Semester: IV						
IOT AND EMBEDDED COMPUTING **Category: PROFESSIONAL CORE COURSE** **(Theory and Practice)** **(Common to CS, CD & CY)**						
Course Code	**:**	CS344AI		**CIE**	**:**	**100+50 Marks**
Credits: L:T:P	**:**	**3:0:1**		**SEE**	**:**	**100+50 Marks**
Total Hours	**:**	**45L+30P**		**SEE Duration**	**:**	**3+3 Hours**

Unit – I	**9 Hrs**
Introduction to Embedded Systems and Applications Embedded Systems: Definition, Desirable Features & General Characteristics. Embedded Systems Vs General Computing Systems, Model of an Embedded System, Classification of Embedded Systems, Examples of Embedded Systems. ARM Processor/Controllers**:** History of the ARM Processor, the ARM Core, features of ARM Processors, ARM Processor families - Cortex A, Cortex R and Cortex M. Interfacing and Application Development Using ARM Microcontroller:LPC 2148 ARM Microcontroller-Features of the LPC 214X Family,Internal Block Diagram of LPC 2148. Block Diagram of MCB 2140 compatible board / RV-ARM-Board, Keil IDE features for embedded application development	
Unit – II	**9 Hrs**
Embedded System Design using ARM Micro-controllerLPC 2148 Digital Interfacing: LPC 2148 GPIO, Interfacing and Programming with LEDs, Switches, seven segment displays, LCD, Matrix Keypad, Stepper motor, DC Motor, Relay, Opto-isolators. Analog Interfacing:Analog Interfacing using LPC 2148 ADC Channels, Interfacing with LDR and Temperature sensors. Using DAC for Waveform Generations. (Programs using embedded C)	
Unit-III	**9 Hrs**
Timers, PWM, Interrupts & Embedded Serial protocols PWM, Timers and Interrupts:Timers – working of the Timer unit, Programming Timers and Writing Delay programs.Interrupts – Types, Nested Vectored Interrupt Controller, priorities and programming Timers with Interrupts. PWM – working of The Pulse Width Modulation Unit and Programming Using PWM Channels. (Programs using embedded C) Embedded Serial Protocols:Working & Programming of LPC 2148 UART – Registers, Baud rate calculation, Interface to PC and program development for data transmission.I2C, SPI:Working and Applications of serial protocols I2C and SPI Buses. (No programs)	
Unit – IV	**9 Hrs**
Internet Of Things – Introduction, Concepts and Use-Cases Introduction and Concepts:Definition & Characteristics of IOT, Physical Design of IOT, Logical Design of IOT, IOT Enabling technologies, Levels of IOT deployment. Use-Cases:Use cases of IOT pertaining to different domains.(Chapters 1,2 from the Reference book 2)	
Unit – V	**9 Hrs**
Design and Deployment of Internet ofThings (IOT)Applications IOT physical devices and End points:NodeMCU/ESP32(RV-IOT-Board),RaspberryPi: Block diagram, Features and Interfaces. IOT Physical Servers & Cloud Offerings: Xively /Thing Speak, AWS IOT : Features, Usage and Deployment. Case Studies: Case studies illustrating IOT design – Home automation, Smart Cities, Agriculture. (Chapters 5,7,8,9 from Reference book 2)	

Course Outcomes: After completing the course, the students will be able to:-	
CO 1	Apply Embedded System and IoT fundamentals and formulate sustainable societal relevant cost-effective solutions.
CO 2	Demonstrate the development of software programs using Embedded C, using Microcontrollers and different sensors and peripheralsto build embedded system applications.
CO3	Design smart systems using various I/O peripherals, Sensors, embedded protocols like UART,I2C,SPI using modern tools like Keil IDE software for various domains like Healthcare, automation, agriculture, smart cities and others.
CO 4	Indulge in developing Novel multi-disciplinary IoT projects using prototype boards, with effective oral & written communication skills and working in teams.
CO 5	Engage in Lifelong Learning by investigating and executing real world societal problems using engineering tools – Cross compilers, debuggers and simulators, emerging processor and controller-based hardware platforms, IOT cloud infrastructure & protocols.

