CSE211

Computer Organization and Design

- *Instruction Codes*
- *Computer Registers*

Overview

- **Instruction Codes**
- **Computer Registers**
- Computer Instructions
- Timing and Control
- Instruction Cycle
- Memory Reference Instructions
- Input-Output and Interrupt
- Complete Computer Description

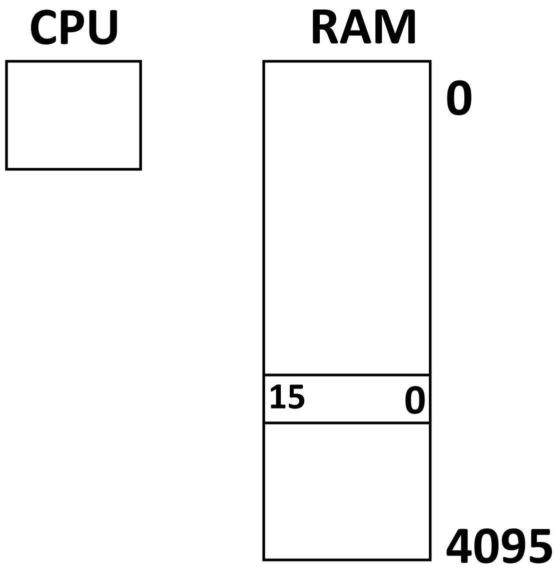
Introduction

- **Organization of computer is defined by its :**
    - **Internal Registers**
    - **Timing and Control Structure**
    - **Set of instructions that it uses**

- **Every different processor type has its own design (different registers, buses, microoperations, machine instructions, etc)**
- **Modern processor is a very complex device**
- **It contains**
    - **Many registers**
    - **Multiple arithmetic units, for both integer and floating point calculations**
    - **The ability to pipeline several consecutive instructions to speed execution**
- **However, to understand how processors work, we will start with a simplified processor model**

Basic Computer

- **The Basic Computer has two components, a processor and memory**
- **The memory has 4096 words in it**
  - **4096 = 2^{12}, so it takes 12 bits to select a word in memory**
- **Each word is 16 bits long**



How many address lines are required for a computer having a memory size of 512x8 ?

a) 8

b) 9

c)10

d)11

Instruction

- **Program**
  - **A sequence of (machine) instructions**
- **Instruction**
  - **binary code that specifies a sequence of microoperations for a computer.**
- **The instructions of a program, along with any needed data are stored in memory**
- **The CPU reads the next instruction from memory**
- **It is placed in an Instruction Register (IR)**
- **Control circuitry in control unit then translates the instruction into the sequence of microoperations necessary to implement it**

Instruction Format

- **Instruction Codes**
  - **A group of bits that tell the computer to *perform a specific operation* (a sequence of micro-operation)**
- **A computer instruction is often divided into two parts**
  - **An opcode (Operation Code) that specifies the operation for that instruction**
    - **Sometimes called as Macrooperation**
  - **An address that specifies the registers and/or locations in memory to use for that operation**

- **In the Basic Computer, the memory contains 4096 (= 2^{12}) words, we needs 12 bit to specify which memory address this instruction will use**

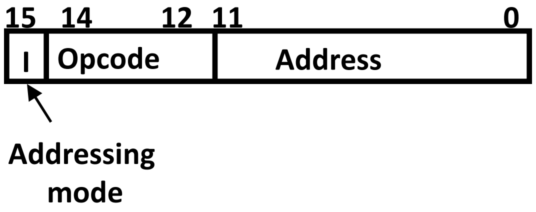
- **In the Basic Computer, bit 15 of the instruction specifies the addressing mode (0: direct addressing, 1: indirect addressing)**

- **Since the memory words, and hence the instructions, are 16 bits long, that leaves 3 bits for the instruction's opcode**

Instruction Format

- **Sometimes the address bit of instruction code represent various different information, classified into different Instruction formats :**
  - **Immediate Instruction : when second part of instruction specifies operand**
  - **When second part of address specify address :**
    - **Direct Addressing : second part of instruction specifies address of an operand**
    - **Indirect Addressing : second part of instruction designates an address of a memory in which the address of the operand is found**

Instruction Format

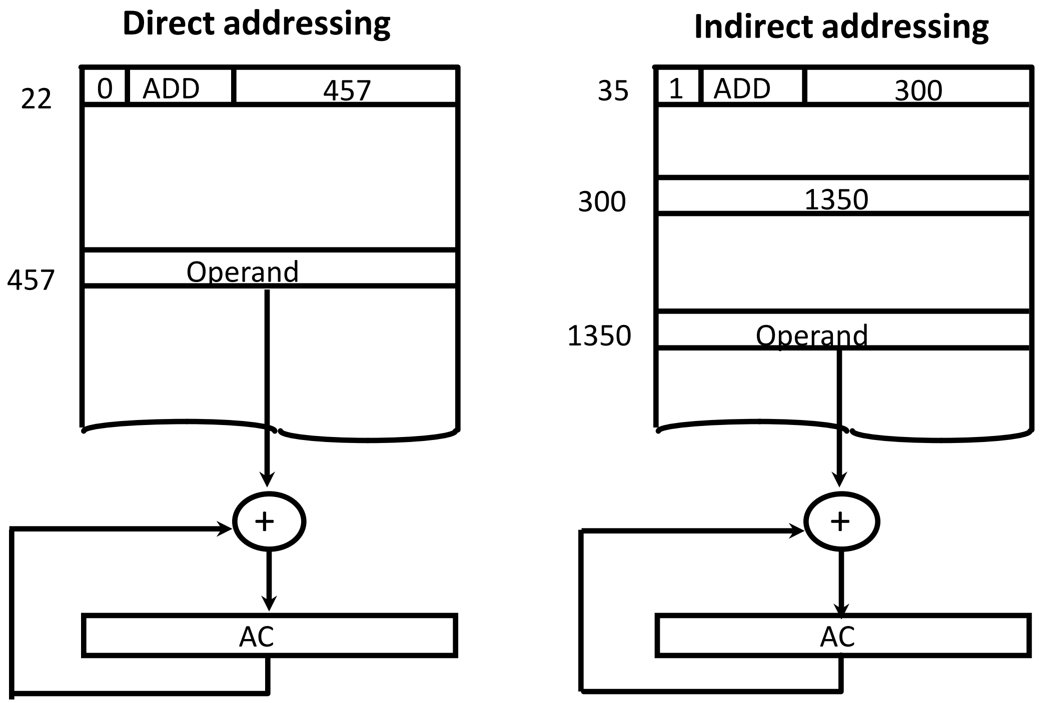


15	14 … 12	11 … 0
I	Opcode	Address

Addressing mode

Addressing Mode

- **The address field of an instruction can represent either**
  - **Direct address**
  - **Indirect address**



- **Effective Address (EA)**
  - **The address, that can be directly used without modification to access an operand for a computation-type instruction, or as the target address for a branch-type instruction**

- Which of the following register is used to store the instruction after fetching it from memory?

a) PR

b) TR

c) AR

d) IR