COMPUTER ARCHITECTURE

LIMKOKWING UNIVERSITY COLLEGE OF CREATIVE TECHNOLOGY

LECTURE 7

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MICROPROCESSOR SYSTEM

Objective

- Evolution of Microprocessors
- Microprocessor Basics
- Architecture and Instruction of INTEL 8085 Microprocessor
- Timing Diagram
- Interfacing Devices

Microprocessor Basics

- When the central processor unit is made of only one integrated circuit, it becomes a microprocessor
- It has millions of transistors and electronic components to process multiple instructions at a time
- All this is on one silicon chip which has memory and other special features to support the computer system.

Microprocessor Basics

- It is programmable in a way to read binary instructions from memory and then execute the task to deliver the needed output.

- It is useful for storing data, device interaction, and sending/receiving data simultaneously.

Microprocessor Basics

- A Microprocessor has many components like transistors, registers, and diodes which come together to perform.

- The ability of the chip has become more complex with technology evolution.
  – The functionality has become better and the speed has become faster.

Microprocessor Basics

- Now, most devices need to have a microprocessor to function.
  - It is the element that brings intelligence to a device.
- Be it a computer or mobile phone, all devices need an interface to handle data that only a microprocessor provides.
- And it still has a long way to go with the development of artificial intelligence.