Reference Books	
1.	Embedded Systems – An integrated approach, Lyla B. Das, 2013, Pearson Education, ISBN- 978-81-317-8766-3.
2.	Internet of Things – A Hands on approach, ArshdeepBahga, Vijay Madisetti, 2016, Universities Press, ISBN – 978-81-7371-954-7.
3.	Embedded Systems, Architecture, Programming and Design, Raj Kamal, 2nd Edition-Reprint 2011, Tata McGraw-Hill, ISBN-978-0-07-066764-8.
4.	Interfacing Digital & Analog Peripherals using ARM LPC 2148 based RV-ARM-Board Handbook
5.	Internet of Things,V.K.Jain, Khanna Publications, 2021, ISBN No: 978-81-952075-2-7

Laboratory Component
Laboratory Experiments comprises of, 1. Part A – Embedded Systems Programs Using RV-AllInOne-ARM Board with Embedded C (Keil IDE) 2. Part B – IOT Projects, Using RV-IOT-Kit / RasberrPie, ThingSpeak / AWS Cloud, Web/MobileApp **3.** Prototype the New idea (Productathon, a hackathon style product development competition)

PART A:

Laboratory Experiments using RV-ARM-Board (LPC 2148 ARM Microcontroller) comprises of,

1B) Simulator Elevator Interface using switches and LEDs.

2B) Seven Segment Display Interface: Write a C program to display messages "FIRE" & "HELP" on 4-digit seven segment display alternately with a suitable delay. Extend the program to implement moving display and displaying the numbers.

3B) Stepper Motor Interface: Write an Embedded C program to rotate stepper motor in clockwise direction for "M" steps, anti-clock wise direction for "N" steps. Extend the program to link the movement with the keys and realize the required RPM.

4B) DAC Interface: Write an Embedded C program to generate sine, full rectified, triangular, sawtooth and square waveforms using DAC module.

5B) Matrix Keyboard Interface: Write an Embedded C program to interface 4 X 4 matrix keyboard using lookup table and display the key pressed on the Terminal. Extend the program to read multi digit number.

6B) DC Motor Interface: Write an Embedded C program to generate PWM wave to control speed of DC motor. Control the duty cycle by analog input. Extend the program to link the speed with LDR/Temperature sensors.

7B) Character/Graphics LCD Interface: Write an Embedded C program to display text messages on the display.

PART-B

Design & Develop IOT based Solutions, using (RV-IOT-Board / Raspberry Pi, Use ThingSpeak /AWS cloud services, Use Web Application Frameworks like Django/Mobile App using C/C++/ Phython coding and relevant libraries/APIs

1b. Smart Lighting

2b. Intrusion Detection System

3b. Smart Parking

4b. Weather Monitoring System

5b. Weather Reporting Bot

6b. Forest Fire Detection

7b. Smart Irrigation

Prototype the New idea (Productathon)

Then students are given specific time (a Day or Two) to build their idea into a prototype using the previous Lab Programs carried out. Then an academic & industry panel of judges will evaluate their works and the best three prototypes will be awarded. All the students are required to submit the report, consisting of Hardware circuits, software codes and screenshots of the prototype.

RUBRICFOR THE CONTINUOUS INTERNAL EVALUATION (THEORY)		
#	COMPONENTS	MARKS
1.	**QUIZZES:** Quizzes will be conducted in online/offline mode. **TWO QUIZZES** will be conducted & Each Quiz will be evaluated for 10 Marks. Each quiz is evaluated for 10 marks adding up to 20 MARKS	**20**
2.	**TESTS:** Students will be evaluated in test, descriptive questions with different complexity levels (Revised Bloom's Taxonomy Levels: Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating). **TWO tests will be conducted**. Each test will be evaluated for **50Marks**, adding upto 100 Marks. **FINAL TEST MARKS WILL BE REDUCED TO 40 MARKS.**	**40**
3.	**EXPERIENTIAL LEARNING:** Students will be evaluated for their creativity and practical implementation of the problem. Case study based teaching learning (10), Program specific requirements (10), Video based seminar/presentation/demonstration (10) Designing & Modeling (10)**Phase 2 will be done in the exhibition mode (Demo/Prototype/any outcome). ADDING UPTO 40 MARKS**.	**40**
4.	**LAB:** Conduction of laboratory exercises, lab report, observation, and analysis (30 Marks), lab test (10 Marks) and Innovative Experiment/ Concept Design and Implementation (10 Marks) adding up to 50 Marks. THE FINAL MARKS WILL BE 50MARKS	**50**
	MAXIMUM MARKS FOR THE CIE THEORY	**150**

RUBRIC FOR SEMESTER END EXAMINATION (THEORY)		
Q.NO.	**CONTENTS**	**MARKS**
	PART A	
1	Objective type of questions covering entire syllabus	20
	PART B (Maximum of THREESub-divisions only)	
2	Unit 1 : (Compulsory)	16
3 & 4	Unit 2 : Question 3 or 4	16
5 & 6	Unit 3 : Question 5 or 6	16
7 & 8	Unit 4 : Question 7 or 8	16
9 & 10	Unit 5: Question 9 or 10	16
	TOTAL	**100**

RUBRIC FOR SEMESTER END EXAMINATION (LAB)		
Q.NO.	**CONTENTS**	**MARKS**
1	Write Up	10
2	Conduction of the Experiments	20
3	Viva	20
	TOTAL	**50**