



GUJARAT TECHNOLOGICAL UNIVERSITY

Program Name: Diploma Engineering

Level: Diploma

Branch: Electrical Engineering / Renewable Energy

Subject Code: DI04000171

Subject Name: Microcontroller & its Applications

w. e. f. Academic Year:	2025-26
Semester:	4 th
Category of the Course:	PCC

Prerequisite:	Basic knowledge of digital electronics and electrical components.
Rationale:	Microcontrollers are at the core of modern automation in applications like energy metering, motor control, and smart systems. This course introduces the architecture and operation of the 8051 microcontroller along with its real-world applications. It equips students with practical skills in developing real-world embedded systems using the industry-preferred Embedded C programming language, known for its portability, readability, and structured approach. Diploma holders in electrical and allied fields will learn to design, assemble, test, and troubleshoot microcontroller-based systems while ensuring safety, reliability, and effectiveness in diverse electrical engineering applications.

Course Outcomes: After Completion of the Course, Student will be able to:

No	Course Outcomes	RBT Level*
01	Describe the architecture and components of the 8051 microcontroller.	R, U
02	Create programs in Embedded C for basic control applications using 8051.	U, A
03	Implement timer, counter, and interrupt-based logic using C.	A
04	Interface microcontrollers with I/O devices like LEDs, LCDs, motors, and sensors.	A
05	Design real-time applications using 8051 microcontroller.	U, A

*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(M)	PA(I)	ESE(V)	
3	0	2	4	70	30	20	30	150



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Course Content:

Unit No.	Content	No. of Hours	% of Weightage
1.	Unit 1 – Introduction to 8051 Micro-controller and its Architecture 1.1 Comparison between Micro-controller and Micro-Processor 1.2 Hierarchy of Microcontrollers. 1.3 Applications of Micro-controller 1.4 Overview of Embedded System and Classification 1.5 Architecture of 8051 Microcontroller: Block Diagram, Flags, Stack, Program counter, DPTR 1.6 Memory Organization: Internal RAM, Internal ROM, SFRs, Stack, Registers and Register Banks 1.7 8051 Pin Diagram: Pin Functions and alternate function, I/O Ports. 1.8 Clocking and Reset Circuitry	13	28%
2.	Unit 2–8051 Programming 2.1 Assembly Language Programming: Addressing Modes, Structure of Assembly program, Assembly Directives, Common instructions like MOV, ADD, SUBB, INC, DEC, ANL, ORL 2.2 Difference between Assembly language and Embedded C programming 2.3 Structure of Embedded C program, header files, comments 2.4 Data types (char, unsigned char, int, sbit, bit) 2.5 Operators: arithmetic, logical, bitwise 2.6 Control statements: if-else, switch, for, while, do-while 2.7 Arithmetic & logical programs (addition, subtraction, multiplication, division) 2.8 Functions and modular programming (delay routines, modular code structure) 2.9 Configuration and programming of I/O port: LED, switches, simple interfacing examples	10	22%
3.	Unit 3 – Timers, Counters, and Interrupts 3.1 Configuration and programming of Timer/Counter using SFRs:	8	18%



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	<p>Timer Registers, TMOD, TCON</p> <p>3.2 Modes of Timer0 and Timer1</p> <p>3.3 Generation of time delay using timer: Steps to generate time delay using Timer Mode 1.</p> <p>3.4 Introduction to interrupts, types of interrupts in 8051</p>		
4.	<p>Unit 4 – 8051 Interfacing</p> <p>4.1 Interfacing LEDs, switches, buzzer, relay</p> <p>4.2 Interfacing 7-segment display</p> <p>4.3 Interfacing 16x2 LCD for displaying text</p> <p>4.4 Interfacing keypad for data entry</p> <p>4.5 Motor control: DC motor via L293D, stepper motor sequence control</p> <p>4.6 Analog interfacing: ADC0804 with sensors (e.g., LM35 temperature sensor)</p> <p>4.7 Displaying analog values on LCD</p>	6	12%
5.	<p>Unit 5 –8051 Applications</p> <p>5.1 Analog to Digital Conversion in 8051: Need, Interfacing</p> <p>5.2 Temperature control system using 8051.</p> <p>5.3 BMS system using Analog Multiplexer, ADC0804, Microcontroller, 7 segment LED, MAX232</p> <p>5.4 Security system using GSM Modem, Microcontroller, Relay, Switches</p> <p>5.5 Solar tracker using Microcontroller, 7Segment LED and Stepper motor, LDR.</p>	8	20%
Total		45	100%

