ME 311: Microprocessors and Automatic Control

Microprocessor architecture
Programming fundes

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Life Skills

Why and How to deal with emotions?

- Emotions, thoughts come to you weather you like it or not. You have no control.
- If mind is caught up in emotions, no focus on studies or any other activities and they eventually drain a lot of your energy
- So need to deal with emotions to make sure focus on what we want to do is not lost

Why and How to deal with emotions?

- How to deal with?
  - First accept the situation as it is! you start resisting creating fight in mind! no use..
  - With acceptance you will get ideas to overcome intellect will have clarity
  - If you are too much bogged by negative emotions Things that will help: do physical exercise, do creative stuff (hobby), dancing (without alcohol ☺), refrain from alchohol and substance abuse if any

Today's class

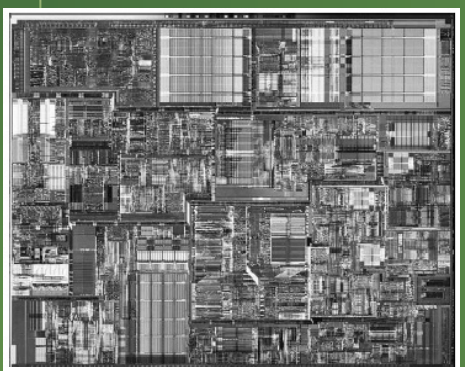
- Microprocessor History
- Architecture
- Example of 8085
- Execution of instructions

History

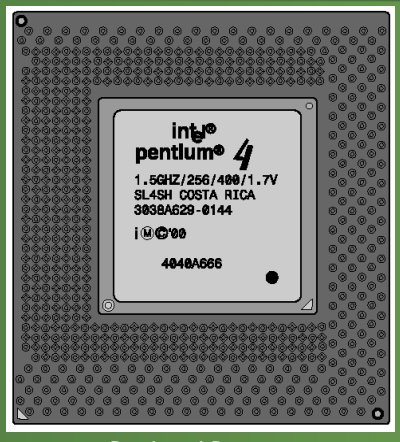
Advancement of Intel Microprocessor

Processor	Year of Introduction	Number of Transistors	Initial Clock Speed	Address Bus	Data Bus	Addressable Memory
4004	1971	2,300	108 kHz	10-bit	4-bit	640 bytes
8008	1972	3,500	200 kHz	14-bit	8-bit	16 K
8080	1974	6,000	2 MHz	16-bit	8-bit	64 K
8085	1976	6,500	5 MHz	16-bit	8-bit	64 K
8086	1978	29,000	5 MHz	20-bit	16-bit	1 M
8088	1979	29,000	5 MHz	20-bit	8-bit	1 M
80286	1982	134,000	8 MHz	24-bit	16-bit	16 M
80386	1985	275,000	16 MHz	32-bit	32-bit	4 G
80486	1989	1.2 M	25 MHz	32-bit	32-bit	4 G
Pentium	1993	3.1 M	60 MHz	32-bit	32/64-bit	4 G
Pentium Pro	1995	5.5 M	150 MHz	36-bit	32/64-bit	64 G
Pentium II	1997	8.8 M	233 MHz	36-bit	64-bit	64 G
Pentium III	1999	9.5 M	650 MHz	36-bit	64-bit	64 G
Pentium 4	2000	42 M	1.4 GHz	36-bit	64-bit	64 G

Microprocesor chip P 4



Pentium 4 die (0.18-micron process, 42 million transistors).