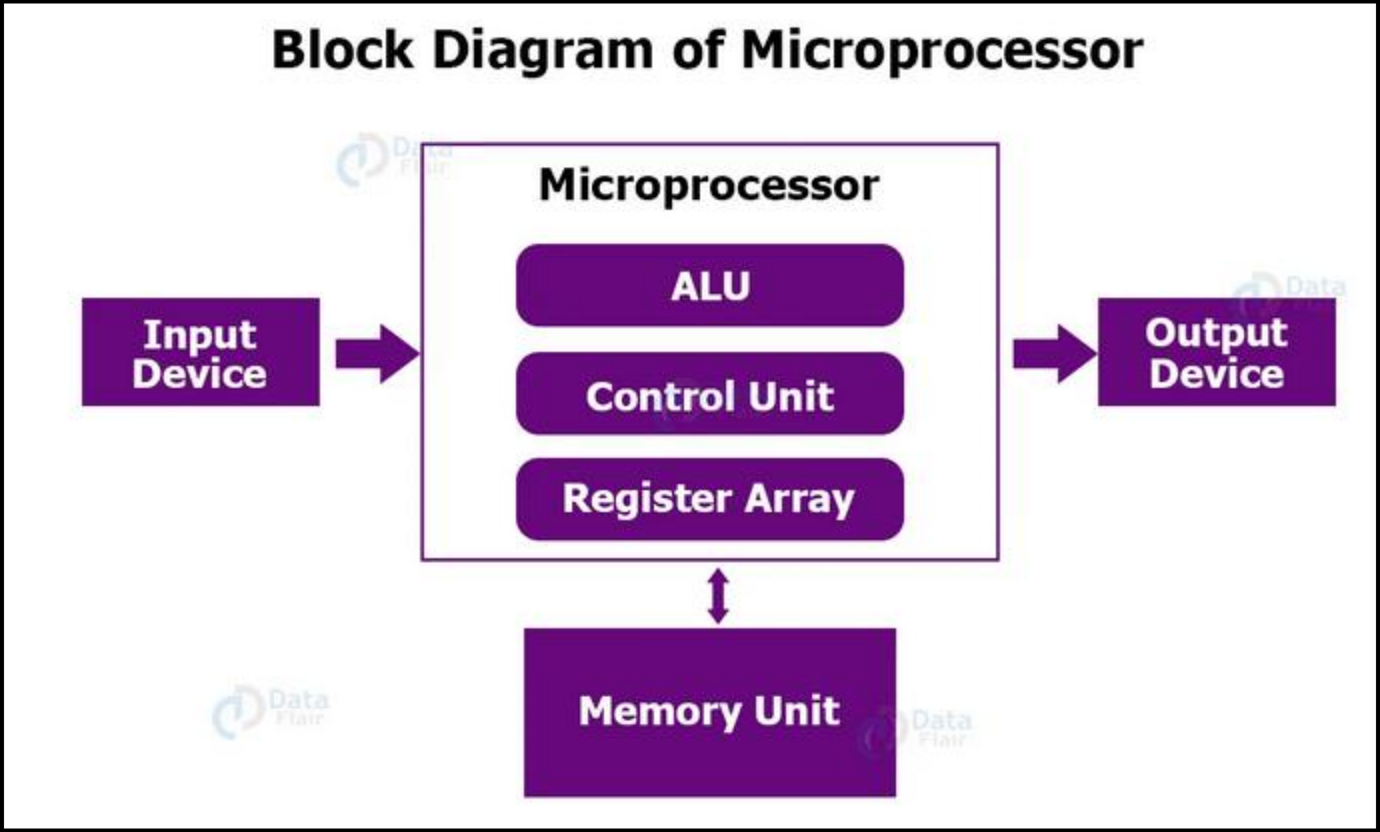
Microprocessor Basics

- There are three steps that a microprocessor follows –
  - 1. Fetch – The instructions are in storage from where the processor fetches them.
  - 2. Decode – It then decodes the instruction to assign the task further. During this, the arithmetic and logic unit also performs to register the data temporarily.
  - 3. Execute – The assigned tasks undergo execution and reach the output port in binary form.

Microprocessor Basics

- Block Diagram of a Microprocessor
  - Arithmetic and Logical Unit, Control Unit, and Register array make up the microprocessor.
    - The ALU deals with input devices or memory for receiving data.
    - The control unit takes care of instructions and structure.
    - Register array identifies and saves the registers like B, C, and accumulator.

Microprocessor Basics



Microprocessor Basics

- Basic Microprocessor Terms
  - Instructions Per Cycle – A way to measure CPU's instruction speed in a single clock.
  - Instruction Set – These are the commands that a processor understands to work between hardware and software.
  - Bus – Set of conductors for data transmission, information control, and tasks addressed in a microprocessor. They are of three types – data bus, address bus, and control bus.

Microprocessor Basics

- Basic Microprocessor Terms
  - Word Length – Refers to the number of bits processed at a time.
  - Clock Speed / Clock Rate – The ability of microprocessors to perform tasks in a second.
  - Bandwidth – Refers to the total bits in a single instruction.
  - Data Types – Data type microprocessor supports like binary, ASCII, etc.
  - SIMD – Single Instruction Multiple Data

Microprocessor Basics

- Basic Microprocessor Terms
  - PGA – Pin Grid Array
  - FPU – Floating Point Unit
  - ALU – Arithmetic and Logic Unit
  - MMX – MultiMedia eXtensions
  - MMU – Memory Management Unit

Evolution of Microprocessors

- First Generation – 4bit Microprocessors
  - The Intel Corporation released these in 1971.
  - They were 4-bit processors namely Intel 4004.
  - The speed of the processor was 740 kHz taking 60k instructions per second.
  - It had 2300 transistors and 16 pins inside.
  - Built on a single chip, it was useful for simple arithmetic and logical operations.
  - A control unit was there to understand the instructions from memory and execute the tasks.

Evolution of Microprocessors

- Second Generation – 8bit Microprocessor
  - The second generation began in 1973 by Intel.
  - Useful for arithmetic & logic operations on 8-bit words.
  - The first processor was 8008 with a clock speed of 500kHz and 50k instructions per second.
  - Followed by an 8080 microprocessor in 1974 with a speed of 2 MHz and 60k instruction per second.
  - Lastly came the 8085 microprocessor in 1976 having an ability of 769230 instruction per second with 3 MHz speed.

Evolution of Microprocessors

- Third Generation – 16bit Microprocessor
  - The third generation began with 8086-88 microprocessors in 1978 with 4.77, 8 & 10 MHz speed and 2.5 million instructions per second.
  - Other important inventions were Zilog Z800, and 80286, which came out in 1982 and could read 4 million instructions per second with 68 pins inside.

Evolution of Microprocessors

- Fourth Generation – 32bit Microprocessors
  - Intel came up with 32-bit microprocessors around 1986.
  - Their clock speed was between 16 MHz to 33 MHz with 275k transistors inside.
  - One of the first ones was the Intel 80486 microprocessor of 1986 with 16-100MHz clock speed and 1.2 Million transistors with 8 KB of cache memory.
  - Followed by the PENTIUM microprocessor in 1993 which had 66 MHz clock speed & 8-bit of cache memory.

Evolution of Microprocessors

- Fifth Generation – 64bit Microprocessors
  - Began in 1995, the Pentium processor was one of the first 64-bit processors with 1.2 GHz to 3 GHz clock speed.
    - There were 291 Million transistors and 64kb instruction per second.
  - Followed by i3, i5, i7 microprocessors in 2007, 2009, 2010 respectively..

Architecture and Instructions of INTEL 8085 Microprocessor

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- Generally, the 8085 is an 8-bit microprocessor, and it was launched by the Intel team in the year of 1976 with the help of NMOS technology.

