Basic Computer Organization and Design

➢ Description of basic Computer

➢ Instruction Format and their execution

➢ Common Bus System

➢ Instruction Cycle

➢ Hardwired Control Unit

➢ IO Configuration and IO handling
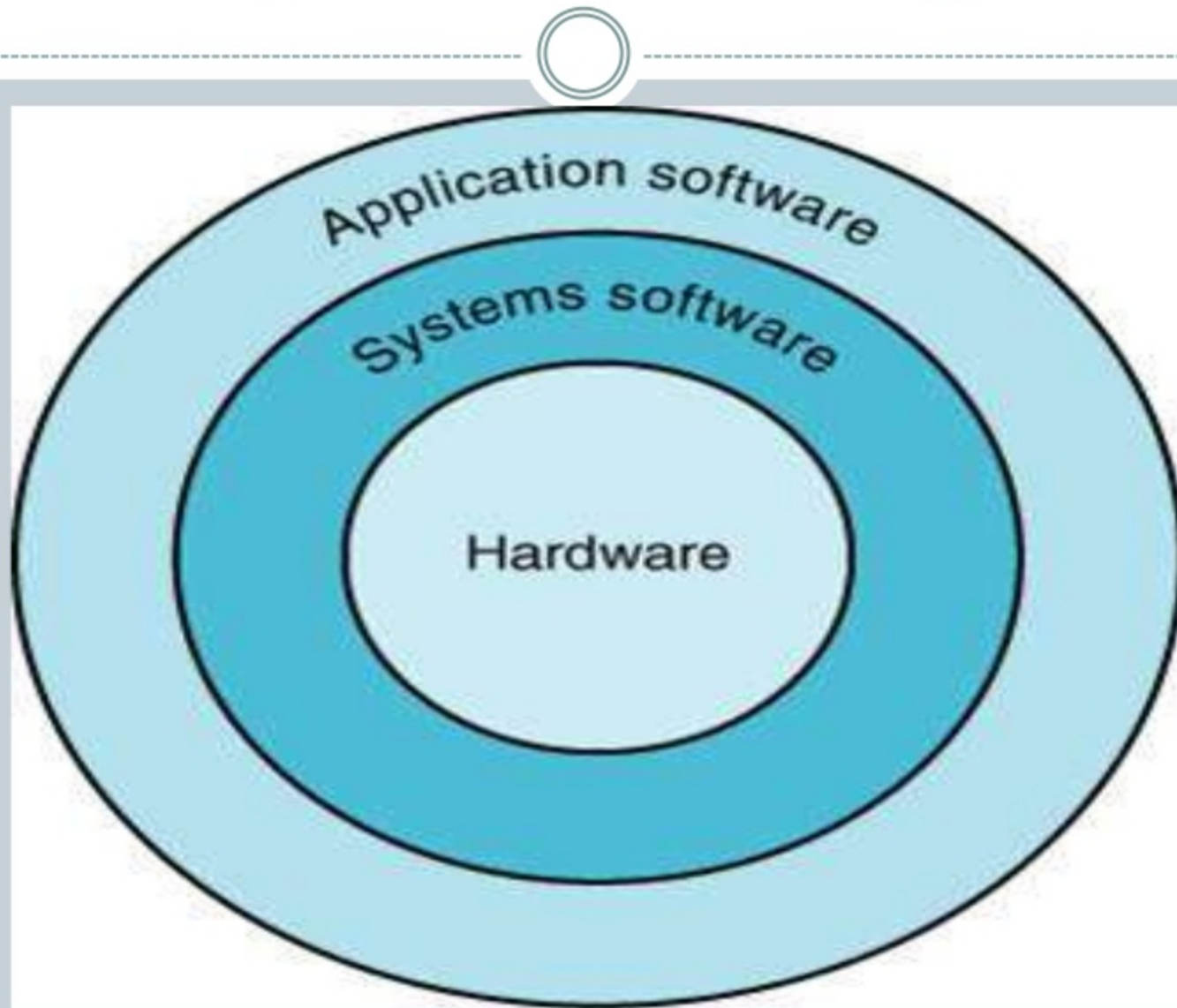
Description of basic computer

- Computers are the digital devices that performs the various computational task.