Pentium 4 Processor

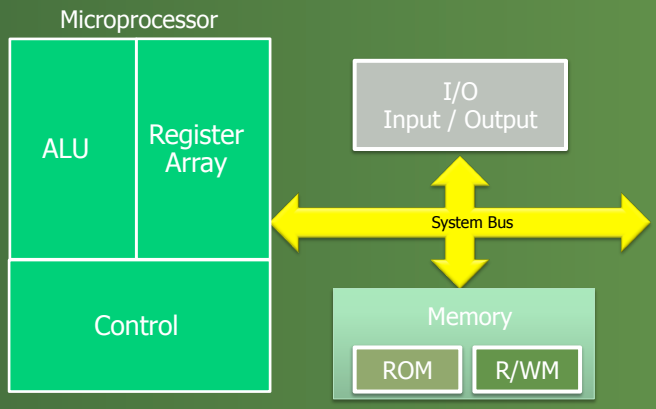
Examples of microprocessors

- 8085
- PIC16F62X (midrange, 18 pin),
- PIC18FXX20 (high level, 64 or 80 pin),
- Atmega128 (high level, 64 pin).
- Freescale XEP 100
- TI Tiva Board

A comparison of these typical processors will reveal most of the properties and capabilities of microprocessors.

Microprocessor system: basic architecture

Example 8085: simplest



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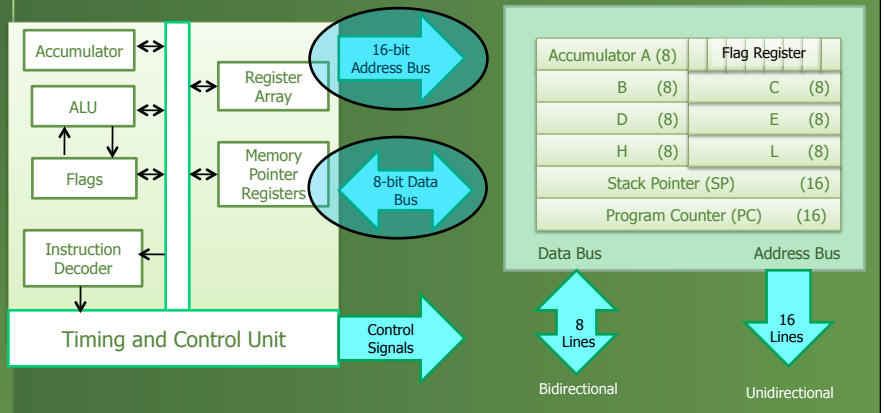
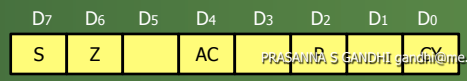
Example: 8085 mup





Flag register format

sign zero Aux carry Parity Carry

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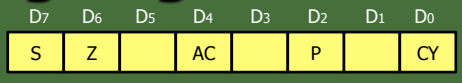
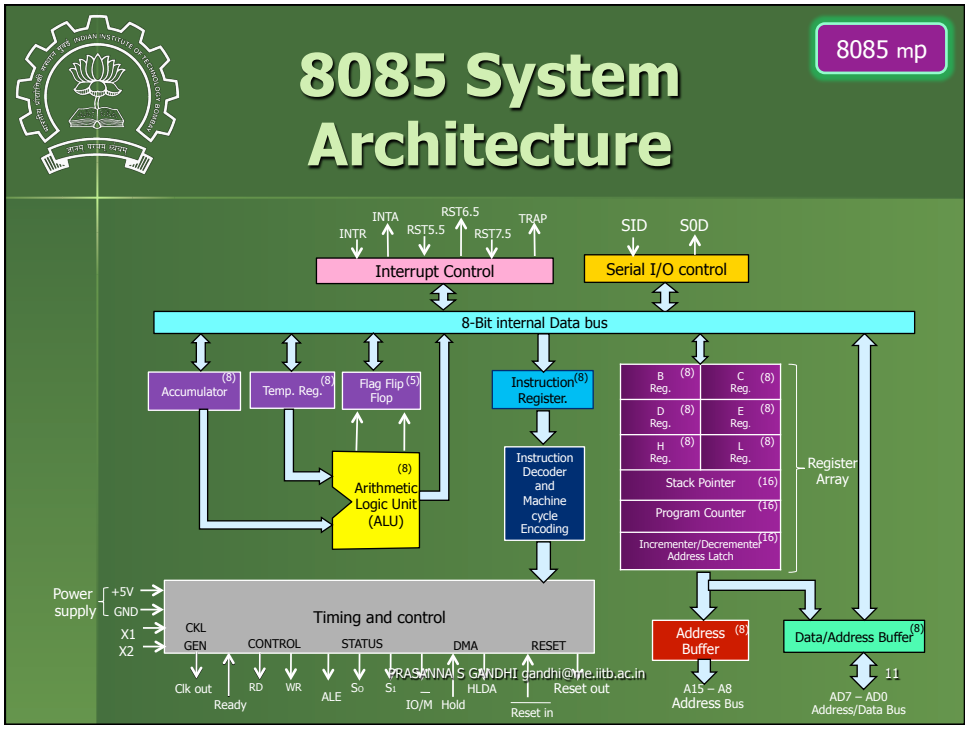
Flag Register Details



