Course Plan (Embedded System and Internet of Things)

CHITKARA UNIVERSITY

A. Course Handout (1.1)

Institute/School Name	Chitkara University Institute of Engineering and Technology
Department Name	Department of Interdisciplinary Courses in Engineering (DICE)
Programme Name	Bachelor of Engineering (B.E.), Computer Science & Engineering

Course Name	Embedded System and Internet of Things	Session	2024-2025
Course Code	23IC002	Semester/Batch	4th/2023
L-T-P(Per Week)	3-0-2	Course Credits	04
Pre-requisite	Basics of Electronics, Programming Fundamentals, Computer Architecture Basics, Networking Basics	NHEQF Level	5
Course Coordinator	Dr. Manvinder Sharma	SDG Number	1, 7, 9, 11, 12

1. Objectives of the Course

Embedded systems and Internet of Things (IoT) are integral aspects of modern technology, enabling devices to sense, communicate, and interact with the environment. This course aims to provide students with a comprehensive understanding of embedded systems and IoT technologies. Through hands-on learning and theoretical study, students will gain insights into the design, programming, and applications of these systems.

- To familiarize the students with the fundamental concepts and architecture of embedded systems.
- To apply the concept of basic building blocks of Embedded systems and Internet of things (IoT).
- To familiarize students with the concepts, architectural design, communication protocols, and challenges associated with the Internet of Things (IoT) paradigm.
- To enable students to develop practical skills in programming embedded systems and IoT devices using the Arduino platform, including interfacing with various sensors and actuators.
- To encourage students to explore emerging trends, research problems and innovative solutions.

2. Course Learning Outcomes

Student should be able:

	Course Outcome	POs	CL*	KC**	Sessions
CLO01	To understand and articulate the architecture and components of embedded systems, including processors, memory, and peripherals.	PO1, PO2,PO3,PO4, PO7	K2	Fundamental Conceptual	10
CLO02	To develop the ability to conceptualize, design, and execute embedded system projects that meet specific requirements	PO1, PO2, PO4, PO5, PO7, PO8, PO 11	K6	Conceptual Procedural	12
CLO03	To apply programming concepts for interfacing sensors, actuators, and other devices with microcontrollers.	PO1, PO2, PO3, PO5, PO7, PO 11, PO 12	K3	Conceptual Procedural	10
CLO04	To analyze and explore the principles and applications of Internet of Things (IoT).	PO1, PO2, PO3, PO4, PO5, PO7, PO 11	K4	Conceptual Procedural	9
CLO05	To analyze communication interfaces such as RS232, RS485, SPI, I2C, USB, Bluetooth, Zigbee and apply in both embedded systems and IoT projects.	PO1, PO2, PO4, PO5, PO7, PO 11, PO 12	K3	Factual Conceptual	8
Total Contact Hours					**50**

Revised Bloom's Taxonomy Terminology
*Cognitive Level =CL
**Knowledge Categories = KC

Course Learning Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CLO1	H	M	L	M	-	-	M	-	-	-	-	-
CLO2	H	H	-	H	L	-	-	M	M	-	L	-
CLO3	M	H	H	-	L	-	L	-	-	-	M	H
CLO4	L	M	H	M	M	-	H	-	-	-	L	-
CLO5	H	M	-	H	M	-	M	-	-	-	L	L

H=High, M=Medium, L=Low

3. **ERISE Grid Mapping**

Feature Enablement	Level(1-5, 5 being highest)
Entrepreneurship	3
Research	3
Innovation	3
Skills	4
Employability	3

4. **Recommended Books** (Reference Books/Text Books)

B1: Embedded Systems: Architecture, Programming and Design by Raj Kamal, TMH, 2nd Ed., 2011.
B2: The 8051 Microcontroller and Embedded Systems by Muhammad Ali Mazidi, Janice Gillispie Mazidi, and Rolin D. McKinlay; Pearson Education India, Second Edition, 2014.
B3: Internet of Things (IoT): Principles, Paradigms, and Applications of IoT by Rajkumar Buyya and Amir Vahid Dastjerdi; Elsevier, First Edition, 2016.
B4: Arduino Cookbook by Michael Margolis; O'Reilly Media, Third Edition, 2018.
B5: Embedded Systems with ARM Cortex-M Microcontrollers in Assembly Language and C by Yifeng Zhu; E-Man Press LLC, Third Edition, 2017.
B6: Real-Time Systems and Programming Languages by Alan Burns and Andy Wellings; Addison-Wesley, Fourth Edition, 2009.
B7: The Internet of Things: Key Applications and Protocols by Olivier Hersent, David Boswarthick, and Omar Elloumi, Wiley, 1st Ed., 2012.

