ITT Technical Institute

ET390T

Embedded Systems

Onsite and Online Course

SYLLABUS

Credit hours: 4

Contact/Instructional hours: 60 (36 Theory Hours, 24 Lab Hours)

Prerequisite(s) and/or Corequisite(s):

Prerequisites: ET156T Introduction to C Programming or equivalent, ET355T Microprocessors or equivalent

Course Description:

This course covers the fundamentals of embedded systems, with emphasis on effectively programming, interfacing, and implementing a microcontroller.

COURSE SUMMARY

COURSE DESCRIPTION

This course covers the fundamentals of embedded systems, with emphasis on effectively programming, interfacing, and implementing a microcontroller.

MAJOR INSTRUCTIONAL AREAS

1. Architecture and Components of Embedded Microcontroller Systems
2. PIC18 Assembly Language Programming
3. MPLAB Integrated Development Environment
4. C Programming to Configure the PIC18 Microcontroller
5. Interface Hardware Components to a PIC18
6. Parallel Port and I/O Programming
7. Interrupt and Reset Programming
8. Timers and Counters
9. Analog-to-Digital (A/D) and (D/A) Converters
10. Serial Communications and Serial Peripheral Interface (SPI) Protocol
11. Capture/Compare/Pulse-Width Modulation (PWM) (CCP) Modules

COURSE LEARNING OBJECTIVES

By the end of this course, you should be able to:

1. Describe the architecture and components of embedded microcontroller systems.
2. Create and debug C program applications using the Microchip MPLAB integrated development environment (IDE).
3. Interface PIC18 parallel ports and create programs to perform input/output (I/O) operations on various devices.
4. Perform PIC18 interrupt and reset handling functions.
5. Create time delays, perform signal measurements, and generate digital waveforms and periodic interrupts using PIC18 timer functions, capture/compare/pulse-width modulation (CCP) modules, and pulse width modulation (PWM).
6. Configure the PIC18 analog-to-digital (A/D) converter to measure physical quantities.

7. Communicate with peripheral devices that support serial peripheral interface (SPI) and RS232/485 protocols using the PIC18 serial modules.
8. Create an embedded system application.

COURSE OUTLINE

MODULE 1: MICROCONTROLLERS AND ASSEMBLY LANGUAGES

COURSE LEARNING OBJECTIVES COVERED

- Describe the architecture and components of embedded microcontroller systems.

TOPICS COVERED

- Microcontrollers and Embedded Processors
- PIC18 Family
- WREG Register, File Register, and Status Register
- Data Format and Directives
- PIC Assembly Programming
- Time Delay

MODULE LEARNING ACTIVITIES	GRADED	OUT-OF-CLASS TIME
Reading: Mazidi, M., Chapters 1, 2, and 3.	No	6.5 hours
Lesson: Study the lesson for this module.	No	1.0 hour
Exercise: Submit the exercise titled "Assembly Language Programming."	Yes	1.5 hours
Lab: Complete the lab titled "MPLAB Assembler."	Yes	N/A
Project: Read and begin the project.	No	0.5 hour

Total Out-Of-Class Activities: 9.5 Hours

MODULE 2: I/O PROGRAMMING

COURSE LEARNING OBJECTIVES COVERED

- Create and debug C program applications using the Microchip MPLAB integrated development environment (IDE).
- Interface PIC18 parallel ports and create programs to perform input/output (I/O) operations on various devices.

TOPICS COVERED

- I/O Port Programming, Port Pins, and Their Functions
- I/O Bit Manipulation Programming
- Arithmetic Instructions, Rotate Instructions, and Data Serialization
- Signed Numbers
- BCD and ASCII

MODULE LEARNING ACTIVITIES	GRADED	OUT-OF-CLASS TIME
Reading: Mazidi, M., Chapters 4 and 5.	No	6 hours
Lesson: Study the lesson for this module.	No	1.5 hours
Discussion: Participate in the discussion titled "Applications of a D/A Converter."	Yes	N/A
Exercise: Submit the exercise titled "I/O Programming."	Yes	1.5 hours
Lab: Complete the lab titled "PIC Trainer."	Yes	N/A
Project: Continue work on Project Part 1.	No	3 hours

Total Out-Of-Class Activities: 12 Hours

MODULE 3: PROGRAMMING LANGUAGES: ASSEMBLY AND C

COURSE LEARNING OBJECTIVES COVERED

- Create and debug C program applications using the Microchip MPLAB integrated development environment (IDE).
- Perform PIC18 interrupt and reset handling functions.