Suggested Specification Table with Marks (Theory):

Distribution of Theory Marks (in %)					
R Level	U Level	A Level	N Level	E Level	C Level
10 %	40 %	50 %	00	00	00

Where R: Remember; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create (as per Revised Bloom's Taxonomy)



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References/Suggested Learning Resources:

(a) Reference Books:

- 1 The 8051 Microcontroller and Embedded Systems: Using Assembly and C, by Muhammad Ali Mazidi, Janice Gillispie Mazidi, Rolin D. McKinlay, Pearson Education Publishing, 2nd Edition (International), ISBN: 9788131710265
- 2 The 8051 Microcontroller, by Kenneth J. Ayala, Cengage Learning Publishing Ltd, 3rd Edition, ISBN: 9788131502006
- 3 8051 Microcontrollers and Embedded Systems by Raj Kamal, McGraw-Hill Education India, 2nd Edition, ISBN: 9789352607135
- 4 Programming and customizing the 8051 Microcontroller, by Myke Predko, McGraw-Hill / TAB Electronics, 2nd Edition, ISBN: 9780071470567
- 5 Design with PIC Microcontrollers and Embedded Systems, by Muhammad Ali Mazidi, Rolin McKinlay, Danny Causey, Pearson Education, 1st Edition, ISBN: 9788131798676
- 6 6. The 8051 Microcontroller: Hardware, Software and Interfacing, James W. Stewart & Kai X. Wu, Oxford University Press, 1st Edition, ISBN: 9780195139021

(b) Open-Source Software and Website:

1. KEIL μ Vision (IDE and Compiler)

Description: KEIL μ Vision is a widely used integrated development environment (IDE) for 8051 microcontroller programming. It provides a powerful debugger and supports assembly language and C programming for 8051-based systems.

- Website: KEIL μ Vision
- Features:
 - C, C++, and assembly programming
 - Integrated debugger and simulator
 - Supports hardware debugging via JTAG

2. Proteus (Simulation Software)

Description: Proteus is a simulation tool for embedded systems, where you can design circuits and simulate the 8051 microcontroller along with other peripherals (like LCDs, motors, sensors). It's widely used for testing and validating embedded designs.

- Website: Proteus
- Features:
 - Circuit simulation and PCB design
 - Support for embedded programming (8051, PIC, AVR, ARM)



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Learning Websites for 8051 Microcontroller

1. NPTEL (National Programme on Technology Enhanced Learning)

1. Course: Embedded Systems – Design and Programming

- Instructor: Prof. Santanu Chattopadhyay (IIT Kharagpur)

- Covers: 8051 microcontroller, embedded C, interfacing, and applications

- Link: Search “NPTEL Embedded Systems IIT Kharagpur” or visit <https://nptel.ac.in>

2. Course: Microprocessors and Microcontrollers

- Instructor: Prof. Badri Subudhi (IIT Goa)

- Includes: 8051 basics, programming, architecture

- Good for Unit 1 & 2

2. Coursera

Introduction to Embedded Systems Software and Development Environments

3. Tutorialspoint – 8051 Microcontroller Tutorial

www.tutorialspoint.com/8051_microcontroller

4. GeeksforGeeks – 8051 Microcontroller Series

www.geeksforgeeks.org

5. Electronics Hub

www.electronicshub.org

6. All About Circuits

www.allaboutcircuits.com

7. YouTube Channels

1. ELECTRICAL SKJPBHARUCH

(https://www.youtube.com/playlist?list=PLqQE5uI_2_7nCGCDiJb6tS68ketoTFnNf)

2. 5 Minutes Engineering

(https://www.youtube.com/watch?v=-UAnh2GlnrY&list=PLYwpaL_SFmcA6SNAD_YVdcibe4xnKmQNp)

3. Engineering Funda

(<https://www.youtube.com/watch?v=MYyydWpZo60&list=PLgwJf8NK-2e49i6neo70aGtFLvKeZ3IQD>)

(<https://www.youtube.com/watch?v=MYyydWpZo60&list=PLgwJf8NK-2e49i6neo70aGtFLvKeZ3IQD>)



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Suggested Course Practical List:

Sr. No.	Practical Outcome/Title of experiment	Unit/CO	Approx. Hours required
1	Write a program for Addition of two numbers and display result at port 1 and it can be seen through software	1	2
2	Write a program for Subtraction of two numbers and display result at port 0 and it can be seen through software	1	2
3	Write a program for Multiplication of two numbers and display result at port 2 and it can be seen through software*	2	2
4	Write a program for Division of two numbers and display result at port 3 and it can be seen through software	2	2
5	Write a C program to blink an LED connected to Port 1 continuously with a delay*	2	2
6	Write a program to read the status of a switch and turn ON/OFF an LED accordingly.	2	2
7	Write a program to blink multiple LEDs with different time delays using while loop.	4	2
8	Write a program to display numbers 0-9 on a 7-segment display using port output. *	4	2
9	Write a program to interface and display "WELCOME" on a 16x2 LCD.	4	2
10	Generate a 1-second delay using Timer0 in Mode 1, and toggle LED.	3	2
11	Generate a 1 kHz square wave on a port pin using Timer1; observe output on DSO or Logic Analyzer. *	3	2
12	Interface a buzzer and turn it ON/OFF based on input condition.	3	2
13	Write a program to read the status of a switch and turn ON/OFF an LED accordingly.	4	2
14	Interface a DC motor using L293D and rotate it forward and reverse. *	5	2
15	Develop a program to interface a Stepper Motor with 8051	5	2
16	Create software-based PWM signal using for loop and delays; observe waveform on DSO.	5	2
17	Develop a program to Interface 8-bit DAC with 8051	5	2



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Compulsory Performance

List of Laboratory/Learning Resources Required:

◆ Hardware Resources

1. **8051 Development Kits** (e.g., AT89C51/Aryabhata Development Board)
2. **Programmer/Downloader** for 8051 (if not built-in USB programmer)
3. **Power supply modules** (+5V regulated, $\pm 12V$ for interfacing ICs)
4. **Input Devices:**
 - Push-button switches
 - Keypad (4x4 matrix)
 - Potentiometer (for ADC input)
 - LDR (for solar tracker experiments)
5. **Output Devices**
 - LEDs (single + array for running pattern)
 - Buzzer
 - Relay modules
 - DC motor with driver IC (L293D)
 - Stepper motor
 - 7-Segment Display (Common Anode & Cathode)
 - 16x2 LCD Module
6. **Analog and Communication Modules**
 - ADC0804 ADC IC
 - LM35 Temperature Sensor
 - Analog Multiplexer 4051
 - MAX232 (for serial communication with PC)
 - GSM Modem (for security system demo)
7. **Measurement Instruments**
 - Digital Storage Oscilloscope (DSO) for observing waveforms and PWM
 - Digital Multimeters

◆ Software Resources

1. **Keil μ Vision IDE** for Embedded C programming of 8051
2. **Flash Magic / Programmer Tool** (to burn HEX file to 8051)
3. **(Optional) Proteus Design Suite** for circuit simulation of 8051 systems
4. **Serial Communication Software** (e.g., HyperTerminal / Keil Serial Window)

◆ Supporting Components & Accessories

- Breadboards and jumper wires
- Resistors, capacitors, diodes, regulators (7805, 7812, 7912)
- Crystal oscillators (11.0592 MHz, 12 MHz)
- Power supply cables, USB-to-Serial converters



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- Component datasheets (8051, ADC0804, LM35, L293D, MAX232, etc.)

Suggested Activities for Students:

Beyond laboratory learning, the following **co-curricular activities** are recommended to enhance the achievement of course outcomes in *Microcontroller and Its Applications*. These activities strengthen students' understanding of microcontroller-based systems, programming logic, interfacing techniques, hardware implementation, and troubleshooting methods. Students are encouraged to carry out these tasks **individually or in groups** and prepare a **detailed report (about five pages)**. They should also **document physical evidence** (photos, code printouts, project snapshots) for their portfolios, which will be valuable during placement interviews:

- a) Students can begin with fundamental tasks such as preparing **pin configuration sheets, interfacing diagrams, and specification tables** for various components like ADCs, sensors, GSM modules, and motor drivers.
- b) Gradually, they should undertake **micro-projects** involving the design and simulation of simple 8051-based systems such as LED patterns, temperature monitors, or motor controllers using Embedded C in Keil.
- c) Participation in **hands-on workshops, mini hackathons, or hardware implementation sessions** involving PCB design, module interfacing, and serial communication projects will improve teamwork, problem-solving, and practical application skills.
- d) Students may prepare **case studies** on industrial automation systems, analyse **real-life applications** such as BMS or solar trackers, or present **seminars on emerging trends** like IoT-enabled microcontrollers and wireless communication in embedded systems.
- e) Maintaining a **portfolio** of their experiments, code documentation, flowcharts, and project outcomes will help consolidate their learning and showcase their applied skills for future academic or professional opportunities.
