LEAD CITY UNIVERSITY, IBADAN
FACULTY OF ENGINEERING AND TECHNOLOGY
DEPARTMENT OF ELECTRICAL AND ELECTRONIC ENGINEERING
SEMESTER/SESSION: 1ST SEMESTER, 2024/2025[1]

Course Particulars

Course Code: EEE 402
Course Title: Introduction to Microcontrollers and Assembly Language
Course Units: 2
Course Status: Core

Lecturer's Details

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Areas of Specialization & Research Interests

Learning; Electrical Engineering Education; Sustainable Energy

Course Synopsis

Principles of digital computer design: Basic element of the digital computer parts and operation.

Types and Uses of Computers Bus organization – Data addresses, control, control.

Outline of central processing unit – parts and operation. Word format: data and instruction.

Microprocessors and microcontrollers: system architecture, instruction execution, addressing modes. Addressing schemes: memory mapping, input/output mapping. Machine code programing.
Microcontroller programming. Language level of abstraction and effect on machine, characteristic of machine code, advantages, justifications of machine code programming, instruction set and dependency on underlying processor.

Intel 8086 microprocessor assembly language programming: Programming model as resources available to programmer, addressing modes, instruction format, instruction set-arithmetic, logical, string, branching, program control, machine control, input/output, etc.

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Modular programming. Interrupt and service routing.

Interfacing of assembly language to C.
Arduino Programming.

Introduction to MMX and SSE programming. Motorola 680x0 assembly language programming. Extensive practical engineering problems solving in assembly language using MASM for Intel, and cross-assembler for Motorola.

Intel 8086 microprocessor assembly language programming: Programming model as resources available to programmer, addressing modes, instruction format, instruction set-arithmetic, logical, string, branching, program control, machine control, input/output, etc. Modular programming. Interrupt and service routing. Interfacing of assembly language to C. Arduino Programming. Introduction to MMX and SSE programming. Motorola 680x0 assembly language programming. Extensive practical engineering problems solving in assembly language using MASM for Intel, and cross-assembler for Motorola.

The course objectives are to:

- facilitate the understanding of the concepts of assembly language programming
- facilitate the understanding of the structure and application 8086 microprocessor
- practical programming of 8086 microprocessor
- Understand the 8086 instruction sets

Course Learning Outcomes (CLOs)
At the end of this course, students should be able to:

1. Demonstrate understanding of the structure and functionality of a typical microcontroller
2. Clearly differentiate between a microcontroller and microprocessor structurally and functionally
3. Write, explain and implement assembly language programming principles for microcontroller and microprocessor
4. Identify the various components of 8086 microprocessor architecture
5. Demonstrate Understanding of the concepts of registers, addressing and memory segmentation in 8086.
6. Explain the process of data manipulation in 8086.

Lecture Delivery Method

- Lecture with interactive sessions

LECTURE PLAN

Course Modules
Module 1: Course overview, concepts, principles of microprocessor and microcontroller
Module 2: Register Organization in 8086
Module 3: Memory segmentation and Bus Operation
Module 4: 8086 instruction sets

Course Outline

Module 1: Course overview, concepts, principles, types of measurement and instrumentation

Number of Lecture Hours: 12

Week	Lecture Topic	Contents	Learning Objectives
1	Introduction and Course Overview	Course outlines, delivery methods, assessments, course materials and recommended text books	Discuss the general overview of the course, rules and regulations for successful achievement in the course will be emphasized.
2	Overview of 8086 microprocessor	Introduction to microprocessors and microcontrollers.	Discuss the basics of microprocessors and microcontrollers
3	Architecture of 8086 microprocessor.	Features of 8086. Architecture of 8086. Bus Interface Unit (BIU). Execution Unit (EU).	Understand the architecture of 8086 microprocessor.
4	Bus operation.	Overview of system buses and operations.	Understand the concepts of bus operations.

Module 2: Register Organization in 8086

Number of Lecture Hours: 9

Week	Lecture Topic	Contents	Learning Objectives
5	Register Organization I	General purpose registers. Segment registers.	Understand the organization of registers in 8086
6	Register Organization II	Pointers and index registers. Flag registers.	Explain the organization of registers in 8086
7	Mid-semester Test		Continuous Assessment

Module 3: Memory segmentation and Addressing Modes

Number of Lecture Hours: 12

Week	Lecture Topic	Contents	Learning Objectives
8	Memory segmentation	Rules of memory segmentation. Advantages of memory segmentation. Pointers and index registers.	Understand and apply the concepts memory segmentation.
9	Addressing Modes I	Data addressing modes. Program memory addressing modes.	Understand addressing modes in 8086
10	Addressing Modes II	Stack memory addressing modes. Default and Alternate Registers	Explain addressing modes in 8086

Module 4: 8086 instruction sets

Number of Lecture Hours: 9

Week	Lecture Topic	Contents	Learning Objectives
11	Data manipulation instructions	MOV instruction. PUSH/POP instruction. Load effective address. Sting data transfer instructions. Miscellaneous data transfer instructions.	Explain data manipulation instructions in 8086.
12	Arithmetic and Logic Instructions.	Addition. Subtraction. Comparison. Multiplication. Division. BDC and ASCII Arithmetic. Shift and Rotate.	Understand and apply arithmetic and logic manipulations in 8086
13	Assembly language programming	Practical examples and solutions	Apply 8086 instruction sets to solve practical programming problems.
14	Revision		
15	Final Exams		

Grading System

This course will be graded as follows:

Attendance: 10%
CA/Assignments: 30%
Examination: 60%
Total: 100%

References

1. Maini, Anil K. *Digital Electronics: Principles and Integrated Circuits*. John Wiley & Sons, 2007.

Tutorial Questions

Question 1 **15 Marks**

(a) What are the fundamental differences between a microprocessor and a microcontroller?

