Overview

> **Register Transfer Language**

> **Register Transfer**

> Bus and Memory Transfers

> Logic Micro-operations

> Shift Micro-operations

> Arithmetic Logic Shift Unit

Register Transfer Language

> ➢ **Combinational and sequential circuits can be used to create simple digital systems.**

> ➢ **Simple digital systems are frequently characterized in terms of**
>   > ➢ **the registers they contain, and**
>   > ➢ **the operations that are performed on data stored in them**

> ➢ **The operations executed on the data in registers are called micro-operations e.g. shift, count, clear and load**

Register Transfer Language

Internal hardware organization of a digital computer :

➢**Set of registers and their functions**

➢ **Sequence of microoperations performed on binary information stored in registers**

➢**Control signals that initiate the sequence of micro-operations (to perform the functions)**

Register Transfer Language

- ➤ **Rather than specifying a digital system in words, a specific notation is used, <u>Register Transfer Language</u>**

- ➤ **The symbolic notation used to describe the micro operation transfer among register is called a register transfer language**

- ➤ **For any function of the computer, the register transfer language can be used to describe the (sequence of) micro-operations**

- ➤ **Register transfer language**
    - ➤ **A symbolic language**
    - ➤ **A convenient tool for describing the internal organization of digital computers in concise/precise manner.**
    - ➤ **Can also be used to facilitate the design process of digital systems.**

Questions

- What is D Flip flop ? Explain it with truth table ?

Register Transfer Language

- ➤ **Registers are designated by capital letters, sometimes followed by numbers (e.g., A, R13, IR)**
- ➤ **Often the names indicate function:**
  - ➤ **MAR**   **- memory address register**
  - ➤ **PC**   **- program counter**
  - ➤ **IR**   **- instruction register**

- ➤ **Registers and their contents can be viewed and represented in *various ways***
  - ➤ **A register can be viewed as a single entity:**

MAR

- the register that holds an address for the memory unit is usually called a memory address register and is designated by the name MAR.

- A program counter (PC) is a CPU register in the computer processor which has the address of the next instruction to be executed from memory.

- Instruction Register (IR) : it contains the instruction most recently fetched or executed.

Register Transfer Language

- **Designation of a register**

    - a register
    - portion of a register
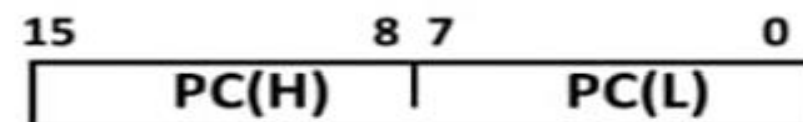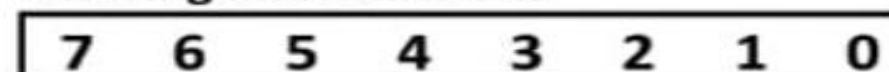   - a bit of a register

- **Common ways of drawing the block diagram of a register**

Register	
R1	

Showing individual bits	
7 6 5 4 3 2 1 0	

15	0
R2	

Numbering of bits

15	8 7	0
PC(H)	PC(L)	

Subfields

Register Transfer Language

- **Copying the contents of one register to another is a register transfer**

- **A register transfer is indicated as**

  R2 ← R1

  - ➢ **In this case the contents of register R1 are copied (loaded) into register R2**
  - ➢ **A simultaneous transfer of all bits from the source R1 to the destination register R2, during one clock pulse**
  - ➢ **Note that this is a non-destructive; i.e. the contents of R1 are not altered by copying (loading) them to R2**

Control Functions

- ➤ **Often actions need to only occur if a certain condition is true**
- ➤ **This is similar to an "if" statement in a programming language**
- ➤ **In digital systems, this is often done via a *control signal*, called a *control function***
  - ➤ **If the signal is 1, the action takes place**
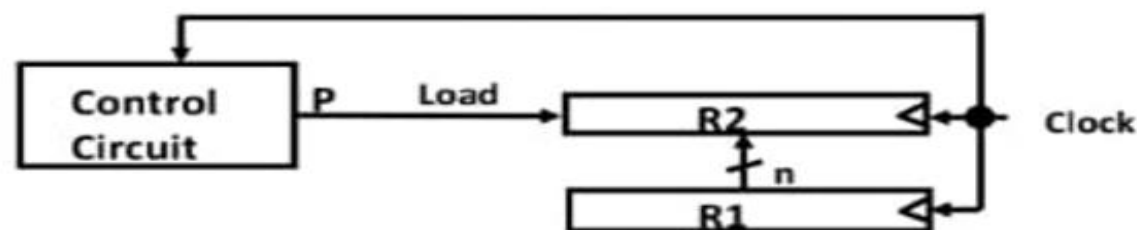- ➤ **This is represented as:**

P: R2 ← R1

Which means "if P = 1, then load the contents of register R1 into register R2", i.e., if (P = 1) then (R2 ← R1)
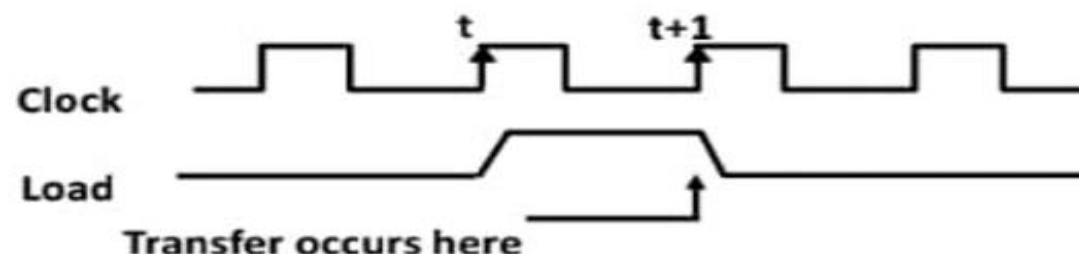
Hardware Implementation of Controlled Transfers

Implementation of controlled transfer

P: R2 ← R1

Block diagram

Control Circuit | P | Load → R2 | Clock

R1

n

Timing diagram

t   t+1

Clock

Load

Transfer occurs here

➢ **The same clock controls the circuits that generate the control function and the destination register**
➢ **Registers are assumed to use *positive-edge-triggered* flip-flops**

Basic Symbols in Register Transfer

Symbols	Description	Examples
Capital letters & Numerals	Denotes a register	MAR, R2
Parentheses ()	Denotes a part of a register	R2(0-7), R2(L)
Arrow ←	Denotes transfer of information	R2 ← R1
Colon :	Denotes termination of control function	P:
Comma ,	Separates two micro-operations	A ← B, B ← A

Questions

- What is JK Flip flop ? Explain it with truth table ?

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> ➢ **Bus and Memory Transfers**

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> ➢ Shift Micro-operations

> ➢ Arithmetic Logic Shift Unit