- Z- Zero: The zero flag is set to 1 when the result is zero otherwise it is reset
- CY-Carry: If an arithmetic operation results in a carry, the carry flag is set otherwise it is reset
- S-Sign: The sign flag is set if bit D7 of the result is equal to 1 otherwise it is reset
- P-Parity: If the result has an even number of ones the flag is set. For an odd number of ones, flag is reset.
- AC-Auxiliary Carry: in an arithmetic operation when carry is generated by digit D3 and is passed to digit D4, AC flag is set otherwise it is reset. This flag is used internally for BCD (Binary Coded Decimal) operation

NOTE: Operations outside ALU (such as MOV) does not affect flags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8085 System Architecture
INTA
INTR
RST6.5
RST5.5
RST7.5
TRAP
SID
SOD
Interrupt Control
Serial I/O control
8-Bit internal Data bus
Accumulator (8)
Temp. Reg. (8)
Flag Flip Flop (5)
Arithmetic Logic Unit (ALU) (8)
Instruction Register. (8)
Instruction Decoder and Machine cycle Encoding
B Reg. (8)
C Reg. (8)
D Reg. (8)
E Reg. (8)
H Reg. (8)
L Reg. (8)
Stack Pointer (16)
Program Counter (16)
Incrementer/Decrementer Address Latch (16)
Register Array
Power supply
+5V
GND
X1
X2
Timing and control
CKL GEN
CONTROL
STATUS
DMA
RESET
Clk out
Ready
RD
WR
ALE
S0
S1
IO/M
Hold
HLDA
Reset in
Reset out
Address Buffer (8)
A15 – A8
Address Bus
Data/Address Buffer (8)
11
AD7 – AD0
Address/Data Bus
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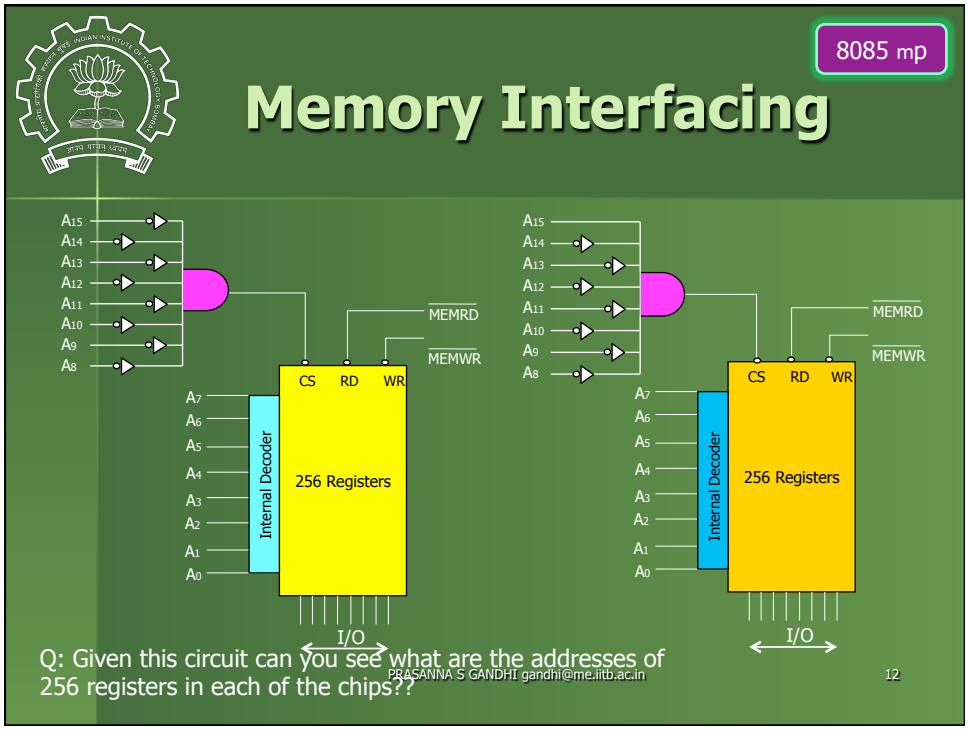
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Memory Interfacing
A15
A14
A13
A12
A11
A10
A9
A8
MEMRD
MEMWR
CS
RD
WR
A7
A6
A5
A4
A3
A2
A1
A0
Internal Decoder
256 Registers
I/O
Q: Given this circuit can you see what are the addresses of 256 registers in each of the chips??
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Example: Instruction Fetch from Memory

