

CHAPTER 3 ELECTRONICS AND COMPUTER SYSTEMS

If you open or look into the interior of an electronics equipment, you will see similar equipment as shown in Figure 3.1. There is a circuit board, cables that connect the components, and various electronics components. Electronics equipment like this that build a computer equipment. Thus, understanding electronics, digital electronics and computer systems is important for you to be active in the software engineering world.

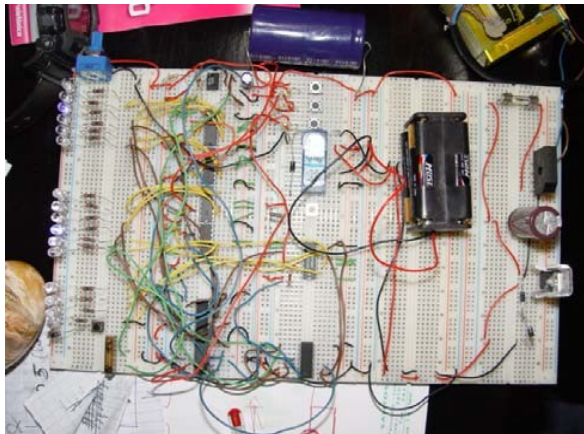


Figure 3.1. An electronics circuit

This chapter will discuss two standards of competence, those are basic electronics and digital electronics, especially that is used in a computer system. There were two basic competence in the standard of competence of basic electronics, namely, understanding principles of basic electronics and knowing electronics components. Whereas the standard of competence for the digital electronics consisted of competence in basic digital electronics and digital electronics in computers. In this book, each basic competence will be elaborated in the text. The summary will be given at the end of the chapter. Basic electronics and mathematics are the prerequisite of this topic.

THE OBJECTIVE

The chapter's objectives are:

- Mastering the concept of basic electronics.
- Knowing electronic components.
- Mastering the concept of digital electronics.
- Mastering the digital electronics and computer systems.

3.1. BASIC ELECTRONICS

3.1.1. Concept of Basic Electronics

Electronics is a knowledge that studied components / equipment that implement **weak flow of electric current** that was operated by means of controlling electron current or particle that carried an electric charge such as in computer, electronics equipment, thermocouple, semiconductor, etc. Electronics is a branch of physics, while knowledge in design and production of the electronics circuit is part of electrical engineering, computer engineering, electronics engineering and instrumentation.

Equipment that uses the electronics principles is known as electronic devices. Example of electronics devices are Cathode Ray Tube (RT), radio, television, cassette recorder, video cassette recorder (VCR), VCD player, DVD player, video camera, digital camera, desktop computer, laptop computer, Pocket Digital Assistance (PDA), robot, smart card, etc..

Electronics is based on the knowledge of electricity. **Electricity**, could be interpreted as follows:

- Electricity is state of sub-atomic particle such as, electron and proton, that caused the pulling and rejecting force among them.
- Electricity is the energy that flow through the cable. An electric current flow as electric charge flow from positive lead to negative lead.

There are two kind of electric charge: positive and negative. Through experiment, similar charge will refused each other and opposite charge is pulling each other. The amount of force between charges is defined by Coulomb law. The **Coulomb law** explain the force between two charges, that are separated by the certain distance. In the international system unit uses "C" to represent electric charge in Coulomb. The Q symbol is used to represent the quantity of electric charge. For example, "Q=0,5 C" mean the "quantity electricity charge is 0.5 coulomb".

When electricity flow through a special material, such as, wolfram and tungsten, the metal will glow light. Such materials are used in light bulb. As electricity flow through material that has resistance, it will release heat. The more the current flow, the hotter it will be. This characteristics is used in the element of iron and the electric stove.

The resistivity is equivalent to the voltage drop on the electronics component and the current pass through it. The resistivity can be formulated as follows:

$$R = V / I$$

or

$$R = \Delta V / I$$

Where V is the voltage and I is the current.

Voltage is the electric potential between two point in a circuit, and expressed in Volt. The potential energy in electric field creates electric current in a conductor. Thus, depends on the electric potential, a voltage can be categorized as extra low, low, high or extra high voltage.

Current is the amount of charge flow in certain time. Electric charge may flow through cable or other good conductor media.

$$I = \frac{Q}{t}$$

In the past, **conventionally electric flow** is define as positive charge current, although we currently know that electric current is produced by electron current that carried negative charge in an opposite directional flow. In International System (SI) unit, current is noted as **Ampere (A)**.

