

GUJARAT TECHNOLOGICAL UNIVERSITY, AHMEDABAD, GUJARAT**COURSE CURRICULUM****COURSE TITLE: PIC MICROCONTROLLER AND EMBEDDED SYSTEMS
(COURSE CODE: 3361705)**

Diploma Programme in which this course is offered	Semester in which offered
Instrumentation and Control	Sixth

1. RATIONALE

PIC Microcontrollers are being extensively used in the field of Embedded Systems. The students studying this subject are supposed to learn the architecture of a PIC Microcontroller and also get acquainted about their use for control purpose. In addition, the course will provide the knowledge of applications and interfacing of PIC microcontrollers used in the field of instrumentation & control. Thus this course is very useful for instrumentation engineers working in the area of embedded systems.

2. COMPETENCIES

The course content should be taught and implemented with the aim to develop required skills in the students so that they are able to acquire following competencies:

- **Program PIC microcontroller for data acquisition and processing application.**
- **Interface sensors, transducers, motors, relays, and various input/output devices with PIC microcontroller.**

3. COURSE OUTCOMES (COs)

The theory should be taught and practical should be carried out in such a manner that students are able to acquire required learning outcomes in cognitive, psychomotor and affective domain to demonstrate following course outcomes:

- Identify and understand function of different blocks of PIC microcontroller.
- Develop programs for data transfer, arithmetic, logical and I/O port operations.
- Develop programs for PIC18 using "C".
- Develop program for PIC18 Timers, Serial port and Interrupts using "C".
- Interface LCD, Keyboard, ADC, DAC, Sensors, Relays, DC motor and Stepper motor with PIC18 microcontroller.

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme (In Hours)			Total Credits (L+T+P)	Examination Scheme				
				Theory Marks		Practical Marks		Total Marks
L	T	P	C	ESE	PA	ESE	PA	150
3	0	2	05	70	30	20	30	

Legends: L-Lecture; T – Tutorial/Teacher Guided Theory Practice; P - Practical; C – Credit
ESE - End Semester Examination; PA - Progressive Assessment.

5. COURSE CONTENT DETAILS

Unit	Major Learning Outcomes (in cognitive domain)	Topics and Sub-topics
Unit – I PIC Microcontrollers : History, Features and Architecture	1a. Explain evolution of Microcontrollers and Embedded Processors.	1.1 Microcontrollers and Embedded Processors. 1.2 Overview of the PIC18 Family.
	1b. Draw PIC18 PIN connection.	1.3 PIC18 PIN connection.
	1c. Explain PIC18 Registers. 1d. Explain file register allocation between GPR and SFR. 1e. Explain file register's status for the given instructions. 1f. Determine the contents of file registers for the given set of instructions.	1.4 PIC18 Configuration Registers. 1.5 The WREG Register in PIC18. 1.6 The PIC18 File Register and access Bank. 1.7 Use of Instructions with the Default Access Bank.
	1g. Explain PIC18 status register. 1h. Find the status of different flags for the given set of instructions	1.8 PIC18 Status Register.
	1i. Represent data in various number formats. 1j. Explain given directives.	1.9 PIC18 Data Format and Directives.
	1k. Explain program counter.	1.10 The Program Counter and Program ROM Space in the PIC18.
	1l. Explain features of RISC. 1m. Compare Harvard architecture with von Neumann architecture	1.11 RISC Architecture in the PIC18.
Unit– II Classification of Instructions and I/O Port Programming	2a. Explain various arithmetic instructions. 2b. Find the status of flags for a set of given instructions.	2.1 Arithmetic Instructions
	2c. Represent signed numbers in PIC18. 2d. Explain OV flag.	2.2 Signed Number Concepts and Arithmetic Operations
	2e. Explain Logic and compare instructions. 2f. Find the contents of WREG register after executing given instructions.	2.3 Logic and Compare Instructions
	2g. Explain rotate instructions.	2.4 Rotate Instruction and Data Serialization.
	2h. Represent BCD and ASCII codes. 2i. Convert given code.	2.5 BCD and ASCII Conversion.
	2j. List PIC18 conditional Branch instructions.	2.6 Branch Instructions and Looping.
	2k. Explain Loop and nested loop.	