5. **Other readings and relevant websites**

Serial No	Link of Journals, Magazines, websites and Research Papers
1.	https://nptel.ac.in/courses/108/106/108106051/
2.	https://nptel.ac.in/courses/106/106/106106238/
3.	https://www.instructables.com/circuits/arduino/projects/
4.	https://create.arduino.cc/projecthub
5.	https://learn.sparkfun.com/tutorials/arduino-overview/all

6. Recommended Tools and Platforms

NPTEL, SWAYAM, TinkerCAD, Wokwi, ThingSpeak and Blynk

7. Course Plan

Session Number	Topic(s)	Book (page no.)
1-2	Introduction to Course Handout **Introduction to Embedded Systems:** Introduction to Embedded Systems, Embedded system characteristics and applications, features of embedded systems	B1 (3-4), B1 (10-18), B1 (52)
3-4	Harvard & Von Neumann architectures, Architecture of Embedded System	B1 (45-48), B5 (29-34)
5-6	Application specific ICs (ASICs), Types of ASIC, Applications	B5 (73-79), B6 (33-47)
7-8	Overview of Embedded Networking & Standards: RS232, SPI, I2C, USB, Bluetooth, Zigbee	B1 (160-175) B7 (93-94)
9-10	Real time embedded systems, its features, Soft v/s Hard Real time embedded systems	B6 (17-23)
11-14	**Microcontrollers and Programming**: Introduction to Microcontroller, Microprocessor v/s Microcontroller, architecture and memory organization, 8051 Pin configuration, input output ports	B1 (62-71) B2(4-7)
15-17	Addressing Modes, Instruction Set and Programming	B2 (50-72), B2 (89-94)
ST-1		
18	Flag bits and PSW register	B2 (50-72), B2 (89-94)
19-22	Timers and Serial Port, Interrupt Handling, Arithmetic instructions and programs	B2(100-106)
23-26	**Introduction to Internet of Things (IoT):** Introduction to Internet of Things, Characteristics of IoT, Application Areas of IoT, Industrial IoT, Real time analytics in IoT and fog computing.	B3(3-5),B3 (14) B3 (32) B3 (183),
27-30	Layered architecture of IoT, SOA based Architecture, API Oriented Architecture, IoT challenges, IoT Communication protocols and comparison	B3(8-9), B3 (184-185)
31	Introduction to Cloud computing, Introduction to Big data	B3(188-193)
ST-2		
32-35	Threats and vulnerabilities in IoT systems- Network and Transport layer challenges, IoT Gateways and security, IoT Routing Attacks, Authorization mechanisms	B3 (185), B3 (189-193)
36-37	Light weight cryptography- Symmetric Key LWC Algorithms, Asymmetric LWC algorithms	B3 (194-195)
38-40	**Arduino and Programming**: Introduction to Arduino, Architecture of Arduino, Pin diagram of Arduino, Types of Arduino	B4 (6-8), B4 (15),
41-42	Arduino Programming Structure, Bare minimum code, Variables, Serial monitor	B4 (11-14), B4 (21-25), B4 (94)
ST-3		
43-44	Types of Sensors and actuators (temperature, light, motion, motors, relays, displays etc)	B4 (167-190)
45-46	Case Studies of Smart home automation, Smart cities, Case Studies of Healthcare and wearable devices	B4 (135-145), B7 (285-300)

8. **Delivery/Instructional Resources**

Session No.	Topics	Web References	Audio-Video
1-8	Introduction to Embedded Systems, Embedded system characteristics and applications, Harvard & Von Neumann architectures, Architecture of Embedded System, Application specific ICs (ASICs), Overview of Embedded Networking & Standards: RS232, RS485, SPI, I2C, USB, Bluetooth, Zigbee	https://www.tutorialspoint.com/embedded_systems/es_overview.htm https://www.geeksforgeeks.org/difference-between-von-neumann-and-harvard-architecture/ https://aruneworld.com/embedded/embedded-protocol/	https://nptel.ac.in/courses/108102045 https://nptel.ac.in/courses/108102045 https://archive.nptel.ac.in/courses/106/105/106105193/
9-10	Real time Embedded Systems, features, Soft v/s Hard Real time embedded systems.	https://www.geeksforgeeks.org/difference-between-hard-real-time-and-soft-real-time-system/ https://testbook.com/key-differences/difference-between-hard-real-time-and-soft-real-time-system	https://www.digimat.in/nptel/courses/video/106105172/L13.html
11-18	Introduction to Microcontroller, Microprocessor v/s Microcontroller, architecture and memory organization, 8051 Pin configuration, input output ports, Addressing Modes, Instruction Set and Programming, flag bits and PSW register	https://www.tutorialspoint.com/microprocessor/microcontrollers_overview.htm https://ebooks.inflibnet.ac.in/csp13/chapter/8051-architecture/ https://electronicsforyou.in/psw-register-in-8051-microcontroller/	https://archive.nptel.ac.in/courses/106/105/106105193/ https://freevideolectures.com/course/3018/microprocessors-and-microcontrollers/22#google_vignette https://archive.nptel.ac.in/courses/108/105/108105102/
19-22	Timers and Serial Port, Interrupt Handling, Arithmetic instructions and programs, Logic instructions and programs	https://www.geeksforgeeks.org/microcontrollers-8051-interrupts/ https://www.tutorialspoint.com/arithmetic-group-in-8051 l https://technobyte.org/logical-instructions-8051/	https://archive.nptel.ac.in/courses/108/105/108105102/ https://freevideolectures.com/course/3018/microprocessors-and-microcontrollers/22#google_vignette
23-31	Introduction to Internet of Things, Industrial IoT, Real time analytics in IoT and fog computing. Architectural design of IoT, SOA based Architecture, API based Architecture, IoT Communication protocols and comparison, Cloud computing,	https://www.javatpoint.com/iot-internet-of-things https://www.techtarget.com/iotagenda/definition/fog-computing-fogging https://www.nabto.com/iot-	https://archive.nptel.ac.in/courses/106/105/106105166/ https://nptel.ac.in/courses/106105166