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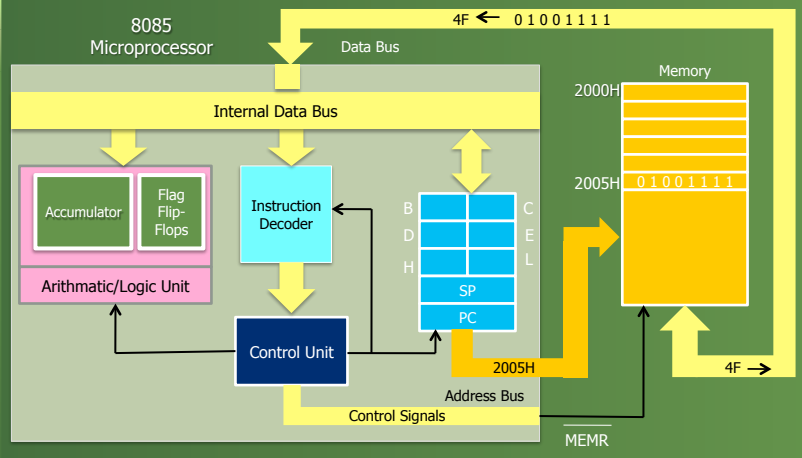

Example: Instruction Fetch from Memory

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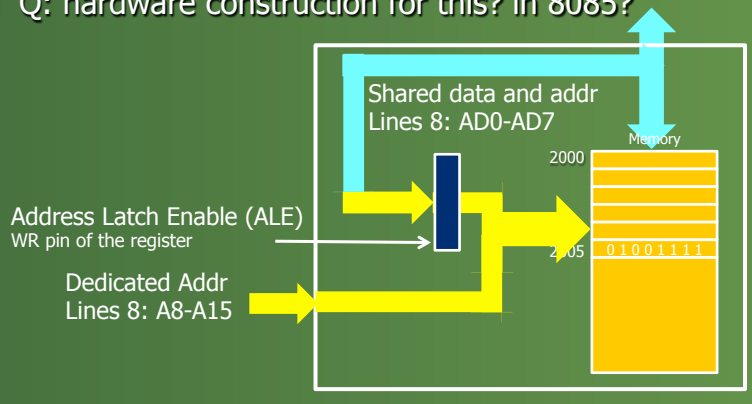
1. 16-bit address 2005H of the memory location is taken from Program counter and placed on the address bus
2. The control unit sends the Memory Read control signal (MEMR, active low) to enable the output buffer of the memory chip.
3. The instruction (4FH) stored in the memory location is placed on the data bus and transferred (copied) to the instruction decoder of the microprocessor.
4. The instruction is decoded and executed according to the binary pattern of the instruction.