3.1.2. Electronics Components

- **Resistor**

Resistor is the basic electronics components used to limit the current flow into a circuit. As noted in the name, resistor is resistive and is generally made from the carbon material. The resistance unit of a resistor is Ohm and is normally designated by the symbol Ω (Omega). In general, a resistor has a tube shape with two copper tips at both end. In the resistor's body, several colored code rings are painted on its body to provide the resistance value without having to measure it using Ohmmeter.

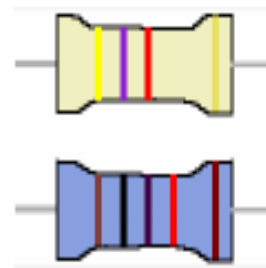


Figure 3.2 Resistor.

- **Capacitor**

A capacitor is an electronic component that keeps electric charge. A capacitor is made of two metal plates separated by a dielectric material. Some known dielectric materials are vacuum air, ceramics, glass etc. If voltage is applies to the two metal tips, one tip will be positively charged and the other negatively charged.

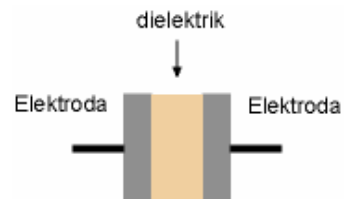


Figure 3.3. Capacitor.

- **Inductor**

An Inductor is a components that could store magnetic energy. This energy is represented by the existence of emf (electromotive force) if electricity pass through an inductor.

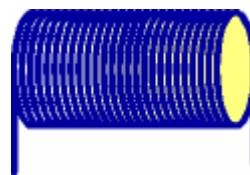


Figure 3.4 Inductor

An inductor in series to current flow will oppose fluctuation in the current pass through it. Usage in DC current will stabilize the DC voltage in fluctuate load. In AC circuit, to reduce unwanted current fluctuation. There are more inductor's application in filter, tuner circuitry etc.

3. 2. DIGITAL ELECTRONICS

3.2.1. Concept of Digital Electronics

Digital electronics is an electronics system that uses digital signal. Digital signal is a discreet signal. It is usually noted as 1 or 0. The notation 1 is a symbol of connection, while notation 0 is no connection. A simple example of this, 1 is when a switch is switched ON, and 0 is when it is OFF.

Digital electronics is an application of boolean algebra and is used in many areas such as computer, cellular telephone and other equipment. Digital electronics provides several advantages, such as, digital system can be easily controlled by computer and software, easier to store information as compared with analog information. Although, there are several disadvantages of digital system, namely, in several cases digital system needs more power, more expensive and fragile.

3.2.2. Logic Gate

Digital electronics or digital circuits build on logic gates. Logic gate execute logic operations on one or more input to provide a single output. Output is a result of a series of logic operation based on boolean algebra principles. In terms of electronics, there input or output is in the form of voltage or current depending the electronics' type.


Each logic gate needs power source with appropriate current and voltage. In the digital logic diagram, power is normally not included.


In its application, logic gate is build on blocks of electronics hardware.


These logic gates are normally made of transistors. The number of transistors highly depends on the gate's complexity. The basic form of the logic gate can be represented in truth table. There three (3) basic form of truth table, namely, AND, OR, and NOT. Shown is the truth table and the symbol of the gate.

Explanation of Figure 3.5 is as follows:

- AND, in two inputs A and B then output or signal is produced when A=1 and B=1.
- OR, in two inputs A and B then output or signal is produced when one of the input is 1.
- NOT, the output signal will be reverse of the input signal.


 AND gate	A B		F
	0	0	0
	0	1	0
	1	0	0
	1	1	1


 OR gate	A B		F
	0	0	0
	0	1	1
	1	0	1
	1	1	1


 NOT gate	A	F
	0	1
	1	0

Logic symbol Truth table

In addition to the above basic form, there several derivative form that important to know. Figure 3.6 shows the truth table and the symbol of NAND, NOR, and XOR gate. NAND is a result of NOT + AND operation, NOR is NOT + OR, whereas XOR is an exclusive OR. NAND and NOR is a logic gate largely used in many digital electronics equipments.

