

NIRMA UNIVERSITY

Institute:	Institute of Technology
Name of Programme:	B Tech Electronics and Instrumentation Engineering
Semester:	V
Course Code:	
Course Title:	Advanced Microcontroller and its applications
Course Type:	Departmental Elective-I
Year of Introduction:	2025-26

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Course Learning Outcomes (CLOs):

At the end of the course, students will be able to –

1. understand the architecture, features, and programming of advanced microcontrollers **(BL2)**
2. develop embedded applications involving real-time interfacing **(BL3)**
3. design and implement IoT-based systems **(BL5)**
4. integrate hardware and software components to build real-world applications. **(BL5)**

Unit	Contents	Teaching Hours (Total 45)
Unit-I	AVR Microcontrollers – Architecture and Programming: AVR architecture (ATmega328P), memory organization, I/O ports, addressing modes, and instruction set. Development tools: AVR-GCC, Atmel Studio. Programming GPIO, LEDs, switches, buzzers using embedded C.: Blinking LED, digital input/output, and delay functions.	08
Unit-II	Timers, Interrupts, and Serial Communication (AVR): Using 8-bit/16-bit timers for delay and waveform generation. PWM for motor control, interrupts (external and timer-based), UART, SPI, I2C protocols. PWM-based LED fading, serial terminal communication, sensor interfacing.	08
Unit-III	ESP8266 (NodeMCU) – IoT-Oriented Microcontroller: Introduction to NodeMCU, ESP8266 architecture, GPIO access, and Wi-Fi setup. Using Arduino IDE for ESP8266, web server creation, HTTP communication, and cloud data upload. Remote sensor monitoring via Wi-Fi, controlling devices using web interface.	07
Unit-IV	ESP32 – Dual-Core, Wi-Fi + Bluetooth Microcontroller: Overview of ESP32 architecture, dual-core and peripheral features. Advanced GPIOs, Bluetooth integration, touch sensors, and analog peripherals (ADC, DAC). BLE communication, ADC data logging, multitasking with FreeRTOS basics.	07
Unit-V	Sensor and Actuator Interfacing: Interfacing analog/digital sensors (temperature, motion, IR), servo/DC motors using PWM, displays (OLED, LCD), and keypads. Working with onboard peripherals across AVR, ESP8266, and ESP32 platforms. Real-time sensor-actuator applications, smart home prototypes.	07

Unit-VI Mini Project and Embedded System Integration:

08

End-to-end embedded application design using AVR/ESP platform.
Topics include power management, data storage (EEPROM, SD card),
IoT cloud services (ThingSpeak, Blynk, Firebase)..

Self Study:

The self study contents will be declared at the commencement of semester. Around 10% of the questions will be asked from self study contents.

Suggested Readings/References:

1. Steven F. Barrett and Daniel J. Pack, Atmel AVR Microcontroller Primer: Programming and Interfacing, Newnes (Elsevier) Publication.
2. Muhammad Ali Mazidi, Sarmad Naimi, Sepehr Naimi, AVR Microcontroller and Embedded Systems: Using Assembly and C for ATmega328P, Pearson Education Publication.
3. Dhananjay Gadre, Programming and Customizing the AVR Microcontroller, McGraw-Hill Education.
4. Michael Margolis, Arduino Cookbook, O'Reilly Media Publication.

Suggested List of experiments:

Laboratory work will be based on the above syllabus with a minimum 09 experiments/exercises to be incorporated. The students in a suitable group size will design and perform one experiment as a part of laboratory work.

(Only for Information)

Sr. No.	Name of Experiments/Exercises	Hours
1.	Blinking LED and Button Interface using AVR (ATmega328P)	(02 Hrs)
2.	PWM-based DC Motor Speed Control using AVR Timers	(02 Hrs)
3.	UART-based Serial Communication between AVR and PC	(04 Hrs)
4.	LED Fading using PWM on ESP8266 (NodeMCU)	(02 Hrs)
5.	Creating a Web Server on ESP8266 for Remote LED Control	(02 Hrs)
6.	Temperature Sensor Data Logging using ESP32 ADC and OLED Display	(02 Hrs)
7.	Bluetooth-Based Device Control using ESP32 and Mobile App (BLE)	(02 Hrs)
8.	Motion Detection and Buzzer Alert System using IR Sensor with AVR	(02 Hrs)
9.	Digital Thermometer using LM35 and 16x2 LCD with AVR	(02 Hrs)
10.	Touch Sensor-Based LED Toggle using ESP32 GPIO	(04 Hrs)