MODULE 3:CAD tools for Hardware & Architectural Representations/Register Transfer Notation

WEEK 3

Learning Outcomes:

After completing this course you are expected to demonstrate the following:

1. *Explain what is CAD and its importance to hardware and architectural representations*
2. *Understand Register Transfer Notation*

A. Engage

Trivia

Engineering drawings have been in use for more than 2000 years. However, the use of orthographic projections was formally introduced by the French mathematician **Gaspard Monge** in the eighteenth century.

B. Explore

Video title:OrCAD PCB Design Tutorial
YouTube Link:https://www.y2mate.com/youtube/axA8QMFSrTc
Module VideoFilename:**Week 3 – OrCAD PCB Design Tutorial**

C. Explain

What is Computer-Aided Design (CAD)?

CAD (Computer Aided Design) is the use of computer software to design and document a product's design process.

Engineering drawing entails the use of graphical symbols such as points, lines, curves, planes and shapes. Essentially, it gives detailed description about any component in a graphical form.

Uses of CAD:

1. **CAD** is used to accomplish preliminary design and layouts, design details and calculations, creating 3-D models, creating and releasing drawings, as well as interfacing with analysis, marketing, manufacturing, and end-user personnel.
2. It facilitates the manufacturing process by transferring detailed information about a product in an automated form that can be universally interpreted by trained personnel.
3. It allows the object to be viewed from any angle, even from the inside looking out. One of the main advantages of a CAD drawing is that the editing is a fast process as compared to manual method.
4. Widely used from conceptual design and layout of products to definition of manufacturing of components

5. CAD reduces design time by allowing precise simulation rather than build and test physical prototypes

Computer-Aided Design (CAD) Features and Capabilities

- 2D/3D Design
- Electrical design
- CAM integration
- Simulation and analysis,
- Augmented reality
- Data management

Computer-aided Design tools that process Hardware & Architectural representations:

1. **AutoCAD**
   AutoCAD is a CAD product from Autodesk. It allows designers to work in 2D and 3D, and has extensive online collaboration tools
2. **Archicad** is a professional building information modeling software solution complying with all digital-delivery requirements, offering an intuitive design environment, accurate building information management, open collaboration and automated documentation.
3. **OrCAD**, a proprietary software tool suite used primarily for electronic design automation. The software is used mainly by electronic design engineers and electronic technicians to create electronic schematics, perform mixed-signal simulation and electronic prints for manufacturing printed circuit boards.

D. Elaborate

Register Transfer Notation

A digital computer system exhibits an interconnection of digital modules such as registers, decoders, arithmetic elements, and Control logic.These digital modules are interconnected with some common data and control paths to form a complete digital system.

Moreover, digital modules are best defined by the registers and the operations that are performed on the data stored in them.The operations performed on the data stored in registers are called **Micro-operations**.

The internal hardware organization of a digital system is best defined by specifying:

a. The set of registers and the flow of data between them.
b. The sequence of micro-operations performed on the data which are stored in the registers.
c. The control paths that initiates the sequence of micro-operation

The **Register Transfer Language** is the symbolic representation of notations used to specify the sequence of micro-operations.

In a computer system, data transfer takes place between processor registers and memory and between processor registers and input-output systems. These data transfer can be represented by standard notations given below:

a. Notations R0, R1, R2..., and so on represent processor registers.
b. The addresses of memory locations are represented by names such as LOC, PLACE, MEM, etc.
c. Input-output registers are represented by names such as DATA IN, DATA OUT and so on.
d. The content of register or memory location is denoted by placing square brackets around the name of the register or memory location.

Register Transfer

The term **Register Transfer** refers to the availability of hardware logic circuits that can perform a given micro-operation and transfer the result of the operation to the same or another register.

Most of the standard notations used for specifying operations on various registers are stated below.

- The memory address register is designated by **MAR**.
- Program Counter **PC** holds the next instruction's address.
- Instruction Register **IR** holds the instruction being executed.
- **R1** (Processor Register).
- We can also indicate individual bits by placing them in parenthesis. For instance, PC (8-15), R2 (5), etc.
- Data Transfer from one register to another register is represented in symbolic form by means of replacement operator. For instance, the following statement denotes a transfer of the data of register R1 into register R2.

R2 ← R1

Bus and Memory Transfers

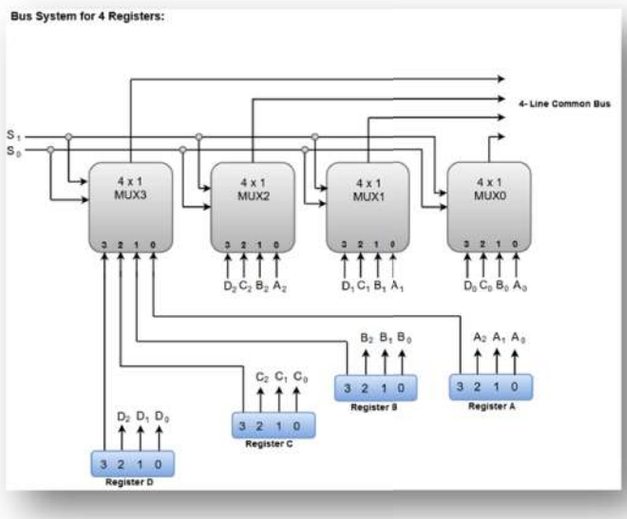
A digital system composed of many registers, and paths must be provided to transfer information from one register to another. The number of wires connecting all of the registers will be excessive if separate lines are used between each register and all other registers in the system.

