GUJARAT TECHNOLOGICAL UNIVERSITY

BIO-MEDICAL ENGINEERING (03)
MICROCONTROLLER & INTERFACING (BIOMEDICAL)
SUBJECT CODE: 2150306
B.E. 5th SEMESTER

Type of course: Core

Prerequisite: Digital Signal & System, Digital Logic Design, Gates, Flip-flops, Counters, Registers, Memory devices, Microprocessor & its interfacing and programming.

Rationale: To prepare the students with basics of microcontroller, its operation & instruction set & interfacing of various peripherals and also acquaint them with basics of assembly & C language programming.

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks						Total Marks
L	T	P	C	Theory Marks			Practical Marks			
				ESE (E)	PA (M)		PA (V)		PA (I)	
					PA	ALA	ESE	OEP		
4	0	2	6	70	20	10	20	10	20	150

L- Lectures; T- Tutorial/Teacher Guided Student Activity; P- Practical; C- Credit; ESE- End Semester Examination; PA- Progressive Assessment; OEP-Open Ended problem; AL-Active learning.

Content:

Sr. No.	Content	Total Hrs	% Wtg
1	8051 MICROCONTROLLER & ARCHITECTURE: Introduction to microcontroller, Comparison of microprocessors and microcontrollers, Overview of 8051 family, 8051 Microcontroller Hardware, Input/Output Pins, Ports & Circuits, External Memory, Counters & Timers, Serial Data Input/Output, Interrupts.	**8**	**15**
2	8051 ASSEMBLY LANGUAGE PROGRAMMING: Introduction to 8051 assembly programming, Assembling and running an 8051 program, The program counter and ROM space in the 8051, 8051 data types and directives, 8051 flag bits and the PSW register, 8051 register banks and stack, Loop and jump instructions, Call instructions time delay for various 8051 chips, 8051 I/O programming, I/O bit manipulation programming, Arithmetic instructions, Signed number concepts and arithmetic operations, Logic and compare instructions, Rotate instruction and data serialization, BCD, ASCII, and other application programs.	**10**	**20**
3	8051 ADDRESSING MODES: Immediate and register addressing modes, Accessing memory using various addressing modes, Bit addresses for I/O and RAM, Extra 128-byte on-chip RAM in 8052.	**4**	**8**
4	8051 PROGRAMMING IN C: Data types and time delay in 8051 C, I/O programming in 8051 C, Logic operations in 8051 C, Data conversion programs in 8051 C, Accessing code ROM space in 8051 C, Data serialization using 8051 C.	**5**	**8**
5	8051 HARDWARE CONNECTION AND INTEL HEX FILE: 8051 Microcontroller specifications, Pin description of the 8051, Microcontroller Design, Minimum connection for 89c51/52 based systems, Testing the Design, Explaining the Intel hex file.	**3**	**5**

6	8051 TIMER PROGRAMMING IN ASSEMBLY AND C: Programming 8051 timers, Counter programming, Programming timers 0 and 1 in 8051 in C.	**5**	**8**
7	8051 SERIAL PORT PROGRAMMING IN ASSEMBLY AND C: Basics of serial communication, 8051 connection to RS232, 8051 serial port programming in Assembly, Programming the second serial port, Serial port programming in C.	**5**	**8**
8	INTERRUPTS PROGRAMMING IN ASSEMBLY AND C: 8051 interrupts programming, Timer interrupts, Programming external hardware interrupts, Programming the serial communication interrupt, Interrupt priority in the 8051/52, Interrupt programming in C.	**5**	**8**
9	INTERFACING & PROGRAMMING APPLICATIONS: LED Interfacing, Switch Interfacing, Seven segment numeric display Interfacing, 4x4 matrix keypad interfacing, 16x2 LCD Interfacing, ADC 0804 & 0808 Interfacing, DAC 0808 Interfacing, LM34/35 Sensor Interfacing & Signal conditioning, Interfacing External memory & Accessing, DS12887 RTC Interfacing, Relay & Optoisolator Interfacing, Stepper motor Interfacing, DC motor Interfacing & PWM.	**15**	**20**

Suggested Specification table with Marks (Theory):

Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level
22%	**25%**	**25%**	**15%**	**13%**	-

Legends: R: Remembrance; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create and above Levels (Revised Bloom's Taxonomy)

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

Reference Books:

1. **The 8051 Microcontroller And Embedded Systems** By Muhammad Ali Mazidi, Tanice Gillispie Mazidi, Rolin D. Mckinlay, Pearson Education.
2. **The 8051 Microcontroller & Embedded Systems using Assembly and C** By K. J. Ayala, D. V. Gadre, Cengage Learning , India Edition.
3. **8051 Microcontroller: An Applications Based Introduction** By David Calcutt, Frederick Cowan, Hassan Parchizadeh, Elsevier/Newnes.
4. **8051 Microcontrollers: MCS51 family and its variants** by Satish Shah, Oxford University Press.
5. **8051 Microcontroller: Internals, Instructions, Programming and Interfacing** by Subrata Ghoshal, Pearson Education.
6. **The 8051 Microcontrollers: Architecture, Programming and Applications** by K. Uma Rao, Andhe Pallavi, Pearson Education.