(b) Briefly describe some of the major application areas of microcontrollers.

(c) A certain microcontroller has an on-chip 16-bit counter/timer system. It is used to measure the width of an input pulse. The microcontroller has been programmed to measure the time of occurrence of rising and falling edges of an input pulse on a certain I/O pin. If the microcontroller uses an 16 MHz clock and the count values observed at the time of occurrence of rising and falling edges of the input pulse are 001F and 00F1 (in hex), determine the pulse width as measured by the microcontroller.

Question 2 **15 Marks**

(a) Briefly describe What is meant by distributed processing?

(b) Describe a possible configuration of interfacing a common cathode (CC) or common anode (CA) display with a microcontroller

(c) In how many categories memories can be classified? Give examples and distinguish between them?

Question 3 **15 Marks**

(a) Describe using relevant schematics:
(i) The Von Neumann Architecture
(ii) The Harvard Architecture
(b) Describe using relevant schematics
(i)Accumulator-based Architecture
(ii) Register-based Architecture
(c) It is desired to design a microcontroller-based periodic signal generator with minimum and maximum time period specifications of 125 ns and 100 ms. What should the system clock frequency be?

Question 4 **15 Marks**
(a) Using schematics differentiate structurally and functionally the one I^2C master and multiple slaves configuration from the multiple master support arrangement
(b) Describe how the following buses operate:
(i)Controller Area Network (CAN) Bus
(ii) Local Interconnect Network (LIN) Bus
(c) Describe using relevant schematics
(i) Pipeline Architecture
(ii) Stack-based Architecture

Question 5 **15 Marks**
(a) Describe how the mnemonics written in assembly language are translated into binary.
(b) Describe the inerfacing of LEDs with a microcontroller
(c) What are the three main constituents of a microprocessor and what is the basic function performed by each one of
them.

Question 6 **15 Marks**
(a) Compare and contrast two (2) different architectures for mapping special function registers into Memory Space.
(b) Describe three (3) power-saving modes implemented in typical microcontrollers
(c) Briefly describe the interfacing keyboards with a microcontroller

Question 7 **15 Marks**
(a) Draw the software hierarchy of a microcomputer system and briefly explain
(b) Draw the pin configuration and functional pin diagram of 8086 microprocessor.
(c) In how many groups can the signals of 8086 be classified?

Question 8 **15 Marks**
(a) Draw the architecture of 8086 and mention its various functional blocks
(b) Using a table, list the various registers of the 8085 with their respective quantity and capacity.
(c) Briefly describe the accumulator register of the 8085

Question 9 **15 Marks**
(a) Discuss the two registers program counter and stack pointer
(b) A data byte is stored in memory location 4200 H. This eight bit data is to be
taken out of SOD pin, bit wise. Draw a flowchart and write a program to implement this.

Question 10 **15 Marks**

(a) Generate a square wave of 50% duty cycle through the SOD pin of 8086

(b) Why are stacks used in programs?

(c) Give one example each of 1-byte, 2-byte and 3-byte instructions.

Question 11 **15 Marks**

(a) List six of the groups in which the instruction set of 8086 can be categorised. 3 Marks

(b) Briefly describe what an instruction essentially consists of?

(c) Explain the CALL instruction.

Question 12 **15 Marks**

(a) List the different types of data transfer instructions.

(b) Explain the following two examples:

(i)MOV CX, CS.

(ii)MOV AX, [ALPHA].

(c) Give one example each of the five types of addressing modes.

Question 13 **15 Marks**

(a) Indicate the different types of arithmetic instructions possible with 8086. List two each for addition, subtraction and multiplication respectively.

(b) Explain DAA instruction.

(c) Show the allowed operands for the instruction ADD, ADC and INC

Question 14 **15 Marks**

(a) (i) Write an ALP (assembly language programming) for addition of two 8-bit data BB H and 11 H.

(b) What is meant by a 'string' and what are the characteristics of a string instruction?

(c) Ten 8-bit numbers are stored starting from memory location 2100 H. Add the numbers, store the result at 3500 H memory location and carry at 3501 H. Draw the flowchart also.

Question 15 **15 Marks**

(a) Write an ALP for addition of two 16-bit data BB11 H and 1122 H.

(b) Write a program, along with flowchart, to find the 2's complement of the number FF H, stored at memory location 2000 H. Store the result in memory location 3015 H.

(c) List the basic string instructions and the operations they perform.