- Digital means there is the process of representing the information by the help of the certain discrete values.

- Information is represented in digital computers in terms of bits.

- By various coding techniques these groups of bits can not only represent numbers but also other discrete symbols.

Description of basic computer

- A computer system is sub-divided into two functional entities: hardware and software.

- Hardware consists of all electronics components.

- Software consists of instruction and data that the computer manipulate to perform various tasks.

Description of basic computer

Description of basic computer

- Application software is all the computer software that causes a computer to perform useful tasks beyond the running of the computer itself.

- System software is computer software designed to operate and control the computer hardware and to provide a platform for running application software.

- Computer hardware is the collection of physical elements that comprise a computer system
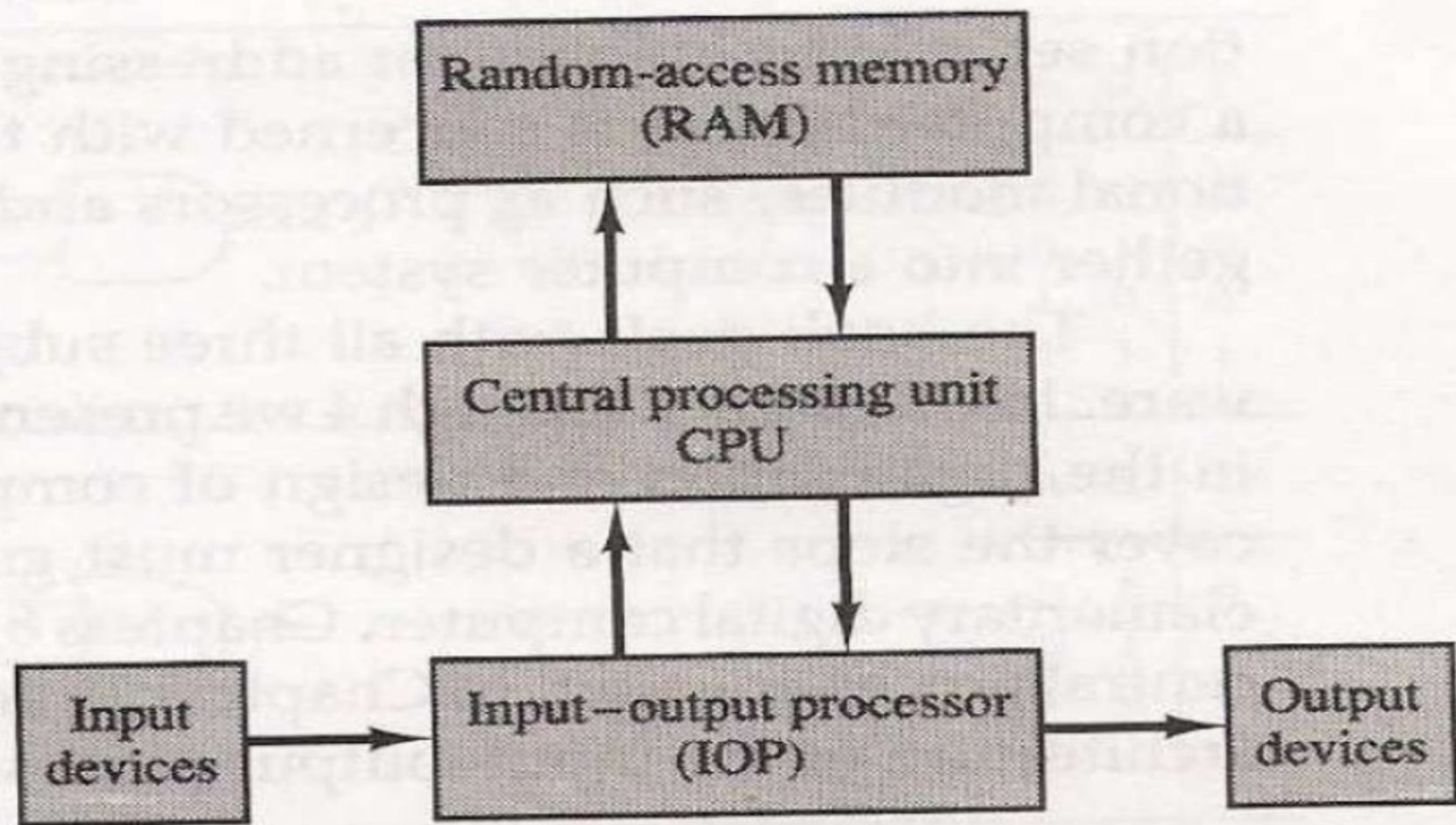
Description of basic computer