TOPICS COVERED

- Immediate and Direct Addressing Modes
- Look-Up Table and Table Processing
- Bank Switching in PIC18
- Macros and Modules
- I/O Programming in C
- Logic Operations in C

MODULE LEARNING ACTIVITIES	GRADED	OUT-OF-CLASS TIME
Reading: Mazidi, M., Chapters 6 and 7.	No	9 hours
Lesson: Study the lesson for this module.	No	1.5 hours
Discussion: Participate in the discussion titled "Pros and Cons of Assembly and C."	Yes	N/A
Exercise: Submit the exercise titled "C Programming."	Yes	1.5 hours
Lab: Complete the lab titled "C Programming Language in Embedded Systems."	Yes	N/A
Project: Submit Project Part 1.	Yes	2 hours

Total Out-Of-Class Activities: 14 Hours

MODULE 4: HARDWARE AND TIMERS

COURSE LEARNING OBJECTIVES COVERED

- Create and debug C program applications using the Microchip MPLAB integrated development environment (IDE).
- Create time delays, perform signal measurements, and generate digital waveforms and periodic interrupts, using PIC18 timer functions, capture/compare/pulse-width modulation (CCP) modules, and pulse width modulation (PWM).

TOPICS COVERED

- PIC18 Configuration Registers
- PIC18 Trainer Design and Loading
- Programming Timers
- Counter Programming

MODULE LEARNING ACTIVITIES	GRADED	OUT-OF-CLASS TIME
Reading: Mazidi, M., Chapters 8 and 9.	No	8.5 hours
Lesson: Study the lesson for this module.	No	2 hours
Discussion: Participate in the discussion titled "The EIA232 Standard."	Yes	N/A
Exercise: Submit the exercise titled "PIC18 Timer."	Yes	2 hours
Lab: Complete the lab titled "Programming an LCD."	Yes	N/A
Project: Begin work on Project Part 2.	No	3 hours

Total Out-Of-Class Activities: 15.5 Hours

MODULE 5: PROGRAMMING IN ASSEMBLY

COURSE LEARNING OBJECTIVES COVERED

- Create and debug C program applications using the Microchip MPLAB integrated development environment (IDE).
- Configure the PIC18 analog-to-digital (A/D) converter to measure physical quantities.
- Communicate with peripheral devices that support serial peripheral interface (SPI) and RS232/485 protocols using the PIC18 serial modules.

TOPICS COVERED

- Serial Communication
- PIC18 Serial Port Programming in Assembly and C
- Programming Timer and External Hardware Interrupts
- Interrupt Priority in PIC18
- LCD and Keyboard Interfacing

MODULE LEARNING ACTIVITIES	GRADED	OUT-OF-CLASS TIME
Reading: Mazidi, M., Chapters 10, 11, and 12.	No	10 hours
Lesson: Study the lesson for this module.	No	2 hours
Discussion: Participate in the discussion titled "The Types of ADCs."	Yes	N/A
Lab: Complete the lab titled "ADC of PIC."	Yes	N/A
Project: Submit Project Part 2.	Yes	2 hours
Final Exam: Prepare for the final exam.	No	5 hours

Total Out-Of-Class Activities: 19 Hours

MODULE 6: PROGRAMMING AND PROTOCOL

COURSE LEARNING OBJECTIVES COVERED

- Describe the architecture and components of embedded microcontroller systems.
- Create and debug C program applications using the Microchip MPLAB integrated development environment (IDE).
- Interface PIC18 parallel ports and create programs to perform input/output (I/O) operations on various devices.
- Perform PIC18 interrupt and reset handling functions.
- Create time delays, perform signal measurements, and generate digital waveforms and periodic interrupts using PIC18 timer functions, capture/compare/pulse-width modulation (CCP) modules, and pulse width modulation (PWM).
- Configure the PIC18 analog-to-digital (A/D) converter to measure physical quantities.
- Communicate with peripheral devices that support serial peripheral interface (SPI) and RS232/485 protocols using the PIC18 serial modules.
- Create an embedded system application.