Course Outcome:

After successful completion of the course students should be able to:

1. Differentiate between microprocessors & microcontrollers.
2. Identify the basic element and functions of microcontroller.
3. Describe the architecture of microcontroller and its operation.
4. Apply the programming knowledge in developing the assembly language program & C language program for microcontroller applications.
5. Interface various devices with microcontroller & program it for operation.
6. Built a microcontroller based project & do the programming on their own.

List of Experiments:

- **Write the following Assembly Language Program/ C Program & perform it on 8051 Kit/ Assembler/ Compiler.**

Practical-1:

1. Write an ALP to exchange the content of memory location 50H with accumulator using direct & indirect addressing modes.
2. Write an ALP to exchange the content of memory location 35H with R_3 of bank-2.
3. Write an ALP to exchange the content of internal RAM location 30H & external RAM location 30H.
4. Write an ALP to exchange the content of register R_2 of bank-1 and external memory location 40H using indirect register addressing mode.
5. Write an ALP to exchange the content of register R_2 of bank-3 and external RAM location 1234H using indirect register addressing.

Practical-2:

1. Write an ALP to add the bytes in RAM locations 34H and 35H, put the result in register R_5 (LSB) & R_6 (MSB) of bank-1.
2. Write an ALP to add the bytes in registers R_3 & R_4 of bank-2, put the result in RAM locations 4AH (LSB) & 4BH (MSB).
3. Write an ALP to add the number F3H to the content of RAM location 17H (LSB) and 18H(MSB).
4. Write an ALP to add bytes in external RAM location 02CDH to the internal RAM location 19H, put the result into external RAM locations 00C0H (LSB) & 00C1H (MSB).

Practical-3:

1. Write an ALP to subtract the content of register R_3 of bank-1 from the number F3h, put the result in external RAM location 0283H.
2. Write an ALP to subtract the content of register R_1 of bank-1 from R_0 of bank-0, put the result in R_7 of bank-3.
3. Write an ALP to subtract the content of RAM location 13H from RAM location 2BH, put the result in RAM location 3CH.
4. Write an ALP to subtract the contents of TH0 from TH1 and put the result in TL0.
5. Write an ALP to increment the contents of RAM locations 13H, 14H, 15H using indirect addressing mode only.

Practical-4:

1. Write an ALP to multiply the data in RAM location 22H by the data in RAM location 15H.Put the result in RAM location 15H. Put the result in RAM location 19H(MSB) and 1AH(LSB).
2. Write an ALP to square the contents of register R_5 of bank-1 and put the result in R_0(LSB) and R_1(MSB) of bank-2.
3. Write an ALP to divide the 3EH by the number 12H. Put the quotient in R_4 & remainder in R_5 of bank 3.
4. Write an ALP to divide the number in RAM location 15H by the number in location 16H. Put the quotient in external RAM location 7CH and remainder in 7DH.

Practical-5:

1. Write an ALP to add the unsigned number found in internal RAM location 25H and 27H together and put result in RAM location 30H(LSB) and 31H(MSB).

2. Write a program to add two 8-bit numbers stored in registers or in internal/external memory location.
3. Write a program to multiply two 8-bit numbers stored in registers or in internal/external memory location.
4. Write an ALP to divide two numbers in which divided in stored in register R_6 of bank-3 and divisor in stored in external RAM location 1380H. Store quotient & remainder in external RAM location 1234H and 1235H respectively.

Practical-6:

1. Write a program to multiply two 16-bit numbers.
2. Write a program to add block of data stored in internal/external memory location.
3. Write a program to transfer block of data from internal memory location to external memory location.
4. Write a program to sort block of data in ascending and descending.
5. Write a program to sort block of data in descending.
6. Write an ALP to find sum of 8-data stored in RAM location starting from 50H. Store result in register R_0(LSB) & R_1(MSB) of bank-1.

Practical-7:

1. Write an ALP to blink lower four LED and higher four LED alternately which are connected to port-1 with ON and OFF period of 200 msec. Assume crystal frequency of 8MHz.
2. Write an ALP to generate square wave with on period of 5 ms and off period of 7.5 ms on all pins of port-0 using timer-0. Assume crystal frequency of 12MHz.
3. Write an ALP to generate square wave of 50% duty cycle on pin P1.5. Use timer-0 to generate delay. Assume crystal frequency of 12MHz.
4. Write an ALP to generate square wave of frequency 100 KHz on pin P2.3. Use timer-1 in mode-1. Assume crystal frequency of 22MHz.
5. Write an ALP to generate square wave with ON time of 3ms and OFF time of 10 ms on all pins of port 0. Assume crystal frequency of 22MHz.
6. Write an ALP to design a counter for counting pulses of an input signal. The pulses to be counted are fed on pin P3.4, crystal frequency is 22MHz.
7. Assuming crystal frequency equal to 16MHz. We are generating square wave on pin P1.4. Find the lowest square wave frequency that we can generate using mode-1.