	Big data	protocols-comparison/ https://www.computer.org/publications/tech-news/trends/big-data-and-cloud-computing	
32-37	IoT challenges, Threats and vulnerabilities in IoT systems-Network and Transport layer challenges, IoT Gateways and security, IoT Routing Attacks, Authorization mechanisms. Light weight cryptography-Symmetric Key LWC Algorithms, Asymmetric LWC algorithms	https://www.geeksforgeeks.org/challenges-in-internet-of-things-iot/ https://www.techtarget.com/iotagenda/definition/IoT-gateway https://www.nec.com/en/global/techrep/journal/g17/n01/170114.html https://www.sciencedirect.com/topics/computer-science/lightweight-cryptography	https://archive.nptel.ac.in/courses/106/105/106105167/ https://archive.nptel.ac.in/courses/106/104/106104189/
38-42	Introduction to Arduino, Architecture of Arduino, Types of Arduino, Arduino Programming Structure, Bare minimum code, Variables	https://www.arduino.cc/en/Guide/Introduction https://www.tutorialspoint.com/arduino/index.htm https://www.javatpoint.com/arduino	https://www.youtube.com/watch?v=ZSUANscJrYc https://nptel.ac.in/courses/106105166
43-46	Types of Sensors and actuators (temperature, light, motion, motors, relays, displays etc), Case Studies of Smart home automation, Smart cities, Healthcare and wearable devices	https://www.geeksforgeeks.org/actuators-in-iot/ https://www.electronicshub.org/different-types-sensors/ https://www.mdpi.com/1424-8220/22/2/527/htm	https://archive.nptel.ac.in/courses/108/105/108105102/ https://nptel.ac.in/courses/106105166

9. **Action plan for different types of learners**

Slow Learners	Average Learners	Fast Learners
Remedial Classes, Doubt Sessions,Guided Tutorials	Workshop, Doubt Session	More Practical Assignments/ Quiz/Competitions, Project

10. **Evaluation Scheme & Components**

Evaluation Component	Type of Component	No. of Assessments	Weightage of Component	Mode of Assessment
Component 1	Continuous Evaluations	05*	25%	Written Test/CBT
Component 2	Sessional Tests (STs)	03**	25%	Computer Based Test
Component 3	End Term Examination (ETE)	01***	50%	Computer Based Test
Total			**100%**	

* There will be two Continuous Evaluations (CE) for a lab in a semester as **CE-1 (Lab work)** and **CE-2 (Project work)**, one will be considered as continuous/day to day evaluation and another one will be based on developed project. Average marks of CE-1 and CE-2 will be taken as

final marks. Lab file record, lab performance in whole semester and internal viva with experiment performance will be taken in consideration of CE-1.

*The evaluation for Continuous Evaluation **CE-1 (Lab work)** has three sub components **performance, viva** and **file**. Evaluation of performance and viva will be in two lab evaluations. These evaluations will be done in mid of semester and after ST-3 respectively. However, File work is continuously checked in each lab and is evaluated in each lab.

* The Continuous Evaluation **CE-2 (Project work**)) will compromise of three evaluations which are **Project & Title defend presentation, progress evaluation presentation** and **final project presentation**.

** All STs are compulsory. ST1 and ST2 have weightage of 25% each and ST3 has 50% out of total weightage of component 2.

***It is mandatory to complete Components 1 and 2. Further, as per Academic Guidelines minimum 75% attendance is required to become eligible for appearing in the End Semester Examination.