 NAND gate	A B		F
	0	0	1
	0	1	1
	1	0	1
	1	1	0

 NOR gate	A B		F
	0	0	1
	0	1	0
	1	0	0
	1	1	0

 XOR gate	A B		F
	0	0	0
	0	1	1
	1	0	1
	1	1	0

Logic symbol Truth table

Figure 3.6. NAND, NOR and XOR truth table and its logic gate symbol.

3.2.3. Digital Circuit

In the above section, we have studied the form of logic gate and its truth table. A digital circuit consists of one or more of these logic gates. Please see Figure 3.7, shown in the figure, the upper figure is four (4) NAND logic gate, one pin for 5V power supply, and one pin four ground. Whereas the lower figure is actual chip type 7400.

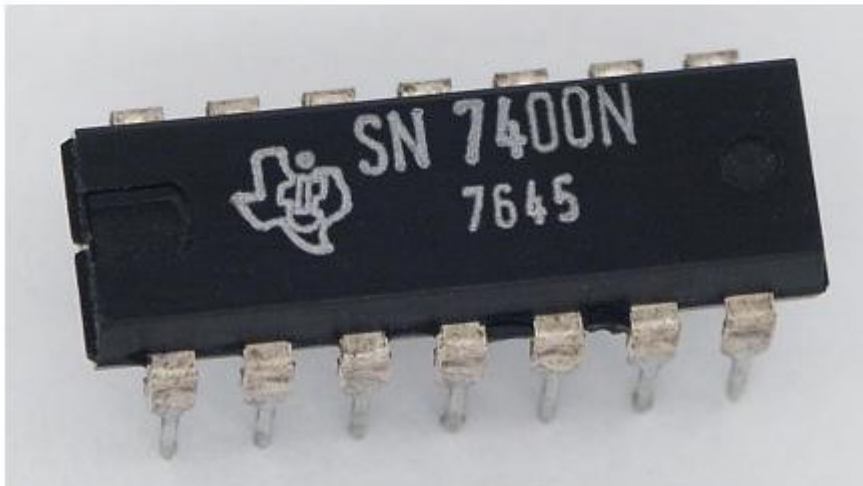
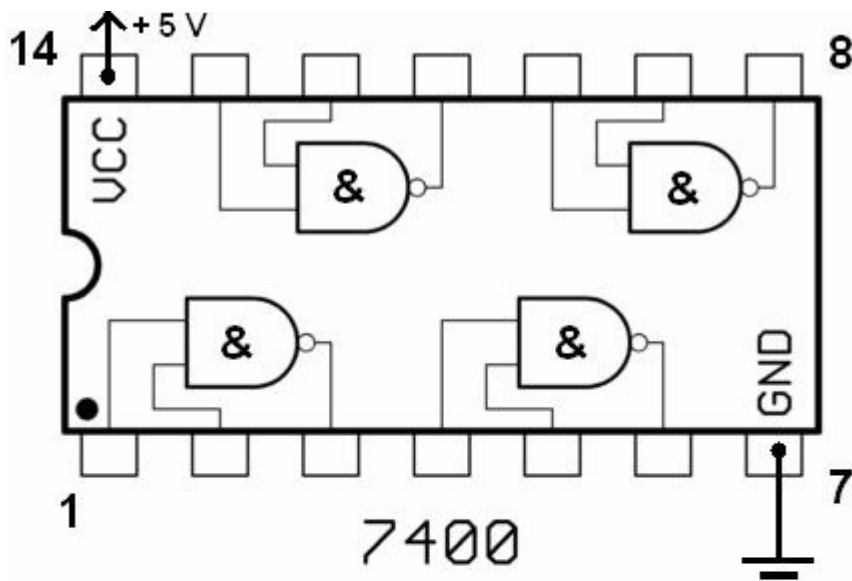


Figure 3.7. Digital circuit example and its hardware representation.

3.3. COMPUTER SYSTEM

The term computer came from Latin “Computare” means to count. Thus, any devices to do counting such as counting machine, calculator, or even abacus all technically called computer. However, in its development, computer had developed into different meaning.

Computer is an electronic data processing that worked and controlled by a set of instructions (the program) (Blissmer, 1985). A **computer system** consists of human, hardware, and software to get a useful information, to ease any job, faster process etc.

There are three (3) main component in computer system, namely, human as user, hardware and software (Figure 3.8) If one is not present then the computer will not properly perform. For example, if there is only human and hardware, computer system will not perform as no software to help human in running the hardware.