Unit	Major Learning Outcomes (in cognitive domain)	Topics and Sub-topics
	2l. Explain CALL, STACK and stack pointer.	2.7 Call Instructions and Stack
	2m. Calculate time delay for the given set of parameters.	2.8 PIC18 Time Delay and Instruction Pipeline.
	2n. Explain alternate functions of Port A, B, C and D. 2o. Explain TRIS register role in inputting and outputting data.	2.9 I/O Port Programming in PIC18.
	2p. Explain single bit instructions. 2q. Develop a short program using bit instructions	2.10 I/O Bit Manipulation Programming.
Unit – III PIC18 Programming in C	3a. Explain data types widely used by PIC18.	3.1 Data Types and Time Delays in C.
	3b. Select data type for given variables.	
	3c. Give factors affecting time delay code size in PIC18.	
	3d. Explain bit-addressable I/O programming. 3e. Develop C program.	3.2 I/O Programming in C.
	3f. Explain bit wise logic operators. 3g. Develop C program.	3.3 Logic Operations in C.
	3h. Develop C program.	3.4 Data Serialization in C.
	3i. Explain advantages and disadvantages using program ROM space for data. 3j. Develop C program.	3.5 Program ROM Allocation in C.
	3k. State advantages and disadvantages using data RAM space. 3l. Develop C program.	3.6 Data RAM Allocation in C.
Unit – IV PIC18 Programming in C: Timer, Serial Port and Interrupt	4a. Explain the timers in PIC18. 4b. Develop C program on timers and counters.	4.1 Programming Timers 0, 1, 2 and 3 in C. 4.2 Counter Programming.
	4c. Compare advantages of serial communication over parallel. 4d. Describe serial communication features and main registers used in PIC18.	4.3 Basics of Serial Communication.
	4e. Interface PIC18 with RS232 connector.	4.4 PIC18 connection to RS232.
	4f. Develop a program.	4.5 PIC18 Serial Port Programming in C.
	4g. Explain all interrupts. 4h. Discuss interrupts priority.	4.6 PIC18 Interrupts.
	4i. Develop a program.	4.7 Programming Timer, External Hardware, Serial communication and Port B change

Unit	Major Learning Outcomes (in cognitive domain)	Topics and Sub-topics
		interrupts.
Unit – V PIC18 Interfacing : LCD, Keyboard, ADC, DAC, Sensor, Relay, DC motor, Stepper Motor	5a. Describe the functions of the pins of a typical LCD.	5.1 LCD Interfacing
	5b. Interface an LCD to the PIC18.	
	5c. Interface a 4 x 4 keypad to the PIC18 using “C”.	5.2 Keyboard Interfacing
	5d. Explain the process of Data acquisition using 8 and 10 bit serial and parallel ADC.	5.3 ADC Characteristics.
	5e. Program the PIC18’s ADC in C.	5.4 ADC Programming in the PIC18
	5f. Interface a DAC chip to the PIC18.	5.5 DAC Interfacing
	5g. Interface temperature sensors to the PIC18.	5.6 Sensor Interfacing and Signal Conditioning.
	5h. Describe signal conditioning and its role in data acquisition.	
	5i. Interface the PIC18 with a relay.	5.7 Relays and Opto-isolators.
	5j. Interface the PIC18 with an opto-isolator.	
	5k. Interface the PIC18 with a stepper motor.	5.8 Stepper Motor Interfacing.
	5l. Program PIC18 to control and operate a stepper motor.	
	5m. Interface the PIC18 with a DC motor.	5.9 DC Motor interfacing and PWM.
	5n. Describe DC motor speed control using PWM.	

6. SUGGESTED SPECIFICATION TABLE WITH HOURS AND MARK (Theory)

Unit No.	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
I	PIC Microcontrollers : History, Features and Architecture	08	04	04	06	14
II	Classification of Instructions and I/O Port Programming.	10	04	04	06	14
III	PIC18 Programming in C.	07	02	02	06	10
IV	PIC18 Programming in C: Timer, Serial Port and Interrupt.	07	02	04	08	14
V	PIC18 Interfacing : LCD, Keyboard, ADC, DAC, Sensor, Relay, DC motor, Stepper Motor	10	02	04	12	18
	Total	42	14	18	38	70

Legends: R = Remember; U = Understand; A = Apply and above levels (Bloom’s revised 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.

7. SUGGESTED EXERCISES / PRACTICALS

The practical should be properly designed and implemented with an attempt to develop different types of skills (**outcomes in psychomotor and affective domain**) so that students are able to acquire the competencies/programme outcomes. Following is the list of practical exercises for guidance.

***Note:** Here only outcomes in psychomotor domain are listed as practical. However, if these practical are completed appropriately, they would also lead to development of certain outcomes in affective domain which would in turn lead to development of **Course Outcomes** related to affective domain. Thus over all development of **Programme Outcomes** (as given in a common list at the beginning of curriculum document for this programme) would be assured.*

Faculty should refer to that common list and should ensure that students also acquire outcomes in affective domain which are required for overall achievement of Programme Outcomes/Course Outcomes.