Figure ⹀   Block diagram of a digital computer.

Description of basic computer

- **Hardware consist of three major parts:**
  - CPU: It has ALU for manipulating data, registers for storing data and control circuit for generating control signals.
  - Memory: It store instruction and data.
  - I/O Processor: It contain electronic circuit for communicating and controlling information flow between computer and input or output devices.
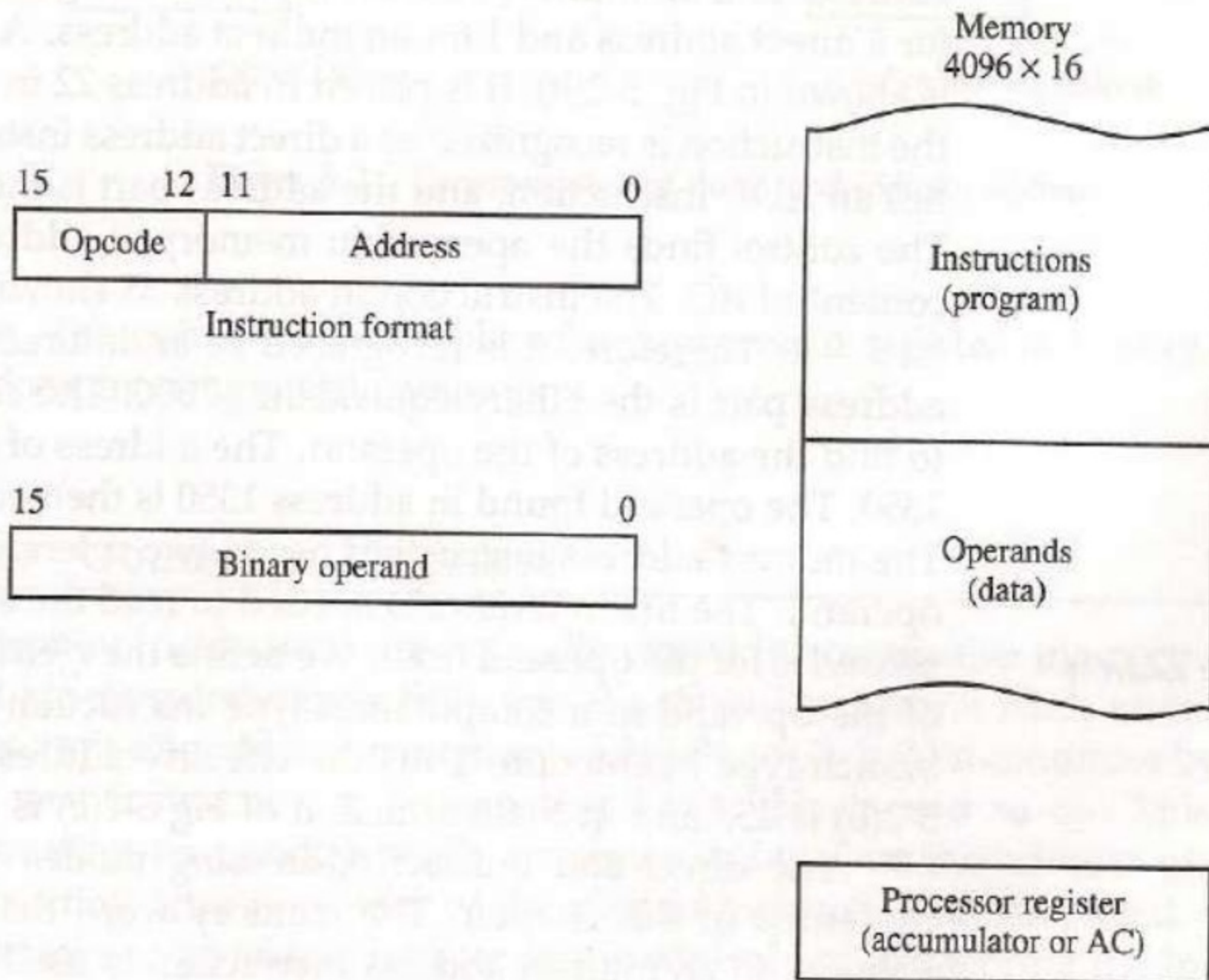
Description of basic computer

