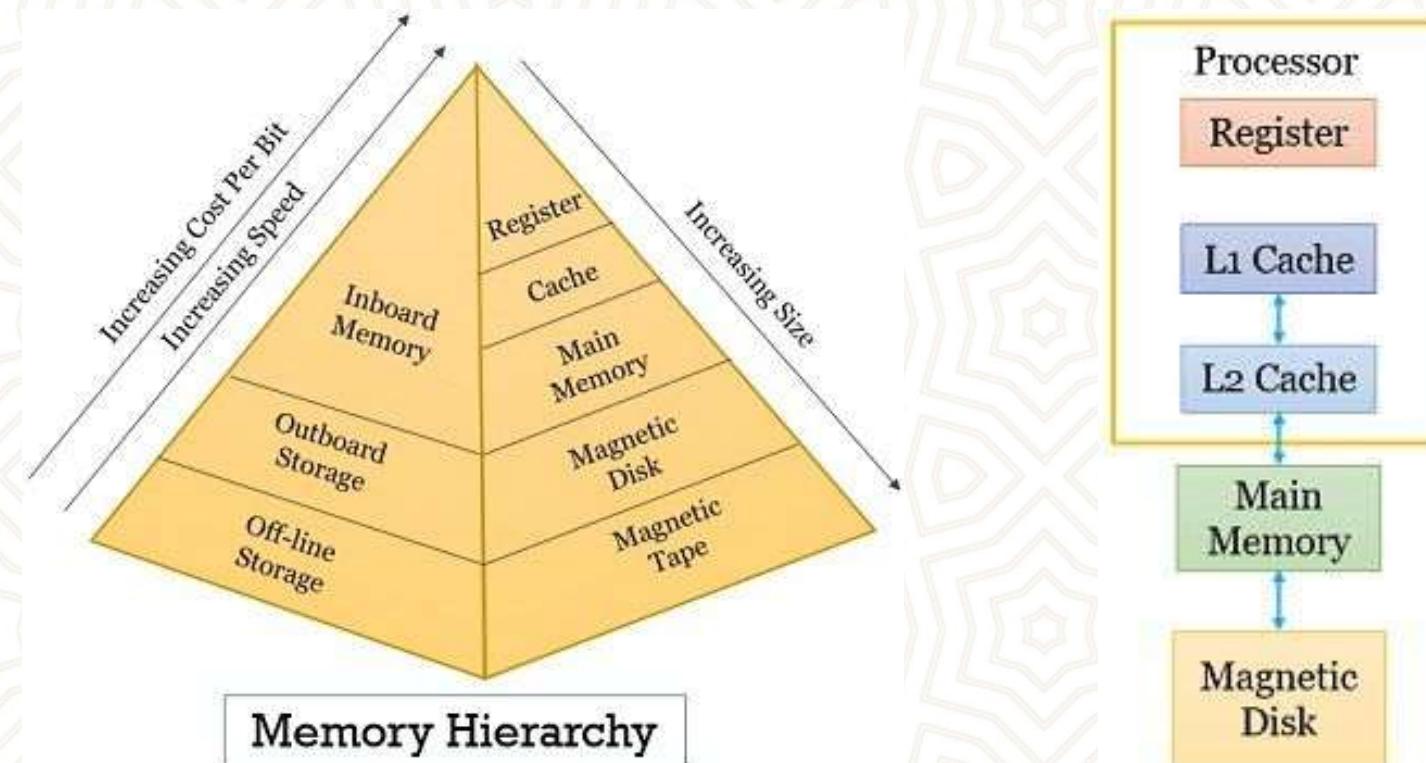


BLM1011 BİLGİSAYAR BİLİMLERİNE GİRİŞ

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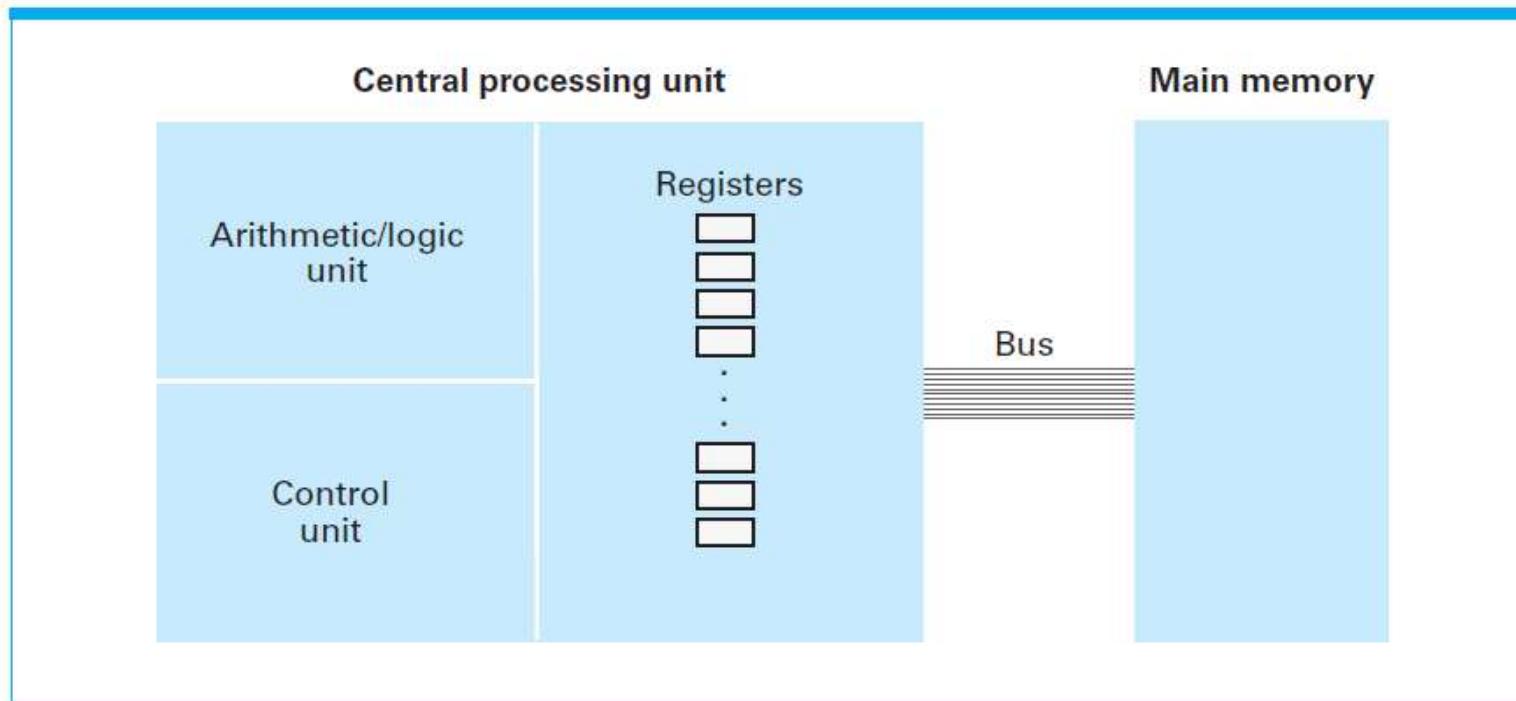


Memory Hierarchy



COMPUTER ARCHITECTURE

CPU and main memory connected via a bus



COMPUTER ARCHITECTURE

Adding values stored in memory

- Step 1. Get one of the values to be added from memory and place it in a register.
- Step 2. Get the other value to be added from memory and place it in another register.
- Step 3. Activate the addition circuitry with the registers used in Steps 1 and 2 as inputs and another register designated to hold the result.
- Step 4. Store the result in memory.
- Step 5. Stop.

TYPES OF REGISTERS

- **Program Counter (PC):** The program counter is a special-purpose register that stores the memory address of the next instruction to be fetched and executed. It keeps track of the current position in the program's execution.
- **Instruction Register (IR):** The instruction register is also a special-purpose register that holds the current instruction being executed. The CPU reads instructions from memory into the IR, decodes them, and executes them.
- **General-purpose registers** used for storing temporary data and intermediate results
- **Accumulator:** The accumulator is a general-purpose register used for various arithmetic and logic operations. It's a common location for intermediate results and is often used for storing results of operations.

CACHE MEMORY

- **Registers** are used to hold the data immediately applicable to the operation at hand.
- **Main memory** is used to hold data that will be needed in the near future
- **Mass storage** is used to hold data that will likely not be needed in the immediate future.
- Many machines are designed with an additional memory level, called **cache memory**.

