



GUJARAT TECHNOLOGICAL UNIVERSITY

Program Name: Minor/Hons. Program

Level: UG

Branch: Minor/Hons. Internet of Things

Subject Code : BE050AI011

Subject Name : IoT Embedded Hardware

w. e. f. Academic Year:	2026-27
Semester:	5
Category of the Course:	Core Courses

Prerequisite:	The students should have knowledge of Digital Systems Design, Micro Processor and Micro Controller.
Rationale:	The knowledge of embedded systems, i.e. different microcontrollers, their programming, interfacing, Linux programming, is essential for IoT. After studying this subject, students will get knowledge of AVR, PIC and ARM based microcontrollers, their architecture, interfacing and programming useful in domain of IoT.

Course Outcome:

After Completion of the Course, Student will be able to:

No	Course Outcomes
01	Review the architecture of microcontrollers used in IoT applications
02	Practice for different programming techniques in C language for IoT
03	Extrapolate embedded Linux platform components and solve different applications using it for IoT
04	Quote python basic functions and test them in IoT applications

Teaching and Examination Scheme:

Teaching - Learning Scheme (in Hours per Semester)					Total Credits = TH/30	Assessment Pattern and Marks					Total Marks
L	T	P	PBL*	TH		Theory		Tutorial / Practical			
						ESE(E)	PA(M)	PA(I)	PBL(I)	ESE(V)	
45	30	00	45	120	04	70	0	0	30	50	150

Where L = Lecture, T= Tutorial, P= Practical, TW/SL = Term-Work / Self-Learning, TH = Total Hours, ESE = End Semester Examination, PA = Progressive Assessment

* Problem Based Learning (PBL) aims to accommodate learning beyond syllabus as per clause 9.4 of NBA manual.



GUJARAT TECHNOLOGICAL UNIVERSITY

Program Name: Minor/Hons. Program

Level: UG

Branch: Minor/Hons. Internet of Things

Subject Code : BE050AI011

Subject Name : IoT Embedded Hardware

Course Content:

Unit No.	Content	No. of Hours	% of Weightage
1.	Introduction of AVR, PIC & ARM Series Architecture, Registers, Operation modes, Overview of instruction Set, Interrupt Management, Exception Handling, Timers, SDKs & IDEs for firmware development, Peripheral Programming (UART, GPIO, ADC, SPI, I2C, etc.), Debugging techniques, CAN basics	12	27
2.	Programming Languages C - Overview of C in view of IOT Devices, Pointers, Functions Arrays, Strings, Structures & Unions. Memory Allocation, Preprocessor, Linked Lists, Stacks & Queues, Sorting & Searching Techniques	9	19
3.	Introduction to Linux, Working with Commands Line, File System Hierarchy, vi Editor, Package Management, Administrative & Networking Essentials, Linux Internals (Process Management, Threads, File Handling, IPC), Working with Target Boards – Raspberry Pi, Beagle Bone Black etc., Native vs. Cross Building Applications, Supporting Libraries, Peripheral Management on Linux(UART, GPIO,ADC, SPI, I2C, etc)	12	27
4.	Introduction to Python, Scope , Data Types, Files, Functions, Modules & Packages, Standard Libraries, Data Structures, OOPs Concepts, Data Analytics related Packages	12	27
Total		45	100

Suggested Specification Table with Marks (Theory):

Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level
10	35	35	10	5	5

Where R: Remember; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create (as per Revised Bloom's Taxonomy)

References/Suggested Learning Resources:

(a) Books:

1. Muhammad Ali Mazidi, Sarmad Naimi and Sepehr Naimi, "The AVR Microcontroller and Embedded Systems", Using Assembly and C, Pearson Education, 1st Edition, 2012.
2. Dhananjay Gadre, "Programming and Customizing the AVR Microcontroller", TMH, 1st Edition, 2001.



GUJARAT TECHNOLOGICAL UNIVERSITY

Program Name: Minor/Hons. Program

Level: UG

Branch: Minor/Hons. Internet of Things

Subject Code : BE050AI011

Subject Name : IoT Embedded Hardware

3. ARM Assembly Language Programming & Architecture By. Muhammad Ali Mazidi, Kindle edition.
4. Arm System Developer's Guide, Designing and Optimizing Software, Andrew N. Sloss, Dominic Symes, Chris Wwright, Elsevier.
5. Embedded Systems By. Lyla Das, Pearson publication.
6. Embedded System: Architecture, Programming and Design by Raj Kamal, 2nd Edition, TMH Publication.
7. Embedded Software Premier David Simon (Pearson).