- Computer organization is concerned with the way hardware operate and the way the way they are connected together to form the computer system.

- Computer architecture is concerned with the structure and behavior of computers as seen by the user. It includes information formats, the instruction set and technique for addressing memory.

Instruction Code

- It is a group of bits that instruct the computer to perform a specific task.

- It contains various parts one of them is the opcode to specify the type of operation to be performed.

- Another field is the address field which is used to specify the operand address on which the operation is to be done.
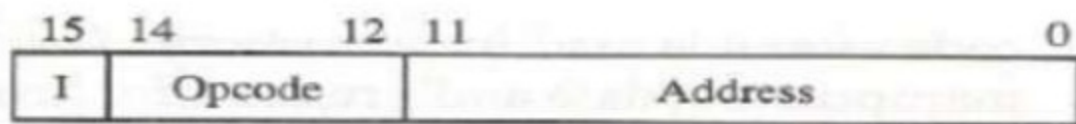
Figure   Stored program organization.

```
 15        12 11                              0
┌──────────┬────────────────────────────────┐
│  Opcode  │            Address             │
└──────────┴────────────────────────────────┘
           Instruction format
```

```
 15                                          0
┌────────────────────────────────────────────┐
│              Binary operand                 │
└────────────────────────────────────────────┘
```

Memory
4096 × 16

Instructions
(program)

Operands
(data)