- This processor is the updated version of the microprocessor.

Architecture and Instructions of INTEL 8085 Microprocessor

- The configurations of 8085 microprocessor mainly include:
  - data bus-8-bit
  - address bus-16 bit
  - program counter-16-bit
  - stack pointer-16 bit
  - registers 8-bit
  - +5V voltage supply
- It operates at 3.2 MHz single segment CLK.

Architecture and Instructions of INTEL 8085 Microprocessor

- The features of the 8085 microprocessor are as below:
  - 1. This microprocessor is an 8-bit device that receives, operates, or outputs 8-bit information in a simultaneous approach.
  - 2. The processor consists of 16-bit and 8-bit address and data lines and so the capacity of the device is 2^{16} which is 64KB of memory.
  - 3. This is constructed of a single NMOS chip device and has 6200 transistors

Architecture and Instructions of INTEL 8085 Microprocessor

- The features of the 8085 microprocessor are as below:
  - 4. A total of 246 operational codes and 80 instructions are present
  - 5. As the 8085 microprocessor has 8-bit input/output address lines, it has the ability to address $2^8 = 256$ input and output ports.
  - 6. This microprocessor is available in a DIP package of 40 pins

Architecture and Instructions of INTEL 8085 Microprocessor

- The features of the 8085 microprocessor are as below:
  - 7. In order to transfer huge information from I/O to memory and from memory to I/O, the processor shares its bus with the DMA controller.
  - 8. It has an approach where it can enhance the interrupt handling mechanism
  - 9. An 8085 processor can even be operated as a three-chip microcomputer using the support of IC 8355 and IC 8155 circuits.

Architecture and Instructions of INTEL 8085 Microprocessor

- The features of the 8085 microprocessor are as below:
  - 10. It has an internal clock generator
  - 11. It functions on a clock cycle having a duty cycle of 50%

Architecture and Instructions of INTEL 8085 Microprocessor

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- The 8085 Microprocessor Architecture
  - The architecture of the 8085 microprocessor mainly includes the:
    - timing & control unit
    - Arithmetic and logic unit
    - Decoder
    - instruction register
    - interrupt control, a register array, serial input/output control.
  - The most important part of the microprocessor is the central processing unit.

Architecture and Instructions of INTEL 8085 Microprocessor

Operations of the 8085 Microprocessor

- The main operation of ALU is arithmetic as well as logical which includes addition, increment, subtraction, decrement, logical operations like AND, OR, Ex-OR, complement, evaluation, left shift or right shift.

Architecture and Instructions of INTEL 8085 Microprocessor

Operations of the 8085 Microprocessor

- Both the temporary registers as well as accumulators are utilized for holding the information throughout the operations then the outcome will be stored within the accumulator.
- The different flags are arranged or rearrange based on the outcome of the operation.

Architecture and Instructions of INTEL 8085 Microprocessor

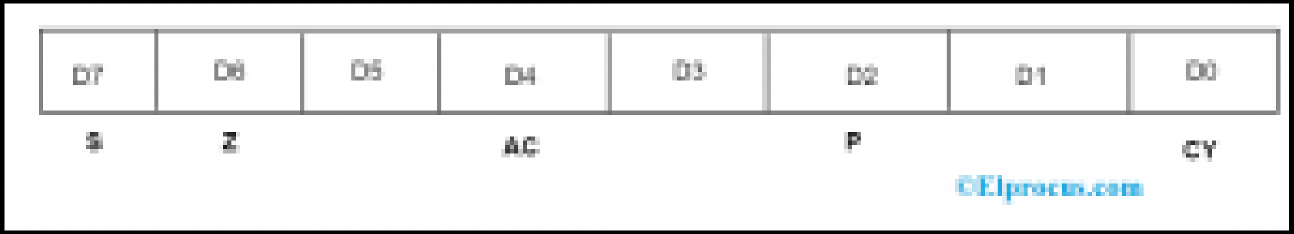
Flag Registers

- The flag registers of microprocessor 8085 are classified into five types namely sign, zero, auxiliary carry, parity and carry.
  - The positions of bit set aside for these types of flags.
- After the operation of an ALU, when the result of the most significant bit (D7) is one, then the sign flag will be arranged.

Architecture and Instructions of INTEL 8085 Microprocessor

Flag Registers

- When the operation of the ALU outcome is zero then the zero flags will be set.
- When the outcome is not zero then the zero flags will be reset.



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Flag Registers

- In an arithmetic process, whenever a carry is produced with the lesser nibble, then an auxiliary type carry flag will be set.

