Course Code: ECE3009	**Course Name**: IoT Sensors, Peripherals and Processors	BML MUNJAL UNIVERSITY FROM HERE TO THE WORLD
Credits: 2 (L-D-P: 1-0-2)	**Contact hours per week:** 1 hour theory and two hours lab per week.	
Batch: CSE 2022, Vth Semester	**Academic Year:** 2024-25	
Course Faculties: Dr. Sandeep Kumar, Ms. Pooja Choudhary	**Coordinator:** Dr. Sandeep Kumar **Email:** sandeep.kumar@bmu.edu.in	

Aim of the course: The objective of course is to introduce the students to a variety of sensors, actuators and signal conditioning operations. To understand the concepts of root level microcontroller programming in C so that they can write the customized programs for different real-world applications.

Prerequisites: Basic understanding of C and basic electronics.

Course Overview and Context: Sensors and microcontrollers are the key to automate and incorporate intelligence in automatic systems which are used for real time operations. Therefore, it is mandatory to develop a good understanding of their operation and how they can be used as building blocks for automated systems and control applications. This course explores the inner workings of a microcontroller from the programmer's perspective for which the course is divided into three main sections; (a) Introduction to sensors, their signal conditioning and actuators (b) Microcontroller embedded C programming (c) Sensors and actuator interfacing.

Topics of the Course

- Introduction to various types of sensors: LDR, photo diodes, motion sensors, ultrasonic sensors, hall effect sensors, temperature and humidity sensors.
- Sensor signal conditioning: Basics types of signal conditioning - Analog signal conditioning (Amplification, level shifting, voltage to current and current to voltage conversion and filtering) Digital signal conditioning (Noise removal, analog to digital conversion and isolation using opto-couplers)
- Introduction to microcontrollers boards: ARDUINO NANO, ARDUINO, ESP8266, NODE MCU, ESP32, RASPBERRY PI, NVIDIA JETSON.
- Architecture, pin diagram and features of ATMega328 microcontroller.
- I/O programming, Timers, watch-dog timer basics, and programming.
- Analog to digital convertor basics and programming in C, interfacing of temperature sensor and LDR.
- Interrupt programming in C.
- Serial communication basics and programming in C: UART, I2C, and SPI.
- Sensors and actuators interfacing: led, push button, de-bouncing of switch and its hardware and software solution. DC, Servo, Stepper, and BLDC motor basics and interfacing.
- PWM basics and programming in C: Fast, phase correct PWM.
- Analog comparator programming in C.
- Creating header files.

Course Outcomes: At the end of the course the students would be able to

CO1 Understand the fundamentals of various sensors and their signal conditioning operations.

CO2 Analyze various types of microcontroller development boards in terms of their architectures and programming.

CO3 Apply the concepts of microcontroller programming for interfacing of various sensors, actuators and other peripherals.

Course Competencies:

Competency	Topics covered	CO#	BL	No. of sessions
C1	Introduction to various types of sensors: LDR, photo diodes, motion sensors, ultrasonic sensors, hall effect sensors, temperature and humidity sensors.	CO1	Understand	2
C2	Sensor signal conditioning: Basics types of signal conditioning - Analog signal conditioning (Amplification, level shifting, voltage to current and current to voltage conversion and filtering)	CO1	Understand and apply	2
C3	Digital signal conditioning (Noise removal, analog to digital conversion and isolation using opto-couplers)	CO1	Understand and apply	1
C4	Introduction to microcontrollers boards: ARDUINO NANO, ARDUINO, ESP8266, NODE MCU, ESP32, RASPBERRY PI, NVIDIA JETSON.	CO2	Understand	2
C5	Architecture, pin diagram and features of ATMega328 microcontroller. I/O programming, Timers, watch-dog timer basics, and programming. Analog to digital convertor basics and programming in C, interfacing of temperature sensor and LDR. Interrupt programming in C.	CO2	Understand and analyze	3
C6	Serial communication basics and programming in C: UART, I2C, and SPI. Sensors and actuators interfacing: led, push button, de-bouncing of switch and its hardware and software solution. DC, Servo, Stepper, and BLDC motor basics and interfacing.	CO3	Analyze and apply	4
C7	PWM basics and programming in C: Fast, phase correct PWM. Analog comparator programming in C. Creating the header files.	CO3	Analyze and apply	2

CO/PO Mapping:

CO/PO Mapping	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1			2		1				1				2			
CO2		3									2	2			1	2
CO3	3		3	2		2	3			2	3			3		

Learning Resources:

Text Books

1. Muhammad Ali Mazidi., "AVR microcontroller and Embedded systems using assembly and C", Prentice Hall.
2. "Richard H., "Embedded C programing and the ATMEL AVR", Thompson Delmar learning.

Reference Book

1. The Intel ATMega 328 datasheet.

Virtual Labs: Proteous and Tinker Cad

Assessment Pattern: The final grade will be based on the marks/ grades obtained in the mid-semester and end-semester evaluation along with other assessments defined in the assessment table. Relative grading method defined in the academic regulations of the university will be followed to grade the students. Student has to secure minimum 40% marks after completing all the assessments in the following table to become eligible for grading.

S. No	Evaluation Component	Weightage	Marks (out of 100)	Evaluation Week	Evaluation Type/Remarks
1	Project Phase Evaluation-1	30%	30	Week-2/3 of September	Presentation and viva: Project proposal, literature review, methodology, preliminary results
2	One Quiz (*Including Coursera component*)	30%	30	Week-4 of October	Closed book
3	Project Phase Evaluation-2 **(END-TERM)**	40%	40	Week-3/4 of November	Project-based (Demonstration + viva + report)
	Total	100%	100		

Experiential Learning Component (70%):

In this course, students are required to study the use cases of IoT to implement new ideas as part of their projects that have not been done earlier in the literature, either by proposing novel improvements to an existing prototype or by proposing a totally new prototype. The students are also expected to implement and show the results of the proposed solution on a research paper with topic of their choice. This facilitates approx. 70% portion of the course as the experiential learning.

Student Responsibilities:

- Attend lectures and labs in order to obtain all the course material.
- Check announcements on G-Class and emails on a regular basis.
- Submit assignments on time.
- Regularly, check the marks on Maitri portal and make sure that they are up to date.

Attendance Policy: Students are expected to attend the classes regularly. Failure to attend the classes may dip the attendance below expected percentage that will result in reduction of grade or course drop-out as per the University's policy.

Assignments: Each assignment will have a deadline for submission and every student should submit his/her assignment on or before that timeline.

Late assignment submission policy: Late submission in assignment is not allowed and any late submission will be awarded "0" marks in that particular assignment.

Recourse examination policy: Recourse is allowed only for end examination with 40% weightage.

Make-up policy: No make-up work will be given for unexcused absences. The faculty needs to be informed in advance in case the student is not going to be able to submit an assignment or take any evolution component, and it is at the discretion of the faculty to sanction make up for an evaluation component.

Behavior expectations: No mobile phones and other distractive gadgets are permitted in the class.

Academic dishonesty/cheating/plagiarism: Plagiarism and dishonesty in any form in any evaluation component will lead to appropriate disciplinary action.