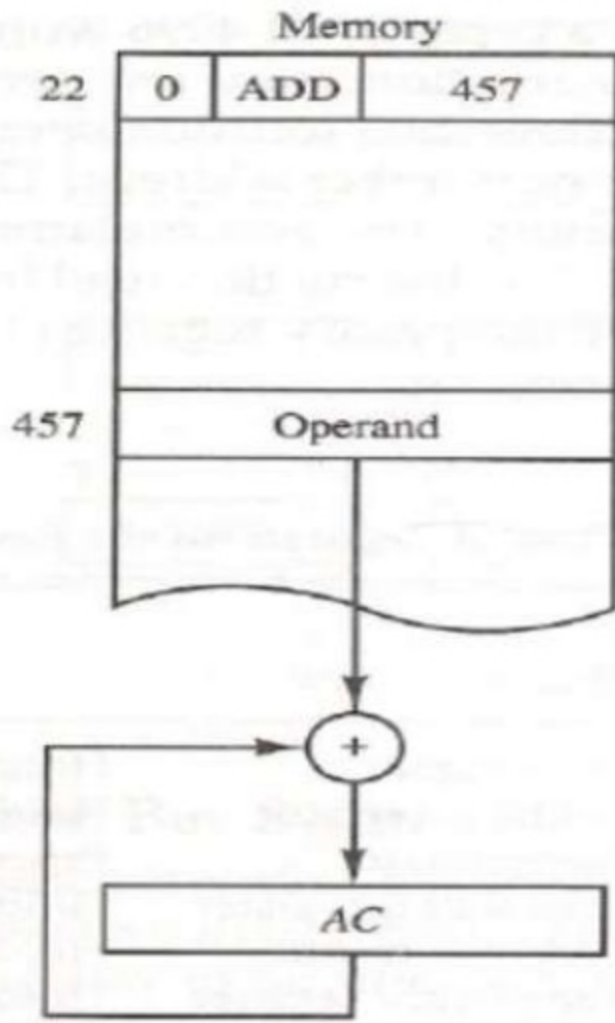Processor register
(accumulator or AC)
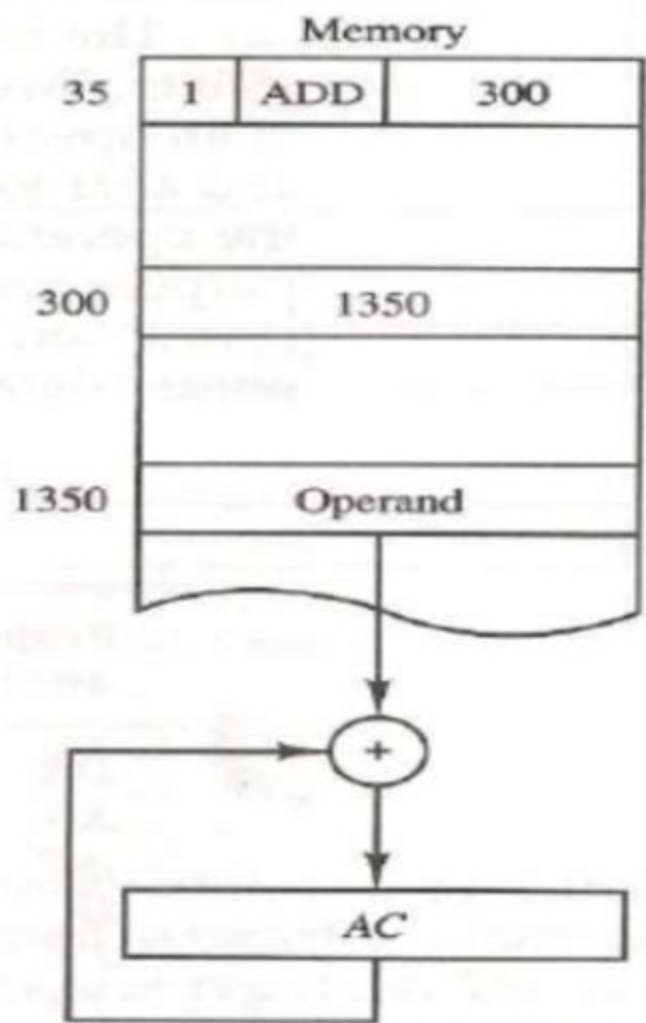
Indirect Address

- In direct address the address field in the instruction gives the address of the operand,

- In case of the indirect address, the address in the address field gives an address of the memory word in which address operand is found.

- Direct and indirect address are separated by bit I. I is 1 for indirect and 0 for direct.

	15	14	12	11	0
	I	Opcode		Address	

(a) Instruction format

Memory

22 | 0 | ADD | 457

457 | Operand

+

AC

(b) Direct address

Memory

35 | 1 | ADD | 300

300 | 1350

1350 | Operand

+

AC

(c) Indirect address

Figure   Demonstration of direct and indirect address.

Effective Address

- It is the address of the actual operand.

- In direct address, content of the address field gives the effective address which is 457 in the given example.

