



# GUJARAT TECHNOLOGICAL UNIVERSITY

Program Name: Master of Engineering

Level: PG

Branch: Biomedical Engineering

Subject Code : ME02031111

Subject Name : Advanced Embedded System

w. e. f. Academic Year:	2024-25
Semester:	2
Category of the Course:	Professional Elective Course

<b>Prerequisite:</b>	Knowledge of Digital Electronics, Basic Electronics, C Language Programming, Microprocessor, Microcontroller & Applications.
<b>Rationale:</b>	To familiarize students with concepts of advanced Embedded Systems and give them knowledge about programming, interfacing, debugging and implementing standalone systems for varied range of Biomedical Applications.

### Course Outcome:

After Completion of the Course, Student will able to:

No	Course Outcomes	RBT Level
01	To understand the aspects of Embedded Systems.	R, U
02	To learn the ARM Cortex -A53 Architecture and setup OS for the Raspberry pi.	R, U, A
03	To learn and apply the programming skills for the open Source Platform.	U, A, N, E
04	To learn the ESP32 platform its programming and interfacing for various Medical Applications	U, A, N, E, C
05	To learn the Jetson Nano platform and its application for Deployment of image analysis using AI tool.	U, A, N, E, C

\*Revised Bloom's Taxonomy (RBT)

### Teaching and Examination Scheme:

Teaching Scheme (in Hours)			Total Credits L+T+ (PR/2)	Assessment Pattern and Marks				Total Marks
L	T	PR	C	Theory		Tutorial / Practical		
				ESE (E)	PA / CA (M)	PA/CA (I)	ESE (V)	
3	0	2	4	70	30	20	30	150

### Course Content:

Unit No.	Content	No. of Hours	% of Weightage
1.	<b>Introduction to Embedded System</b> Overview of embedded systems, Characteristics of Embedded System, Classification of embedded systems, Application areas, Elements of Embedded System, Core of Embedded System, Classification of Program Memory and Working Memory, Onboard & External Communication Interfaces, Embedded Firmware, Reset and Crystal Circuit, Brown out reset and Watchdog timer.	8	10



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2.	<b>Introduction to Raspberry Pi</b> Comparison of various Rpi Models, Understanding SoC architecture and SoCs used in Raspberry Pi, Pin Description of Raspberry Pi, On-board components of Rpi, Booting Up RPi- Operating System and Linux Commands, Installing Raspbian on Pi, first boot and Basic Configuration of Pi, LED Blinking with Raspberry Pi using GPIO commands, LED control with Button using GPIO commands	8	15
3.	<b>Raspberry Pi Programming</b> Python IDE, Data types, Variables, Controlling Statement, File read/write operation, Image read/write operation, Audio and Video playback on the RPi, Interfacing of Camera with Pi, <b>Case Study:</b> Temperature and Humidity Sensor (DHT11), Motion Sensor (PIR), Obstacle detection using Ultrasonic sensor, Object detection using Pi camera	10	25
4.	<b>Introduction to ESP32</b> Overview of ESP32, Features of ESP32, ESP32 Pin out (GPIO), Advance Peripheral Interface of ESP32, ESP32 Programming using Arduino IDE, Interface of LED, Switch using ESP32, read analog value using ESP32, PWM Operation using ESP32 <b>Case Study:</b> DHT11, HC- SR 04 Sensor, LM35, MPU 6050, ADXL335 Accelerometer, PIR Sensor, MAX 30100 Pulse oximeter Sensor interfacing with ESP32	10	25
5.	<b>Introduction to Jetson Nano</b> Overview of Jetson Nano - Features, applications, and variant comparisons, Setup of Jetson Nano, Setup pi camera with Jetson nano, installing Libraries & Setting up AI Computer <b>Case Study:</b> Object detection and classification using Jetson nano and AI Algorithm, Face recognition and Attendance using Jetson nano	9	25
<b>Total</b>		<b>45</b>	<b>100</b>

## Suggested Specification Table with Marks (Theory):

Distribution of Theory Marks (in %)					
R Level	U Level	A Level	N Level	E Level	C Level
15	20	30	10	10	15

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. Embedded System: Architecture, Programming and Design by Rajkamal, 2nd edition, 2010, Tata McGraw Hill



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2. David E. Simon, An Embedded Software Primer, Pearson Education Asia, First Indian Reprint 2000.
3. Raspberry Pi User Guide by Eben Upton, Gareth Halfacree, John Wiley & Sons (2016)
4. The Official ESP32 Book Learn, Design, Share by Dogan Ibrahim, Ahmet Ibrahim, Elektor International Media, 2017.
5. IoT Projects with NVIDIA Jetson Nano: AI-Enabled Internet of Things Projects for Beginners, by Agus Kurniawan, Apress Berkeley, CA

## (b) Open source software and website:

1. <https://www.electronicwings.com/esp32/introduction-to-esp32>
2. <https://github.com/espressif/esp32-c3-book-en>
3. <https://github.com/Qengineering>
4. <https://gilberttanner.com/blog/jetson-nano-getting-started/>

## Suggested Course Practical List:

1. Introduction of Raspberry Pi model and installing operating system.
2. Interfacing Led Blinking using Raspberry Pi
3. Interfacing Switch with Raspberry Pi – Python
4. Interfacing DS18B20 Temperature sensor with Raspberry Pi
5. Interfacing HC-SR04 Ultrasonic Sensor with Raspberry Pi
6. Introduction of ESP32 Development hardware and Arduino IDE.
7. Interfacing MAX 30100 Pulse oximeter Sensor with ESP32.
8. Interfacing DHT11 Sensor with ESP32.
9. Introduction of Jetson Nano Development Board with necessary Installations.
10. Interface pi camera with Jetson Nano board.
11. Deploy Object detection algorithm on Jetson Nano with Camera module.
12. Deploy Face recognition algorithm on Jetson Nano.

## List of Laboratory/Learning Resources Required:

1. Raspberry Pi Platform and sensors
2. ESP32 development board with Sensors
3. NVidia Jetson Nano development board

## Suggested Project List:

- Face Recognition Using Raspberry Pi/ Jetson Nano
- Ultrasonic Distance Meter
- Raspberry Pi Based Surveillance Robot
- Sign Recognition and Voice Conversion Device for Dumb
- Measuring Acceleration with ADXL345 Accelerometer & Raspberry Pi
- Obstacle Avoidance Robot using Raspberry Pi 4 & HC-SR04

## Suggested Activities for Students:

Students should design projects using Raspberry Pi, ESP32, or Jetson Nano to address real-life problems.

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