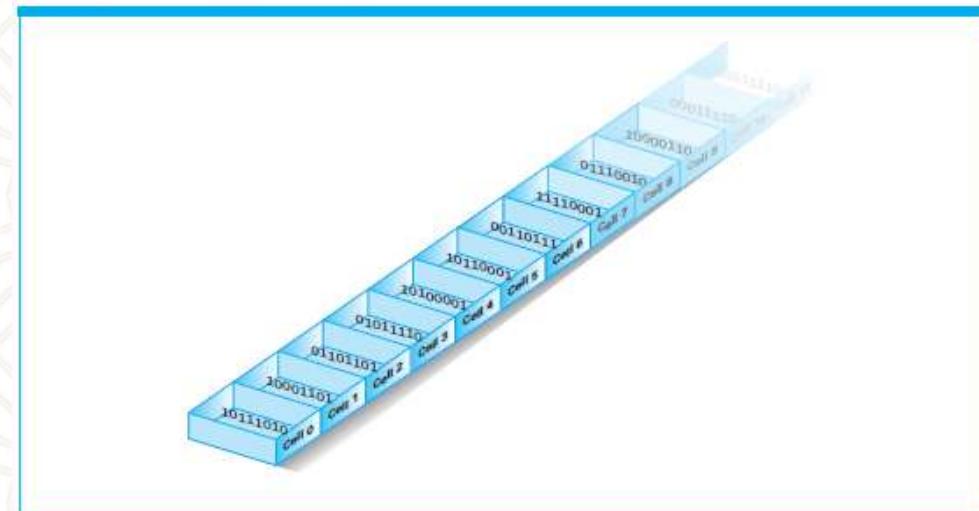
CACHE MEMORY

- **Cache memory** is a portion of high-speed memory located within the CPU itself.
- In this special memory area, the machine attempts to keep a copy of that portion of main memory that is of current interest.
- Data transfers that normally would be made between registers and main memory are made between registers and cache memory.
- Any changes made to cache memory are then transferred collectively to main memory at a more opportune time.
- The result is a CPU that can execute its machine cycle more rapidly because it is not delayed by main memory communication.

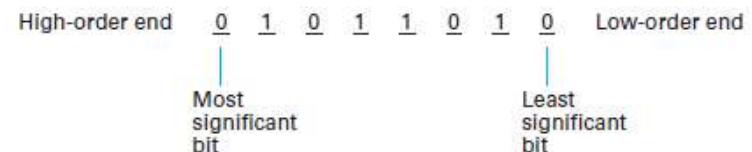
MAIN MEMORY

- For the purpose of storing data, a computer contains a large collection of circuits
- A computer's main memory is organized in manageable units called **cells**, with a typical cell size being eight bits.
- A machine with 4096 memory cells was said to have a 4KB memory ($4096 = 4 * 2^{10}$).

Memory cells arranged by address



The organization of a byte-size memory cell



MEMORY CELLS

- Suppose you want to interchange the values stored in memory cells 2 and 3.
- What is wrong with the following sequence of steps ?

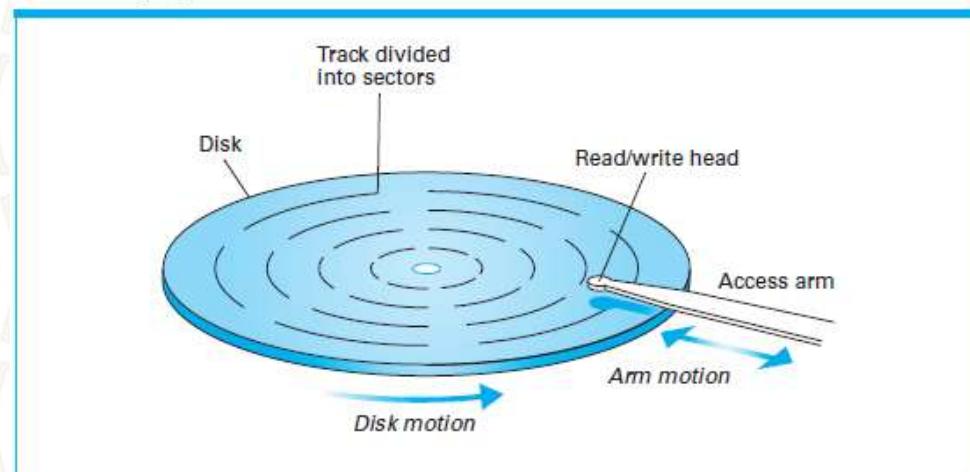
Step 1. Move the contents of cell number 2 to cell number 3.