Practical-8:

1. Write a program to transfer a letter ‘Y’ serially at 9600 baud rate continuously and also send a letter ‘N’ through port-3 which is connected to display device.
2. Write an ALP to take data in through port-0,1 and 2 one after another and transfer these data serially continuously.
3. Write a program to receive the data which has been sent in serial form and send it out to port-0 in parallel form. Also save data at RAM location 60H.
4. Write a program that display ASCII value of ‘Y’ at port-0 and ‘N’ at port-2.Also generate a square wave of 10 kHz with timer-0 in mode-2 at P1.2 assume that crystal frequency of 22 KHz.
5. Write a program to generate two square waves (i) 5 KHz at P1.3 and (ii) 25 KHz at P2.3. Assume crystal frequency of 25 MHz.
6. Write a program in which 8051 reads data from port-1 and writes it to port-2 continuously while giving a copy of it to serial com port to be transferred serially. Assume crystal frequency 11.0592 MHz & baud rate 9600.

Practical-9:

1. Write a program to perform the following:

(a) Keep monitoring P1.2 until it becomes high
(b) When P1.2 becomes high write value 45H on P0.
(c) Sent a high to low pulse to P2.3.

2. A switch is connected to P1.7. Write a program to check the status of switch and perform the following:
   (a) If switch=0, send letter 'N' to P_2.
   (b) If switch=1, send letter 'Y' to P_2.
3. Write a program to generate 5 Hz pulse waveform of 50% duty cycle on P1.0 using timer-1 in mode-2.
4. Write a program to generate 1 KHz pulse waveform of 10% duty cycle on pin 1.0 using timer-1.
5. Write a program to transfer the message "YES" serially. Do this continuously.
6. Program the 8051 to receive bytes of data serially, & put them in P_1.

Practical-10:

1. Write an 8051 C program to toggle all the bits of P0 and P2 continuously with a 250ms delay.
2. A door sensor is connected to the pin P1.1, and a buzzer is connected to P1.7. Write an 8051 C program to monitor the door sensor, and when it opens, sound the buzzer. You can sound the buzzer by sending a square wave of a few hundred Hz.
3. Write an 8051 C program to toggle all bits of P2 continuously every 500 ms. Use timer-1, mode-1 to create delay.
4. Write an 8051 C program to create a frequency of 2500 Hz on pin P2.7. Use timer-1, mode-2 to create the delay.
5. A switch is connected to pin P1.2. Write an 8051 C program to monitor SW and create the following frequencies on pin P1.7:
   (a) SW=0; 500Hz (b) SW=1; 750 Hz.
6. Assume that a 2 Hz external clock is being fed into pin T1(P3.5). Write an 8051 C program for counter-0 in mode-2 (8-bit auto reload) to display the count in ASCII. The 8-bit binary count must be converted to ASCII. Display the ASCII digit (in binary) on P0, P1 & P2, where P0 has the least significant digit. Set the initial value of TH0 to 0.
7. Write an 8051 C program to transfer the message "YES" serially at 9600 baud, 8-bit data, and 1-stop bit. Do this continuously.
8. Write an 8051 C program to receive bytes of data serially and put them in P1. Set the baud rate at 4800, 8-bit data, and 1-stop bit.
9. Write a C program that continuously gets a single bit of data from P1.7 and sends it to P1.0, while simultaneously creating a square wave of 200 µs period on P2.5. Use timer-0 to create the square wave. Assume XTAL=11.0592 MHz.
10. Write a C program using interrupts to do the following:
    (a) Receive data serially & send it to P0,
    (b) Read port P1, transmit data serially, and give a copy to P2,
    (c) Make timer-0 generate a square wave of 5 KHz frequency on P0.1.
    Assume that XTAL=11.0592 MHz. Set the baud rate at 4800.

Design based Problems (DP)/Open Ended Problem: As per topics all the students must have to submit microcontroller based mini project in group/individual before end of the semester. This work is weighted under progressive assessment.

Major Equipment/Software: Dyna-51 kit, Universal programmer, µV Keil software, 8051 Assembler/Compiler, Proteus/Multisim.

List of Open Source Software/learning website:

http://nptel.ac.in/syllabus/syllabus.php?subjectId=117104072

http://nptel.ac.in/courses/117104072/6

ACTIVE LEARNING ASSIGNMENTS: Preparation of power-point slides, which include videos, animations, pictures, graphics for better understanding theory and practical work – The faculty will allocate chapters/ parts of chapters to groups of students so that the entire syllabus to be covered. The power-point slides should be put up on the web-site of the College/ Institute, along with the names of the students of the group, the name of the faculty, Department and College on the first slide. The best three works should submit to GTU.