Sharing of Data Lines with a Part of Address

- Data lines are 8 (bit) and address lines are 16. Idea is to allow sharing of 8 lines between data and address so that number of wires running around can be reduced
- Q : How this can be achieved? Additional signal necessary to know/control what is currently there on those shared 8 lines. What additional thing is necessary?
- VIMP: an 8 bit register to store the shared part of the current address so that when the lines turn into data mode address is not lost or mistaken

Sharing of Data Lines with a Part of Address

- Q: hardware construction for this? in 8085?



Example: Memory and instruction fetch

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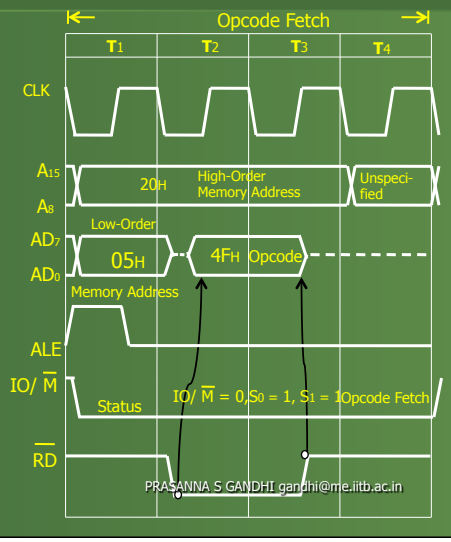

Typical Operations of microprocessor

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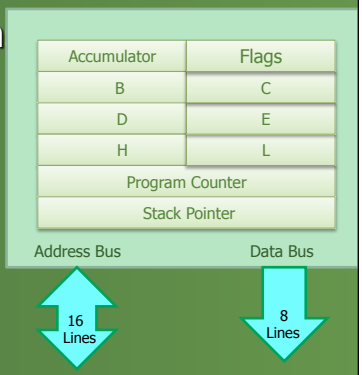
- Internal data transfer operation
- Arithmetic operations
- Logical operations
- Branching operation:
  - Microprocessor initiated
  - Externally initiated

Computing and interfacing using these operations: IMP from control perspective



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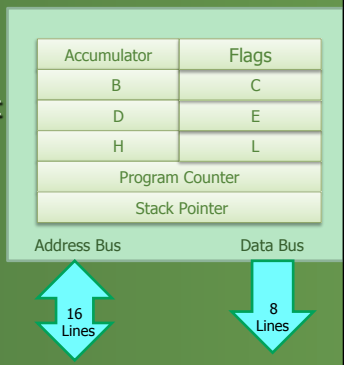
Internal data transfer

Operations of data exchange between the following registers and between registers and memory

- Registers:
  - Six general purpose registers – B, C, D, E, H, and L – used to store 8-bit data
  - can be combined to perform some 16-bit operations
- Accumulator (Register A):
  - 8-bit register used to store 8-bit data and perform arithmetic and logical operations
- Flags:
  - Five flip-flops that set or reset after an operation depending on the result of that operation



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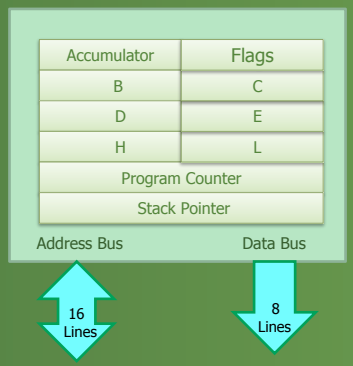
Arithmetic and logic operations

- Accumulator A is main register used for storing the result of these operations



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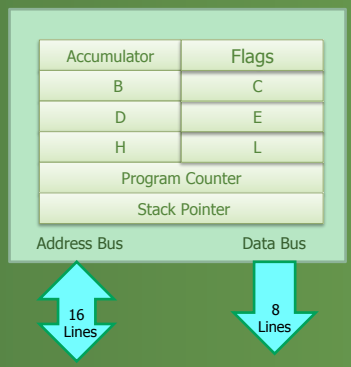
Branching operations