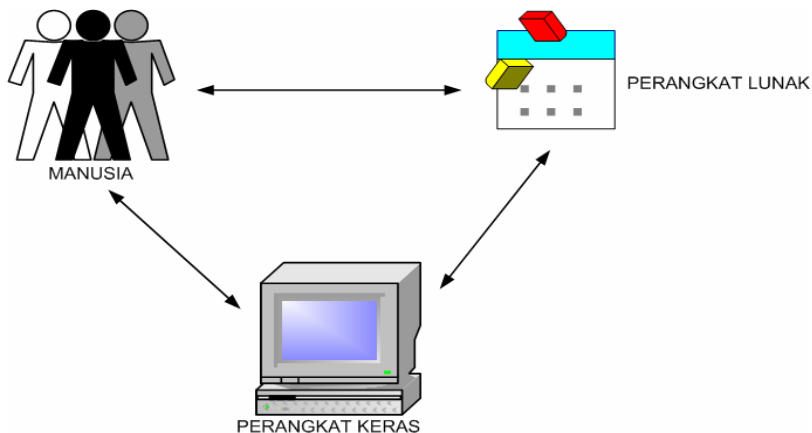


Figure 3.8. Computer System.

3.1.1 Hardware

Hardware is the physical part of computer. Hardware is distinguished from the data that is inside or that operated inside, and software that provided the instruction for the hardware to complete its task. Generally it has four (4) basic components to the computer that is mutually related (see Figure 3.9).

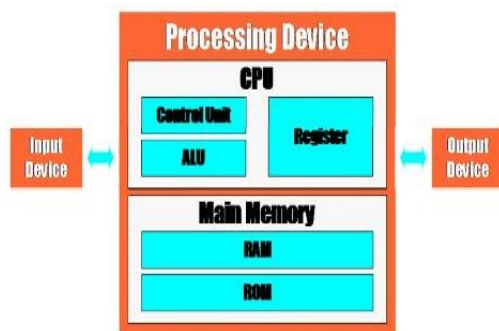


Figure 3.9. Basic Computer Components

- Input – a device that enables user to enter data or command into the computer. Input device examples including keyboard, mouse, joystick, and digitizer.
- Output – a device that provide the used on information produced by computer. The example of output devices are the monitor, printer, and plotter.
- Main memory – device that stores data, program and information produced by computer during processing. The main memory unit consisted of many cells, that each stores one information unit. There are two (2) types of main memory unit, namely, ROM (Read Only Memory) and RAM (Random Access Memory). ROM could only be written on just once and then read many times. RAM could be repeatedly write, remove and read. Data, Program, and Information that are processed is kept in RAM, and will be lost if the computer shuts down. That is the reason why data, program, and information is kept on secondary storage media such as hard the disk, diskette, CD, etc.
- Central Processing Unit – the brain of computer that process data, program, and information. There are two (2) important parts in CPU that is Arithmetic and Logical Unit (ALU) and Control Unit. Many people refer ALU as the brain of computer. ALU responsible for two (2) basic operations, namely, arithmetics operation and matching / comparisons. While Control Unit responsible for coordination activities of other unit, such as, how to recognize keyboard and work as input device.

The physical appearance of personal computer can be seen in Figure 3.10. A PC consists of many components,

1. Display
2. Motherboard
3. CPU
4. Main Memory
5. Expansion Cards
6. Power Supply
7. Optical Disk Drive.
8. Secondary Storage (Hard Disk)
9. Keyboard
10. Mouse

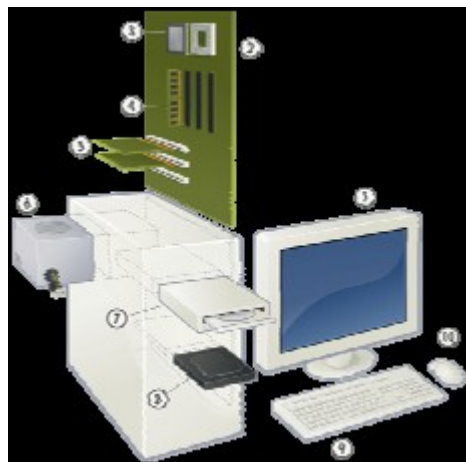


Figure 3.10. Computer Hardware.