Step 2. Move the contents of cell number 3 to cell number 2.

MASS STORAGE

- Due to the limited size of a computer's main memory, computers have additional memory devices called **mass storage** (or secondary storage)
- Magnetic disks, CDs, DVDs, magnetic tapes, flash drives..
- Require mechanical motion and therefore require significantly more time to store and retrieve data

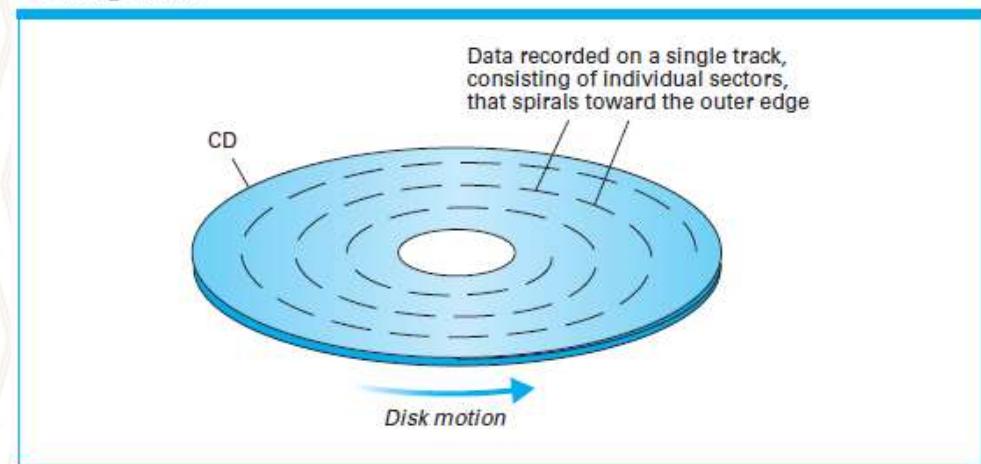
A disk storage system



OPTICAL SYSTEMS

- Exp **Compact disk (CD)**. Consist of reflective material covered with a clear protective coating.
- Information is recorded on them by creating variations in their reflective surface
- More information is stored in a loop around the outer portion of the spiral than in a loop around the inner portion.