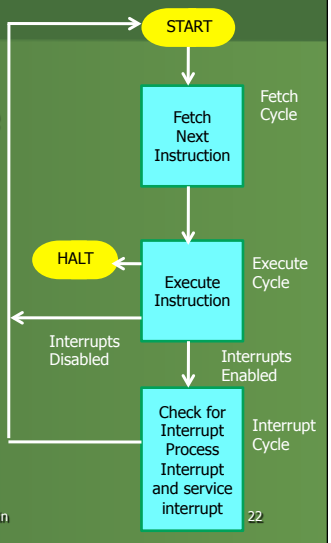
Following registers are used for sequencing and branching

- Program Counter:
  - 16-bit register
  - Holds the address of the next instruction
  - Function - sequencing the execution of the instructions
- Stack Pointer:
  - 16-bit register
  - Points to a memory location in R/W memory called STACK



Externally initiated branching

- INTERRUPT
- The microprocessor's operations are interrupted and the microprocessor executes what is called a "service routine"
- This routine "handles" the interrupt, (perform the necessary operations). Then the microprocessor returns to its previous operations and continues.
- This part is used to setup sampling time for real time control systems

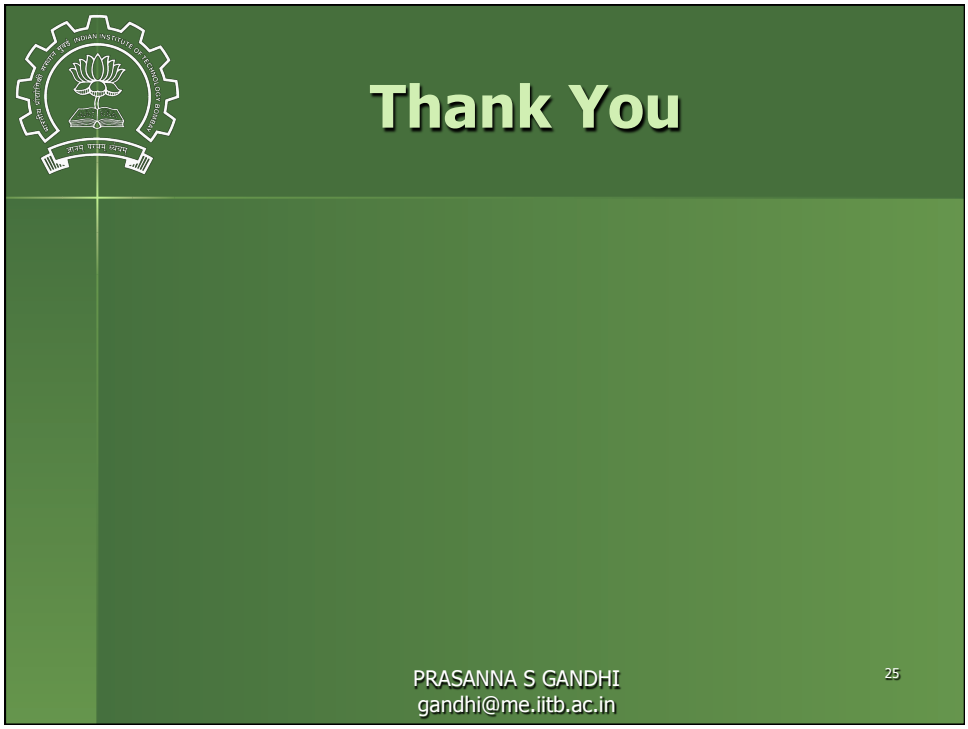


Data Sheet of 8085

- How to read through the data sheet? Example, 8085 (no internal memory)
- VIMP: Need not know each and every detail before start using. One can start with sample programs understanding them and then modifying for your purpose

Things to look for in datasheet of microcontroller?

- Interfaces provided (if any)
- Memory map (internal for most muPs)
- Data bit accuracy
- Instruction set: most modern muPs provide compilers and high level C programming can be used
- Sample programs to do some routine operations


Thank You
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