11. Syllabus of the Course

S. No.	Topic (s)	No. of Sessions	Weightage %
	Subject: Embedded Systems and Internet of Things		
1	**UNIT I - Introduction to Embedded Systems** Introduction to embedded processors, features of embedded system, Embedded system characteristics and applications, Harvard & Von Neuman architectures, Architecture of Embedded System, Application specific ICs (ASICs) and basic types, Overview of Embedded Networking & Standards: RS232, RS485, SPI, I2C, USB, Bluetooth, Zigbee, Real time embedded systems and features, Soft vs Hard Real time embedded systems.	10	20%
2	**Unit II- Microcontrollers and Programming** Introduction to Microcontroller, Microprocessor v/s Microcontroller, architecture and memory organization, 8051 Pin configuration, input output ports, Addressing Modes, Instruction Set and Programming, flag bits and PSW register, Timers and Serial Port, Interrupt Handling. Arithmetic instructions and programs; logic instructions and programs	12	30%
3	**Unit III- Introduction to Internet of Things (IoT)** Introduction to Internet of Things, Characteristics of IoT, Application Areas of IoT, Industrial IoT, Real time analytics in iot and fog computing. Layered architecture of IoT, SOA based Architecture, API Oriented Architecture, IoT challenges, IoT Communication protocol comparison, Cloud computing, Big data, threats and vulnerabilities in IoT systems- Network and Transport layer challenges, IoT Gateways and security, IoT Routing Attacks, Authorization mechanisms, Light weight cryptography- Symmetric Key LWC Algorithms, Asymmetric LWC algorithms	15	30%
4	**Unit IV- Arduino and Programming** Introduction to Arduino, Architecture of Arduino, Types of Arduino, Arduino Programming Structure, Bare minimum code, Variables, Serial Moitor, Types of Sensors and actuators (temperature, light, motion, motors, relays, displays etc) . Case Studies of Smart home automation, Smart cities, Healthcare and wearable devices	9	20%

12. **Complete Lab Course Coverage Plan:**

Session No.	Lab Session	Resource Link
1	Introduction to Arduino, read value of Switches and control LED through Arduino	Reading Switch- https://roboticsbackend.com/arduino-push-button-tutorial/ Blinking LED- https://www.geeksforgeeks.org/led-blinking-using-arduino/ Port Programming- https://docs.arduino.cc/micropython/basics/digital-analog-pins/
2	To Implement and analyze Serial Monitor on Arduino	https://docs.arduino.cc/software/ide-v2/tutorials/ide-v2-serial-monitor/
3	To Implement Gas leakage detector circuit using MQ-02/03 Gas sensor with Arduino	https://circuitdigest.com/microcontroller-projects/interfacing-mq3-alcohol-sensor-with-arduino
4	To Interface IR Sensor and Ultrasonic Sensor with Arduino	IR sensor- https://circuitdigest.com/microcontroller-projects/interfacing-ir-sensor-module-with-arduino Ultrasonic Sensor- https://howtomechatronics.com/tutorials/arduino/ultrasonic-sensor-hc-sr04/
5	To Implement Temperature and Humidity monitoring setup with Arduino and DHT sensor	https://www.circuitbasics.com/how-to-set-up-the-dht11-humidity-sensor-on-an-arduino/
6	To Implement light based audio response circuit using LDR sensor and buzzer with Arduino	https://steemit.com/utopian-io/@pakganern/active-buzzer-with-ldr-and-led-arduino
7	To control Servo motor and DC motor with Arduino	Servo motor- https://docs.arduino.cc/tutorials/generic/basic-servo-control/ DC motor- https://www.tutorialspoint.com/arduino/arduino_dc_motor.htm
8	To display various characters using 16x2 LCD, I2C and Aurdino	https://www.geeksforgeeks.org/how-to-interface-i2c-lcd-display-with-arduino/
9	To Setup a cloud platform to log the data and establish a communication link between IoT devices and cloud platform	Thingspeak- https://learn.sparkfun.com/tutorials/internet-of-things-experiment-guide/configure-thingspeak Blynk- https://blynk.io/getting-started
10.	To Design an IoT based system to acquire sensor data and show on cloud platform (use any arduino, nodemcu)	https://how2electronics.com/dht11-humidity-temperature-nodemcu-thingspeak/#google_vignette
11.	Introduction to raspberry pi	https://www.electronicwings.com/raspberry-pi/raspberry-pi-introduction

This Document is approved by:

Designation	Name	Signature
Course Coordinator	Dr. Manvinder Sharma	
Dean-DICE	Dr. Rajneesh Talwar	
Date (DD-MM-YYYY)	27-11-2024	