(b) Open source software and website:

1. Atmel Studio
2. MPLab IDE
3. Python
4. Raspberry pi OS
5. <https://www.coursera.org/specializations/iot>
6. <https://nptel.ac.in/courses/106/105/106105193/>
7. <https://nptel.ac.in/courses/106/105/106105166/>

Suggested Course Practical List:

1. Write c programs for ATmega32 Microcontroller and simulate using ATMEL Studio.
2. Interface Digital/Analog input and output devices with ATmega32 Microcontroller and write programs related to I/O applications along with IoT.
 - a. Switches
 - b. Relays
 - c. Temperature Sensor
 - d. Ultrasonic PING Sensor
 - e. DC Motor
 - f. Servo Motor
3. Generate PWM waveform and change intensity of LED connected with ATmega32 Microcontroller board through cloud commands.
4. Also implement above experiments using PIC18 series Microcontroller development board.
5. Understand ARM cortex based Raspberry Pi development board and configure it with OS and programming software installation.
6. Make different programs in Python on Raspberry Pi development board and interface different devices with it.
 - a. Different sensor modules
 - b. Camera Interface
 - c. Image capturing and storing on cloud



GUJARAT TECHNOLOGICAL UNIVERSITY

Program Name: Minor/Hons. Program

Level: UG

Branch: Minor/Hons. Internet of Things

Subject Code : BE050AI011

Subject Name : IoT Embedded Hardware

- d. Video capturing and storing on cloud
7. To apply concepts covered in the subject to design, simulate, and analyze a mini project using appropriate online tools and simulation platforms.

List of Laboratory/Learning Resources Required:

1. DC Power Supply/ Batteries
2. Function Generator
3. CRO/DSO
4. Multimeter
5. Discrete components like bread board, switches, LEDs, Buzzers, single lead wires(connectors), Arduino, Raspberry Pi, ESP32, ESP8266, ATMEGA32, ARM, PIC.
6. Open source softwares : Arduino IDE, Atmel Studio, MPLab IDE, Python, Raspberry pi OS
7. Learning resources: NPTEL website.

List of suggested activities for Problem Based Learning:

Sl. No.	Name of the activity	No. of hours	Evaluation Criteria
1.	Industry/Research laboratory visit	Visit = 5h, Report preparation = 5h Total = 10h	Based on report submitted. Report should contain observations and calculations based on industry/ lab data.
2.	Technical Video based learning related to the subject	Duration of video = 5h Report preparation = 5h Total = 10h	Report /presentation based on the video learning outcomes.
3.	Assignment writing. Numerical based assignment is preferable.	5 assignments of 2h each. Total = 10h	Based on the assignment submitted.
4.	Problem solving/Coding using C, C++, Python, SCILAB, MATLAB, MS-EXCEL or any other relevant software	5 small coding-based assignment of 2h each. Total = 10h	Based on the coding solution submitted.



GUJARAT TECHNOLOGICAL UNIVERSITY

Program Name: Minor/Hons. Program

Level: UG

Branch: Minor/Hons. Internet of Things

Subject Code : BE050AI011

Subject Name : IoT Embedded Hardware

5.	Self-learning on-line course.	Minimum duration of the course should be 10h.	Examination based assessment at the end of course. Based on the certificate produced.
6.	Complex problem solving.	Maximum 2 problem. Study of the problem and solution finding, Total = 10h	Based on the depth of the solution submitted.
7	Videos on Industrial safety aspects based on subject.	Duration of video = 5h Report preparation = 5h Total = 10h	Based on quiz/report submitted
8	Discussion on research paper based on relevant subject	5 research paper = 20 h	Summarize research paper and evaluation critical parameters
9.	Poster/chart/power point preparation on technical topics	Duration = 6 h	Based on poster/chart preparation and presentation skills
10	Working/non-working model on technical topics	Working = 12 h Non- working = 8 h	Based on inter department/external evaluation
11	Industrial exposure for 2-3 days to observe and provide tentative solutions on society/environment/health/any other issue	Duration = 15 h for industrial exposure Problem identification and tentative solution = 10 h Total = 25 h	Based on evaluation of critical problems and solutions
12	Group Discussion on emerging/trending technical topics based on subject	Duration = 1 h each	Based on performance in group discussion, technical depth, knowledge etc.



GUJARAT TECHNOLOGICAL UNIVERSITY

Program Name: Minor/Hons. Program

Level: UG

Branch: Minor/Hons. Internet of Things

Subject Code : BE050AI011

Subject Name : IoT Embedded Hardware

13.	Real world case studies-based learning.	Duration of data collection/study = 5h Report preparation = 5h Total = 10h	Based on in-depth study, technical depth, data collected, fact finding, etc.
14.	Application/Software development.	Duration = 10 h	Depending on the complexity of the Application/Software

Note:

- All the suggested activity should be related to the subject.
- The number of hours is suggestive. Faculty can sub-divide the number of hours based on the activity. However, total number of hours is fixed.
- Rubrics for the evaluation can be prepared by the faculty.
- All records pertaining to the evaluation and assessment of self-learning activities must be properly maintained and preserved at the institute level. These records should be made available to the university upon request.
- Institutes are encouraged to utilize digital platforms, such as Microsoft Teams, for effective record-keeping and to ensure transparency in the evaluation and assessment of self-learning activities.

* * * * *