
r) https://www.instructables.com/How-to-Setup-Node-MCU-for-IOT-ESP8266-Board/
s) https://docs.espressif.com/projects/esp-idf/en/latest/esp32/get-started/
t) https://randomnerdtutorials.com/getting-started-with-esp32/
u) https://randomnerdtutorials.com/projects-esp32/
v) https://www.youtube.com/watch?v=UmoQKsDEWqA
w) https://www.youtube.com/watch?v=xPIN_Tk3VLQ

15. PO-COMPETENCY-CO MAPPING

Semester V	Internet of Things (Course Code: 4352404)						
	POs and PSOs						
Competency & Course Outcomes	PO 1 Basic & Discipline specific knowledge	PO 2 Problem Analysis	PO 3 Design/ development of solutions	PO 4 Engineering Tools, Experimentation &Testing	PO 5 Engineering practices for society, sustainability & environment	PO 6 Project Management	PO 7 Life-long learning
Competency	**Integrate various sensors and actuators with IoT devices.**						
Course Outcomes							
CO 1) Explain the Importance and Role of IoT in new age world.	2	1	1	0	2	1	3
CO 2) Describe communication and cloud technologies required for IoT.	2	1	2	1	1	2	3
CO 3) Build various IoT applications using ESP32 and Arduino Cloud.	2	2	3	3	2	3	2
CO 4) Build special IoT applications with the use of different cloud and web services.	2	2	3	3	2	3	3
CO 5) Understand the Vehicular and Health care case studies with New IoT Paradigm.	2	1	2	1	2	2	2

Legend: '**3**' for high, '**2**' for medium, '**1**' for low or '**-**' for the relevant correlation of each competency, CO, with PO/ PSO

16. COURSE CURRICULUM DEVELOPMENT COMMITTEE

GTU Resource Persons

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