TOPICS COVERED

- Standard CCP Modules
- Mode Programming and ECCP Programming
- Bus Protocol
- Interfacing and Programming

MODULE LEARNING ACTIVITIES	GRADED	OUT-OF-CLASS TIME
Reading: Mazidi, M., Chapters 15 and 16.	No	7 hours
Lesson: Study the lesson for this module.	No	1.5 hours
Lab: Complete the lab titled "PIC Timer."	Yes	N/A
Final Exam: Take the final exam.	Yes	N/A

Total Out-Of-Class Activities: 8.5 Hours

EVALUATION AND GRADING

EVALUATION CRITERIA

The graded assignments will be evaluated using the following weighted categories:

CATEGORY	WEIGHT
Discussion	10%
Exercise	20%
Lab	30%
Project	20%
Final Exam	20%
TOTAL	100%

GRADE CONVERSION

The final grades will be calculated from the percentages earned in the course, as follows:

GRADE	PERCENTAGE
A (4.0)	90–100%
B+ (3.5)	85–89%
B (3.0)	80–84%
C+ (2.5)	75–79%
C (2.0)	70–74%
D+ (1.5)	65–69%
D (1.0)	60–64%
F (0.0)	<60%

LEARNING MATERIALS AND REFERENCES

REQUIRED RESOURCES

COMPLETE TEXTBOOK PACKAGE

Mazidi, M. (2008). *PIC microcontroller and embedded systems. Upper Saddle River, NJ: Pearson Prentice Hall.*

RECOMMENDED RESOURCES

- Professional Associations
  - ETA-Electronics Technicians Association
  - IEEE-International Electrical and Electronic Engineers
  - ISA-International Society of Automation
  - ISCET-International Society of Certified Electronic Technicians
  - SME-Society of Manufacturing Engineers
- ITT Tech Virtual Library (accessed via Student Portal | https://studentportal.itt-tech.edu)
  - Basic Search>
    - Designing embedded systems with PIC microcontrollers principles and applications [electronic resource] by Tim Wilmshurst
    - Intelligent sensor design using the microchip dsPIC [electronic resource] by Creed Huddleston
- Other References
  - Designing embedded systems with 32-bit PIC microcontrollers and MikroC [electronic resource] by Dogan Ibrahim
  - Microcontrollers fundamentals and applications with PIC [electronic resource] by Fernando E. Valdes-Perez and Ramon Pallas-Areny

INSTRUCTIONAL METHODS AND TEACHING STRATEGIES

The curriculum employs a variety of instructional methods that support the course objectives while fostering higher cognitive skills. These methods are designed to encourage and engage you in the learning process in order to maximize learning opportunities. The instructional methods include but are not limited to lectures, collaborative learning options, use of technology, and hands-on activities.

To implement the above-mentioned instructional methods, this course uses several teaching strategies, such as hands-on labs and exercises that allow students to practice programming with embedded systems. Your progress will be regularly assessed through a variety of assessment tools including exercises, labs, discussions, project, and a final exam.

OUT-OF-CLASS WORK

For purposes of defining an academic credit hour for Title IV funding purposes, ITT Technical Institute considers a quarter credit hour to be the equivalent of: (a) at least 10 clock hours of classroom activities and at least 20 clock hours of outside preparation; (b) at least 20 clock hours of laboratory activities; or (c) at least 30 clock hours of externship, practicum or clinical activities. ITT Technical Institute utilizes a “time-based option” for establishing out-of-class activities which would equate to two hours of out-of-class activities for every one hour of classroom time. The procedure for determining credit hours for Title IV funding purposes is to divide the total number of classroom, laboratory, externship, practicum and clinical hours by the conversion ratios specified above. A clock hour is 50 minutes.

A credit hour is an artificial measurement of the amount of learning that can occur in a program course based on a specified amount of time spent on class activities and student preparation during the program course. In conformity with commonly accepted practice in higher education, ITT Technical Institute has institutionally established and determined that credit hours awarded for coursework in this program course (including out-of-class assignments and learning activities described in the “Course Outline” section of this syllabus) are in accordance with the time-based option for awarding academic credit described in the immediately preceding paragraph.

ACADEMIC INTEGRITY

All students must comply with the policies that regulate all forms of academic dishonesty or academic misconduct. For more information on the academic honesty policies, refer to the Student Handbook and the School Catalog.

INSTRUCTOR DETAILS

Instructor Name	
Office Hours	
Contact Details	

(End of Syllabus)