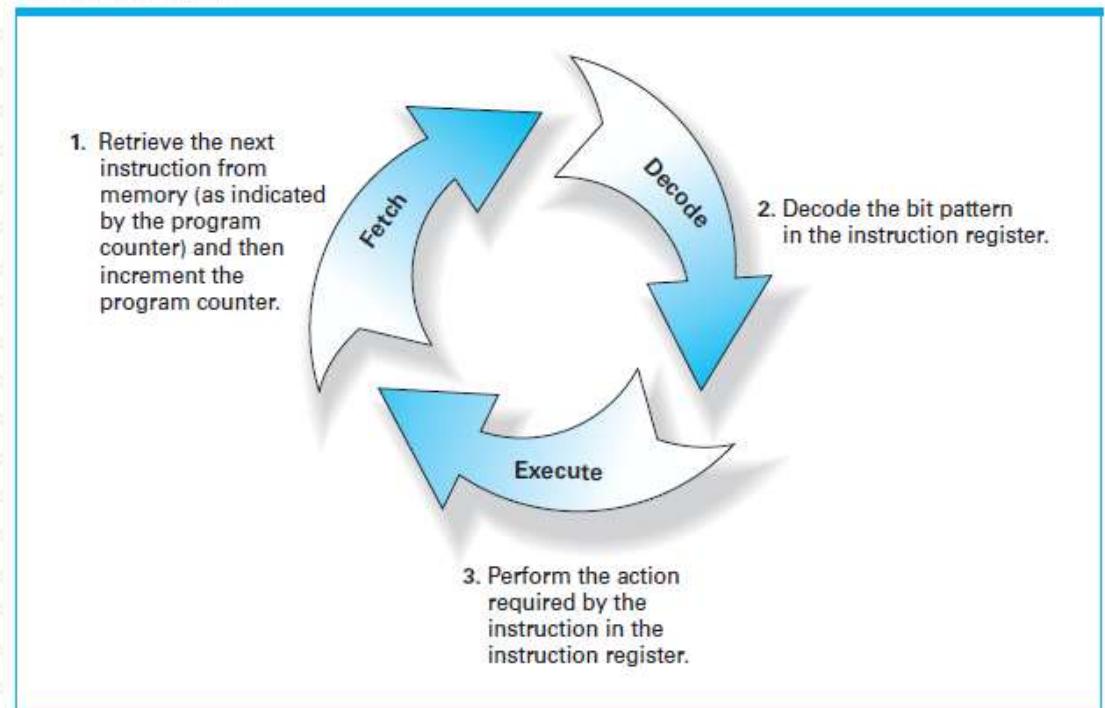
CD storage format



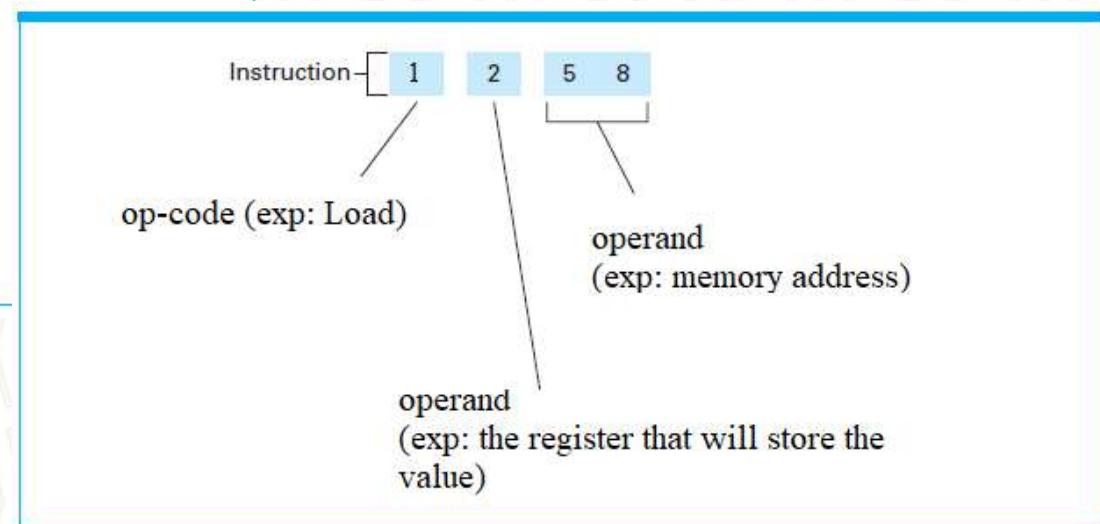
PROGRAM EXECUTION

- A computer follows a program stored in its memory by copying the instructions from memory into the CPU as needed.
- The instruction register is used to hold the instruction being executed.
- The program counter contains the address of the next instruction to be executed.
- The CPU performs its job by continually repeating an algorithm that guides it through a three-step process known as the **machine cycle**

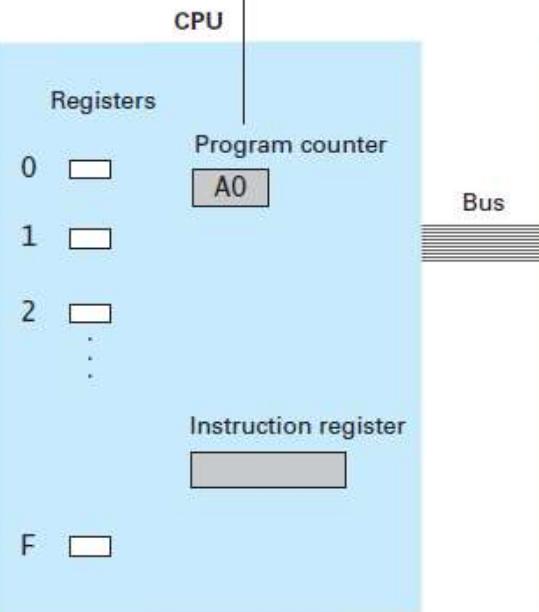
The machine cycle



Encoded instructions	Translation
156C	Load register 5 with the bit pattern found in the memory cell at address 6C.
166D	Load register 6 with the bit pattern found in the memory cell at address 6D.
5056	Add the contents of register 5 and 6 as though they were two's complement representation and leave the result in register 0.
306E	Store the contents of register 0 in the memory cell at address 6E.
C000	Halt.