- After an ALU operation, when the outcome has an even number then the parity flag will be set, or else it is reset.

Architecture and Instructions of INTEL 8085 Microprocessor

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Flag Registers

- When an arithmetic process outcome in a carry, then carry flag will be set or else it will be reset.
- Between the five types of flags, the AC type flag is employed on the inside intended for BCD arithmetic as well as remaining four flags are used with the developer to make sure the conditions of the outcome of a process.

Architecture and Instructions of INTEL 8085 Microprocessor

Control and Timing Unit

- The control and timing unit coordinates with all the actions of the microprocessor by the clock and gives the control signals which are required for communication among the microprocessor as well as peripherals.

Architecture and Instructions of INTEL 8085 Microprocessor

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Control and Timing Unit

- The control and timing unit coordinates with all the actions of the microprocessor by the clock and gives the control signals which are required for communication among the microprocessor as well as peripherals.
  - Decoder and Instruction Register
    - As an order is obtained from memory after that it is located in the instruction register, and encoded & decoded into different device cycles.

Architecture and Instructions of INTEL 8085 Microprocessor

Register Array

- The general purpose programmable registers are classified into several types apart from the accumulator such as B, C, D, E, H, & L.
  - These are utilized as 8-bit registers otherwise coupled to stock up the l6 bit of data.
- The permitted couples are BC, DE & HL, and the short term W & Z registers are used in the processor & they cannot be utilized by the developer

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Special Purpose Registers

- These registers are classified into four types namely program counter, stack pointer, increment or decrement register, address buffer, or data buffer

- You already know these

Architecture and Instructions of INTEL 8085 Microprocessor

Stack Pointer in 8085

- The SP or stack pointer is a 16-bit register and functions similar to a stack, which is constantly increased or decreased with two throughout the push and pop processes.

Architecture and Instructions of INTEL 8085 Microprocessor

Increment or Decrement Register

- The 8-bit register contents or else a memory position can be increased or decreased with one.
- The 16-bit register is useful for incrementing or decrementing program counters as well as stack pointer register content with one.
- This operation can be performed on any memory position or any kind of register.

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Address-Buffer & Address-Data-Buffer

- Address buffer stores the copied information from the memory for the execution.

- The memory & I/O chips are associated with these buses; then the CPU can replace the preferred data by I/O chips and the memory.

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Address Bus and Data Bus

- The data bus is useful in carrying the related information that is to be stock up.
- It is bi-directional, but the address bus indicates the position as to where it must be stored & it is uni-directional, useful for transmitting the information as well as address input/output devices.

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Timing & Control Unit

- The timing & control unit can be used to supply the signal to the 8085 microprocessor architecture for achieving the particular processes.
- The timing and control units are used to control the internal as well as external circuits.
  - These are classified into four types namely control units like RD’ ALE, READY, WR’, status units like S0, S1, and IO/M’, DM like HLDA, and HOLD unit, RESET units like RST-IN and RST-OUT.

Architecture and Instructions of INTEL 8085 Microprocessor

Pin Diagram

- This 8085 is a 40-pin microprocessor where these are categorized into seven groups.

- With the 8085 microprocessor pin diagram, the functionality and purpose can be known easily.

Architecture and Instructions of INTEL 8085 Microprocessor

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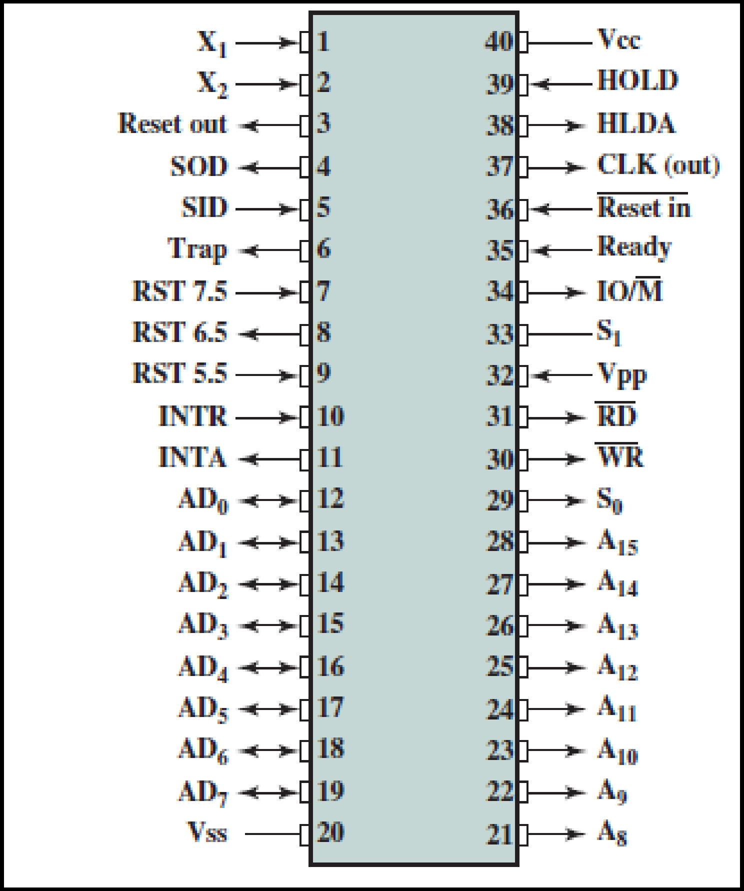
Pin Diagram