A bus structure, on the other hand, is more efficient for transferring information between registers in a multi-register configuration system.

A bus consists of a set of common lines, one for each bit of register, through which binary information is transferred one at a time. Control signals determine which register is selected by the bus during a particular register transfer.

The following block diagram shows a Bus system for four registers. It is constructed with the help of four 4 * 1 Multiplexers each having four data inputs (0 through 3) and two selection inputs (S1 and S2).

We have used labels to make it more convenient for you to understand the input-output configuration of a Bus system for four registers. For instance, output 1 of register A is connected to input 0 of MUX1.



Memory Transfer

- **The transfer of information** from a memory word to the outside environment is called a read operation. The transfer of new information to be stored into the memory is called a write operation.
- **A memory word** will be symbolized by the letter M. The particular memory word among the many available is selected by the memory address during the transfer.
- **It is necessary to specify the address** of M when writing memory transfer operations. This will be done by enclosing the address in square brackets following the letter M.
- **Consider a memory unit** that receives the address from a register, called the address register, symbolized by AR.
- **The data are transferred** to another register, called the data register, symbolized by DR. The read operation can be stated as follows: Read: DR ← M[AR]
- **This causes a transfer of information** into DR from the memory word M selected by the address in AR.

- **The write operation** transfers the content of a data register to a memory word M selected by the address. Assume that the input data are in register R1 R3 ← R1 + R2 + 1. R2 is the symbol for the 1's complement of R2.
- **Adding 1 to the 1's complement** produces the 2' s complement. Adding the contents of R1 to the 2's complement of R2 is equivalent to R1 - R2.

Symbolic designation	Description
$R3 \leftarrow R1 + R2$	Contents of $R1$ plus $R2$ transferred to $R3$
$R3 \leftarrow R1 - R2$	Contents of $R1$ minus $R2$ transferred to $R3$
$R2 \leftarrow \overline{R2}$	Complement the contents of $R2$ (1's complement)
$R2 \leftarrow \overline{R2} + 1$	2's complement the contents of $R2$ (negate)
$R3 \leftarrow R1 + \overline{R2} + 1$	$R1$ plus the 2's complement of $R2$ (subtraction)
$R1 \leftarrow R1 + 1$	Increment the contents of $R1$ by one
$R1 \leftarrow R1 - 1$	Decrement the contents of $R1$ by one

Table 3.1 Arithmetic Micro-operations

- **The increment and decrement micro-operations** are symbolized by plusone and minus-one operation, respectively. These micro-operations are implemented with a combinational circuit or with a binary up-down counter.
- **The arithmetic operations** of multiply and divide are not listed in Table above. These two operations are valid arithmetic operations but are not included in the basic set of micro-operations.
- **The only place** where these operations can be considered as micro-operations is in a digital system, where they are implemented by means of a combinational circuit.
- **In such a case**, the signals that perform these operations propagate through gates, and the result of the operation can be transferred into a destination register by a clock pulse as soon as the output signal propagates through the combinational circuit
- **In most computers**, the multiplication operation is implemented with a sequence of add and shift micro-operations.
- **Division** is implemented with a sequence of subtract and shift micro-operations.
- **To specify the hardware** in such a case requires a list of statements that use the basic micro-operations of add, subtract, and shift

E. Evaluate

ASSESSMENT:

Instructions: You may write your answer on the Answer Sheet (AS) provided in this module.

CONTENT FOR ASSESSMENT:

I. **Identification**. Write your answer in the space provided before the number.

1. French Mathematician introduced the use of orthographic projections
2. Create flat one-dimensional drawings that are typically floor plans, elevations and sections
3. Create realistic presentations of what the design object will look like
4. Availability of hardware logic circuits that can perform a given micro-operation and transfer the result of the operation to the same or another register
5. Set of common lines, one for each bit of register, through which binary information is transferred one at a time
6. A digital circuit that has three gates, two of which are signals equivalent to logic 1 and 0 as in a conventional gate.
7. Operation performed on the data stored in registers
8. Operation which refers to the transfer of information from a memory to the outside environment.
9. Most commonly used three state gates in case of the bus system
10. Symbolic representation of notations used to specify the sequence of micro-operations

References:

1. *OrCAD PCB Design:* https://www.y2mate.com/youtube/axA8QMFSrTc
2.

Facilitated By:		
Name	:	
MS Teams Account (email)	:	
Smart Phone Number	:	