Program counter contains address of first instructions.



Address	Cells
A0	15
A1	6C
A2	16
A3	6D
A4	50
A5	56
A6	30
A7	6E
A8	C0
A9	00

Program is stored in main memory beginning at address A0.

CPU

Main memory

Program counter

A0

Instruction register

156C

Bus

Address Cells

A0	15
A1	6C
A2	16
A3	6D

- a. At the beginning of the fetch step the instruction starting at address A0 is retrieved from memory and placed in the instruction register.

CPU

Main memory

Program counter

A2

Instruction register

156C

Bus

Address Cells

A0	15
A1	6C
A2	16
A3	6D

- b. Then the program counter is incremented so that it points to the next instruction.



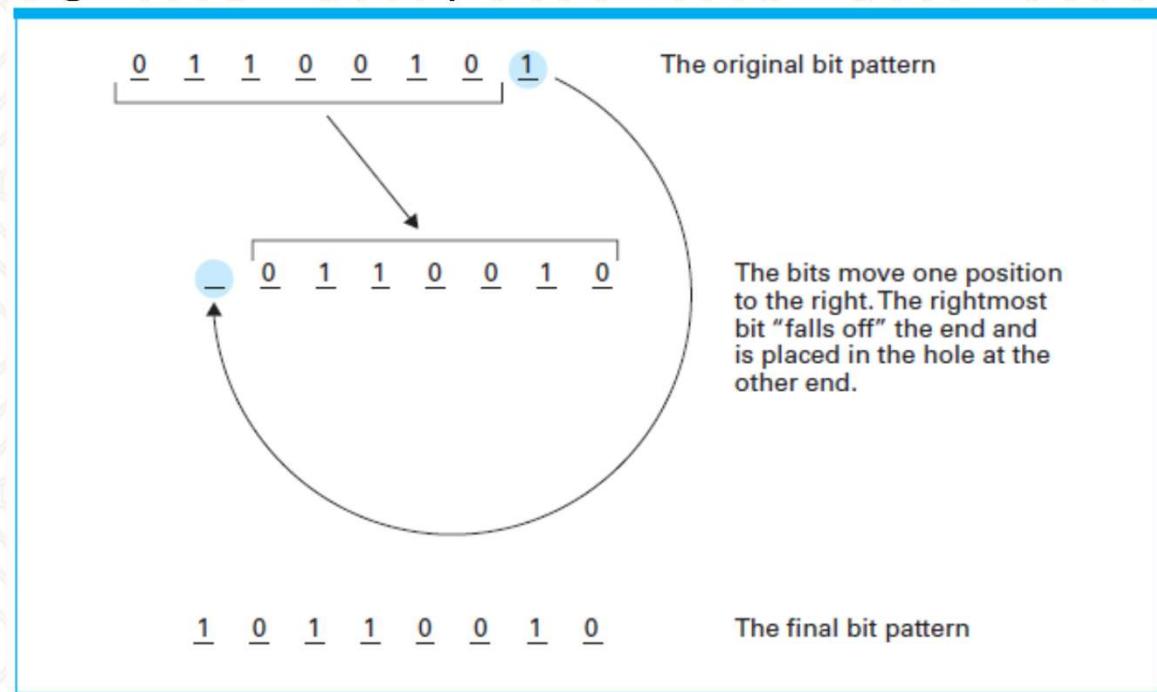
ARITHMETIC/LOGIC INSTRUCTIONS

- The arithmetic/logic group of instructions consists of instructions requesting arithmetic, logic, and shift operations

$$\begin{array}{r} 10011010 \\ \text{AND } 11001001 \\ \hline 10001000 \end{array}$$

$$\begin{array}{r} 10011010 \\ \text{OR } 11001001 \\ \hline 11011011 \end{array}$$

$$\begin{array}{r} 10011010 \\ \text{XOR } 11001001 \\ \hline 01010011 \end{array}$$



Remember

- Logical Gates
- Number Systems

ARITHMETIC/LOGIC INSTRUCTIONS

- Suppose you want to complement the four middle bits of a byte while leaving the other four bits undisturbed. What mask must you use together with what operation?
- What input bit patterns will cause the following circuit to produce an output of 1?