- In indirect address, the word in the memory address specified in the address field gives the effective address which is 1350 in the given example.
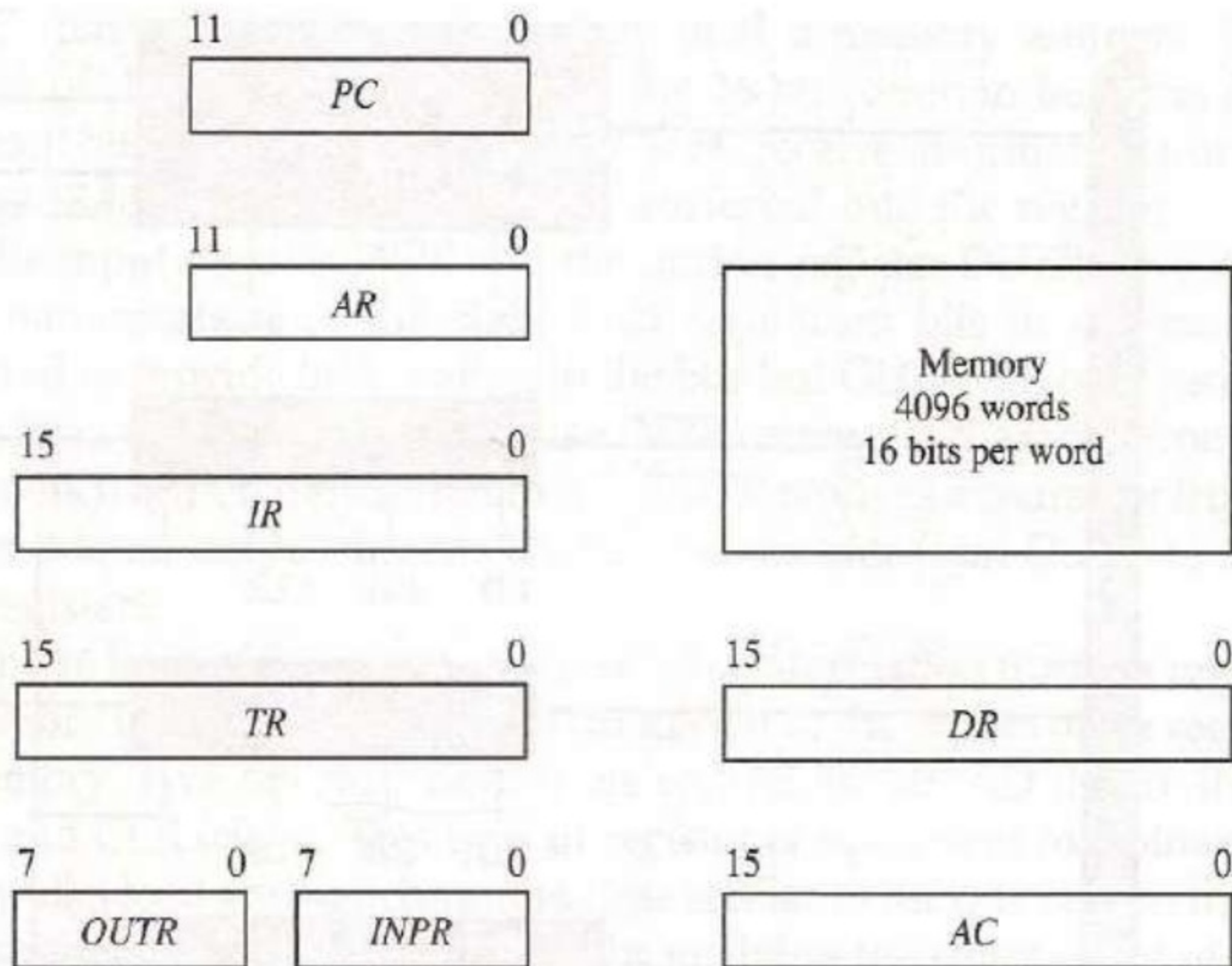
Figure   Basic computer registers and memory.