The following is a short explanation of the computer's physical components:

1. *Display.* *Display* or *monitor* devices is the output unit of a computer. A cable connects the monitor to a video adapter installed in the *motherboard's* expansion slot. Computer sent signal to video adapter to put forward characters, picture or graphics. Video adapter will convert the signal into a collection instructions for the monitor to put forward text, or picture in its screen.



Figure 3.11. Display or monitor

2. *Motherboard.* Motherboard also as *mainboard*, *system board* or *logic board* (Apple Computer) and sometimes shortened as *mobo* is the main electronics system, such as in modern computer hardware. On this board we can put other components such as, main memory, processor, video adapter, voice adapter, etc, to form a complete computer system.



Figure 3.12. Motherboard of a computer.

3. CPU. *Central Processing Unit (CPU)*, often known as *Processor*, is a component in digital computer that interprets instructions and processes data as instructed by computer program. CPU provided the important part of digital system namely the ability to be programmed. CPU must be installed in every computer hardware.



AMD Athlon processor



Intel processor

Figure 3.13. Central Processing Unit (CPU).

4. Main Memory. Main Memory also known as Primary Storage, or Internal Memory, is the computer's memory with direct access to CPU without using any special input/output path. Main memory is used to keep the actively used data. Primary storage can be formed in several type of storage, such as, main storage, cache memory, and special registers.



Figure 3.14. Several types of main memory.

5. Expansion Cards. Expansion card is a printed circuit board (PCB) that can be inserted into motherboard's expansion slot to increase computer's functionality. The example of expansion card are video adapter, audio adapter card, network card etc.



Figure 3.15. Installation of expansion card

6. Power Supply. Power supply also known as Power Supply Unit (PSU) is the equipment to supply the required energy mainly electrical power in a computer.



Figure 3.16. Power Supply Unit.

7. Optical Disc Drive. Optical Disc is a secondary storage media with a disc like shape. Data kept in an optical disc may be accessed through the help of a laser beam onto the disc. There are two (2) major types of optical disc, namely, CD (Compact Disc) and DVD (Digital Versatile Disc). The device to read, write, or erase in an optical disc is known as Optical Disc Drive.



Figure 3.17. CD-RW Drive, an example of Optical Disc Drive.

8. **Secondary Storage (Hard Disk).** *Secondary Storage* is a device used to help the *Primary Storage (main memory)*, especially to keep data, program, or information that will be used again. Different from *primary storage*, data, program and information in *secondary storage* will not be lost even the computer is shutdown, except if it is deliberately removed. Secondary storage often used in a computer is *Hard Disk*. *Hard disk* keeps the data in a magnetic disc in certain patterns to represent the data.



Figure 3.18. Hard Disk

9. **Keyboard.** *Keyboard* is a device to type in text or character into a computer. This device also provides special control keys in computer. Figure 3.19 shows the layout of a *keyboard*.



Figure 3.19. General layout of a keyboard

10. **Mouse.** *Mouse* is usually a pointing device that can be used to detect relative movement in two dimensional plane to be display later on the screen. Mouse sometimes equip with other functions, such as, *wheel*. In addition, mouse play role in command execution through a its left / right button of either single click or double click.



Figure 3.20. Various types of mouse.

3.1.2 Software

Software is a computer program that act as a media to interact between the user and hardware, or can be view as the “interpreter” of the user command to pass it on or process by the hardware.

In a computer program, its content can be easily modified. In the computer, software is normally run on the RAM before being executed in the CPU. At the lowest level, software is in machine language specific to certain processor.

There were several software classifications. In general, software could be divided into three (3) groups, namely:

1. System Software

System Software is the software that help overlook the hardware and the computer system. The objective of **system software** is to remove the computer complexity as remote as possible from the application programmer. Thus, application programmers don't have to directly access memory and hardware in their program.



Figure 3.21. Windows XP. Operating System Picture

Example of system software are operation system, driver, diagnose software, windowing system, utilities etc. Among these softwares, operation system is the most important software. This software acts as interface between computer and the outside world. In hardware section, operation system will describe any available hardware connected to the computer. The operation system provides the driver of these hardware so as to be known and would work properly. Detailed explanation of an operating system can be seen in Chapter 4.

2. Programming Software

Programming Software provides aids or function to help programmer in creating computer program.

The software highly depends on the programming language used. The aids covers text editor, compiler, linkers, debugger etc. An Integrated Development Environment (IDE) or an integrated development environment combine these tools to ease programmer. We will focus on this in this book.