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Pin Diagram

- Data Bus
  - The pins from 12 to 17 are the data bus pins which are AD0 – AD7, this carries the minimal considerable 8-bit data and address bus.
- Address Bus
  - The pins from 21 to 28 are the data bus pins which are A8 – A15, this carries the most considerable 8-bit data and address bus.

Architecture and Instructions of INTEL 8085 Microprocessor

Pin Diagram

- Status and the Control Signals
  - In order to find out the behavior of the operation, these signals are mainly considered.
  - In the 8085 devices, there are 3 control and 3 status signals.
    - RD – This is the signal used for the regulation of READ operation. When the pin moves into low, it signifies that the chosen memory is read.

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Pin Diagram

- In the 8085 devices, there are 3 control and 3 status signals.
  - WR – This is the signal used for the regulation of WRITE operation. When the pin moves into low, it signifies that the data bus information is written to the chosen memory location.
  - ALE – ALE corresponds to Address Latch Enable signal. The ALE signal is high at the time of the machine’s initial clock cycle and this enables the last 8 bits of the address to get latched with the memory or external latch.

Architecture and Instructions of INTEL 8085 Microprocessor

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Pin Diagram

- In the 8085 devices, there are 3 control and 3 status signals.
  - IO/M – This is the status signal that recognizes whether the address to be allotted for I/O or for memory devices.
  - READY – This pin is used to specify whether the peripheral is able to transfer information or not. When this pin is high, it transfers data and if this is low, the microprocessor device needs to wait until the pin goes to a high state

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Pin Diagram

– In the 8085 devices, there are 3 control and 3 status signals.
  - S0 and S1 pins – These pins are the status signals which defines the below operations and those are:

S0	S1	Functionality
0	0	Halt
1	0	Write
0	1	Read
1	1	Fetch

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Pin Diagram

- Clock Signals
  - CLK – This is the output signal which is pin 37. This is utilized even in other digital integrated circuits. The frequency of the clock signal is similar to the processor frequency.
  - X1 and X2 – These are the input signals at pins 1 and 2. These pins have connections with the external oscillator that operates the device's internal circuitry system. These pins are used for the generation of the clock that is required for the microprocessor functionality.

Architecture and Instructions of INTEL 8085 Microprocessor

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Pin Diagram

- Reset Signals
  - There are two reset pins which are Reset In and Reset Out at pins 3 and 36.
    - RESET IN – This pin signifies resetting the program counter to zero. Also, this pin resets the HLDA flip-flops and IE pins. The control processing unit will be in a reset state till RESET is not triggered.
    - RESET OUT – This pin signifies that the CPU is in reset condition.

Architecture and Instructions of INTEL 8085 Microprocessor

Pin Diagram

- Serial Input/Output Signals
  - SID – This is the serial input data line signal. The information that is on this dateline is taken into the 7th bit of the ACC when the RIM functionality is performed.
  - SOD – This is the serial output data line signal. The ACC’s 7th bit is the output on the SOD data line when the SIIM functionality is performed.

Architecture and Instructions of INTEL 8085 Microprocessor

8085 Microprocessor Instruction Set

- The instruction set of 8085 microprocessor architecture is nothing but instruction codes used to achieve an exact task, and instruction sets are categorized into various types namely control, logical, branching, arithmetic, and data transfer instructions.

Architecture and Instructions of INTEL 8085 Microprocessor

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Addressing Modes of 8085

- The addressing modes of the 8085 microprocessors can be defined as the commands offered by these modes which are utilized for denoting the information in different forms without altering the content.
- These classified into five groups namely immediate, register, direct, indirect, and implied addressing modes.

THE END

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