TABLE List of Registers for the Basic Computer

Register symbol	Number of bits	Register name	Function
DR	16	Data register	Holds memory operand
AR	12	Address register	Holds address for memory
AC	16	Accumulator	Processor register
IR	16	Instruction register	Holds instruction code
PC	12	Program counter	Holds address of instruction
TR	16	Temporary register	Holds temporary data
INPR	8	Input register	Holds input character
OUTR	8	Output register	Holds output character

Common Bus System

- The basic computer has eight register, memory unit and control unit.
- Path must be provided to transfer information from one register to another and from memory to the register.
- The number of wires will be excessive if the connection is made between the output of each register and input of other.
- A more efficient scheme in transferring information in a system having many register is to use a common bus.
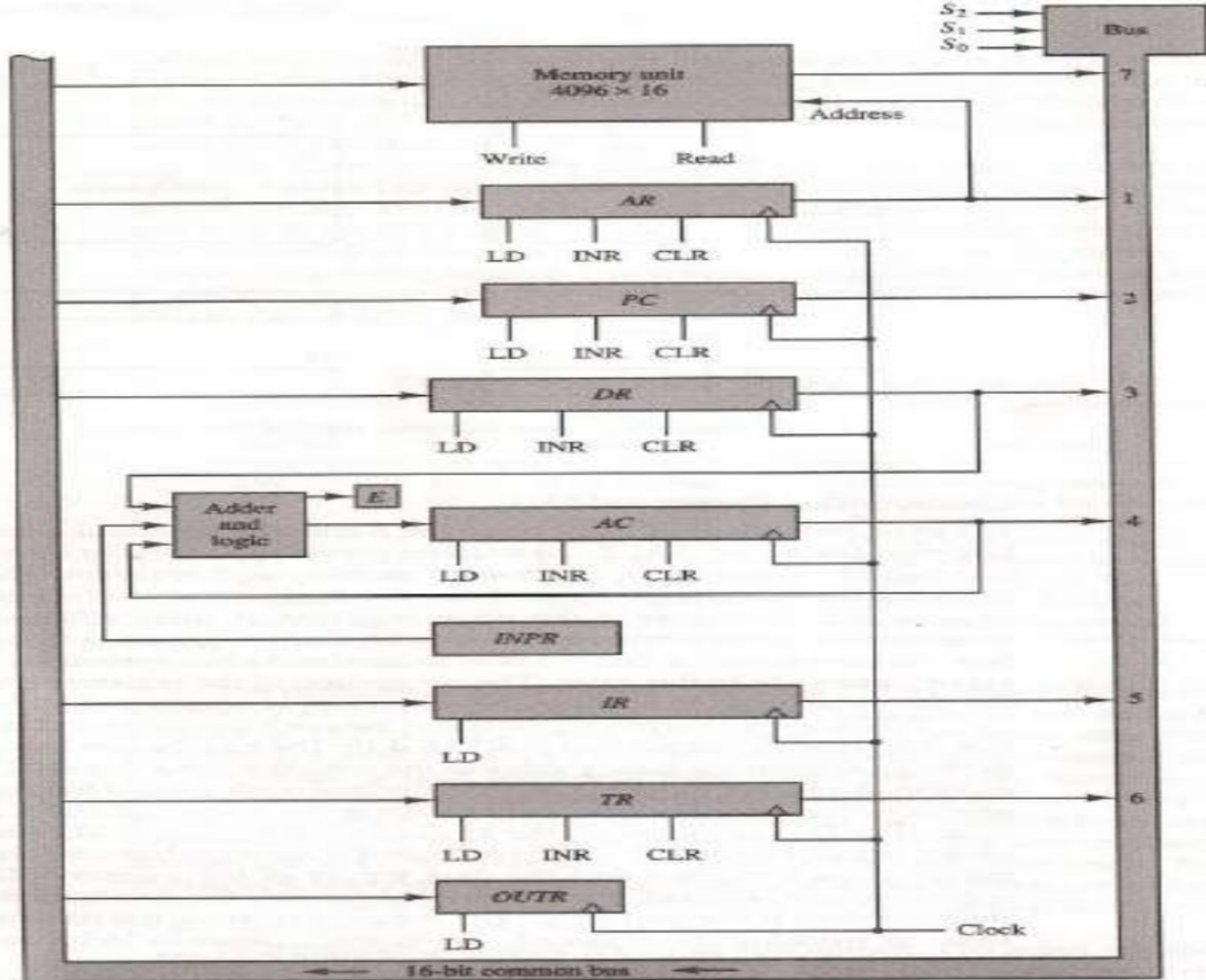
Figure 5-4 Basic computer registers connected to a common bus.