S. No.	Unit No.	Practical Exercises (Outcomes' in Psychomotor Domain)	Approx. Hours Required
1	I	Test Hardware and Software development tool for PIC18.	02
2	I	Check Register and Memory with MPLAB Simulator	02
3	II	Develop and Execute Programs on Arithmetic instructions.	02
4	II	Develop and Execute Programs on Logical and Compare instructions.	02
5	II	Develop and Execute Programs on Rotate instructions and Data Serialization.	02
6	II	Develop and Execute Programs on BCD and ASCII code conversion.	02
7	II	Develop and Execute Programs on branching instructions and Looping.	02
8	II	Develop and Execute Programs on Call instructions.	02
9	II	Develop and Execute Programs on Time delay.	02
10	II	Develop and execute program on I/O Port programming.	02
11	II	Develop and execute programs on single bit manipulation.	02
12	IV	Develop and execute programs on Timers and Counters.	02
13	IV	Develop and execute programs on Serial Communication.	02
14	IV	Develop and execute programs on Different Interrupt handling.	02
15	V	Interface LCD with PIC18.	02
16	V	Interface Keyboard with PIC18.	02
17	V	Interface ADC with PIC18.	02
18	V	Interface DAC with PIC18.	02
19	V	Interface Different Sensors with PIC18.	02
20	V	Interface relay with PIC18.	02
21	V	Interface stepper motor with PIC18.	02
22	V	Interface DC motor with PIC18.	02
23	V	Perform DC motor speed control using PWM with PIC18.	02
Total Hours			46
Note: Perform any of the practical exercises from above list for total of minimum 28 hours depending upon the availability of resources so that skills matching with the most of the outcomes of every unit are included.			

8. SUGGESTED STUDENT ACTIVITIES

Following are some of the proposed student activities such as:

- i. Execute PIC18 “C” programs using microcontroller Development kits.
- ii. Verify above programs using simulators.
- iii. Interface various peripherals with PIC 18 microcontroller.

9. SPECIAL INSTRUCTIONAL STRATEGIES (if any)

- i. Arrange seminar/symposium where student should present on different aspects of PIC Microcontroller
- ii. Ask students to do mini projects related to PIC Microcontroller
- iii. Arrange expert lecture by engineers having experience of using PIC for instrumentation purposes.

10. SUGGESTED LEARNING RESOURCES**A) Books**

Sl. No.	Title of Book	Author	Publication
1.	PIC Microcontroller And Embedded Systems.	Mazidi M. A., McKinlay R. D., Causey D.	Pearson Education International, 2008
2.	PIC Microcontroller	Gaonkar R. S.	Penram International Publishing (India) Pvt. Ltd.
3.	PIC Microcontrollers – Programming in C	Verle Milan	Mikroelektronika, 1 st Edition, 2009
4.	PIC Microcontroller	Matic Nebojsa	Mikroelektronika, 1 st edition 2008
5.	Embedded C Programming And The Microchip PIC	Barnett R. H., Cox S., O'cull L.	Cengage; Pap/Cdr edition 2003
6.	Design with PIC Microcontrollers	Peatman John B.	Pearson Education

B) Major Equipment/ Instrument with Broad Specifications

1. Computer capable to support “C” programming and required simulators.
2. PIC 18 Development kit. With inbuilt power supply, keyboard, LCD displays, ports for interfacing peripheral and memory.
3. Microcontroller based interfacing study cards. Capable to interface LCD, Keyboard, ADC, DAC, Sensor, Relay, DC motor, Stepper Motor With PIC 18 Development kit.
4. Microcontroller Simulator softwares.

C) Software / Learning Websites

- i. www.nptel.com
- ii. http://en.wikipedia.org/wiki/PIC_microcontroller
- iii. www.microchip.com/pic/
- iv. www.engineersgarage.com/articles/pic-microcontroller-tutorial
- v. www.best-microcontroller-projects.com/pic-microcontroller.html

- vi. www.pic18-simulator-ide.software.informer.com
- vii. www.gpsim.sourceforge.net

11. COURSE CURRICULUM DEVELOPMENT COMMITTEE

Faculty Members from Polytechnics

- **Prof. M. V. Dabhi**, I/C HOD (DBM), Government Polytechnic, Gandhinagar.
- **Prof. A. M. Patel**, Lecturer, Government Polytechnic, Palanpur.
- **Prof. (Smt.) S. K. Raval**, Lecturer, Government Polytechnic, Ahmedabad.
- **Prof. M. J. Vadhvaniya**, Lecturer, Government Polytechnic, Gandhinagar.

Coordinator and Faculty Members from NITTTR Bhopal

- **Dr. Joshua Earnest**, Professor, Department of Electrical and Electronics Engineering
- **Dr Shashi Kant Gupta**, Professor and Coordinator for State of Gujarat