Common Bus System

- The outputs of seven registers and memory are connected to the common bus.

- The specific output that is selected for the bus lines at any given time is determined from the binary value of the selection variables S_2, S_1 and S_0.

- The numbers along each output shows the decimal equivalent of the required binary selection.

- The lines from the common bus are connected to the inputs of each register and data input of the memory.
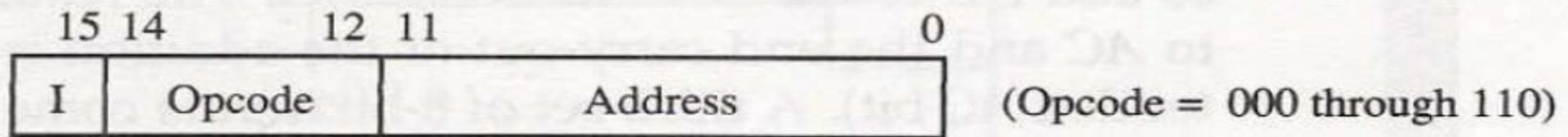
Common Bus System

- The particular register whose LD(load) input is enabled receives the data from the bus during the next clock transition.

- The memory receives the content of the bus when its write input is activated.
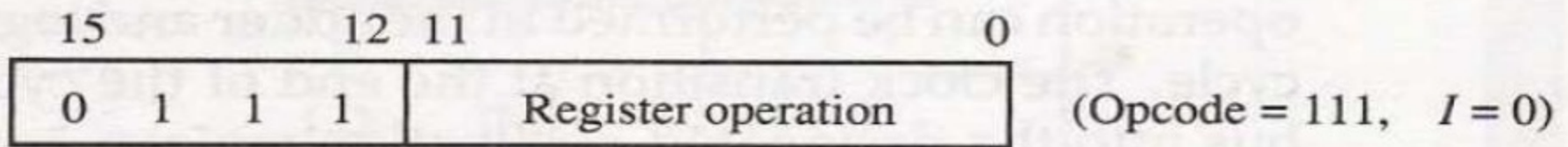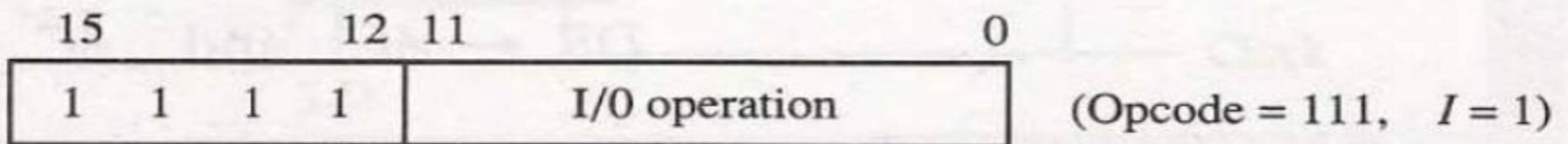
Basic Instruction Format

Figure [ ] Basic computer instruction formats.

```
 15 14        12 11                  0
┌───┬──────────┬──────────────────────┐
│ I │  Opcode  │       Address        │   (Opcode = 000 through 110)
└───┴──────────┴──────────────────────┘
```
(a) Memory – reference instruction

```
 15           12 11                  0
┌───┬──┬──┬──┬──────────────────────┐
│ 0 │ 1│ 1│ 1│  Register operation   │   (Opcode = 111,   I = 0)
└───┴──┴──┴──┴──────────────────────┘
```
(b) Register – reference instruction

```
 15           12 11                  0
┌───┬──┬──┬──┬──────────────────────┐
│ 1 │ 1│ 1│ 1│     I/0 operation     │   (Opcode = 111,   I = 1)
└───┴──┴──┴──┴──────────────────────┘
```
(c) Input – output instruction