3. Application Software

Application Software is a software that used to help user in performing certain task that may not be related to computer.

There are several type of application software, such as, industrial automation software, business software, educational software, database, and computer game. Examples of these application can be seen in the following pictures.

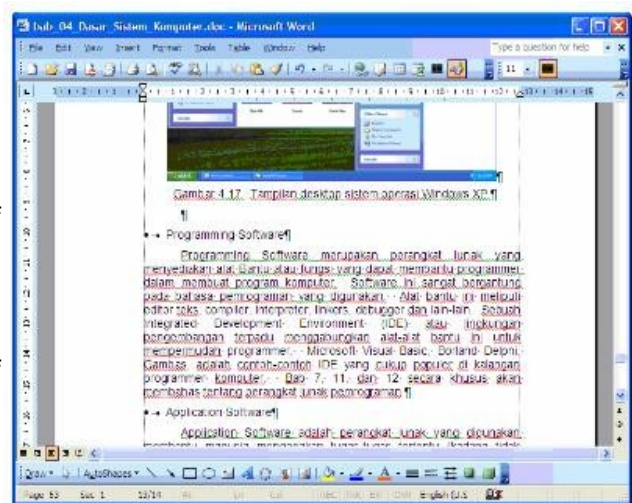


Figure 3.22. Microsoft Word (Word Processing Software)

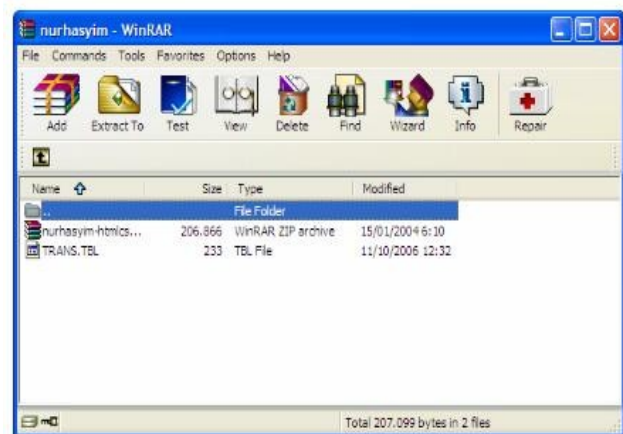


Figure 3.23. Winrar (File compression and extraction software)

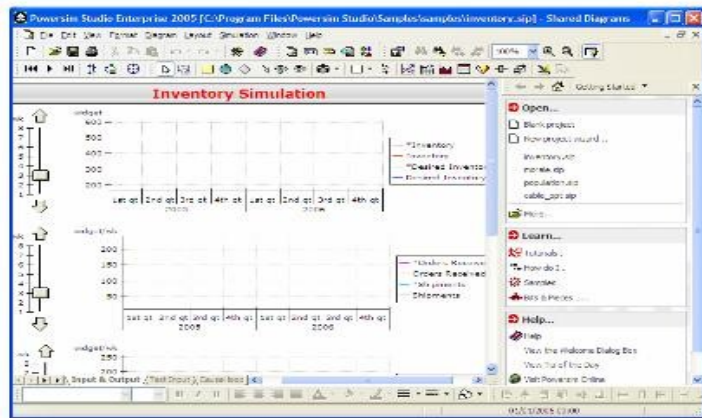


Figure 3.24. PowerSim (System simulation software).

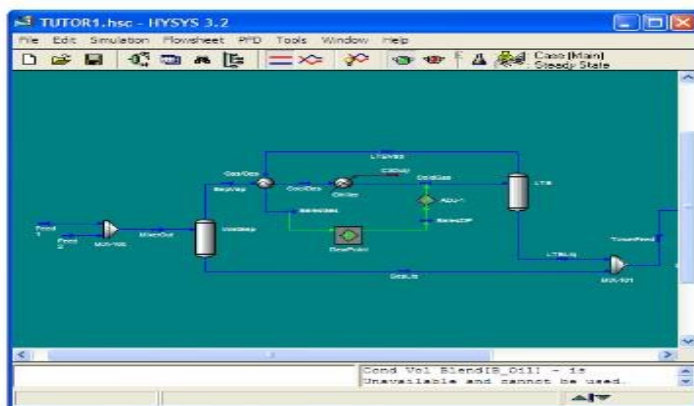


Figure 3.25. Hysis (Manufacturing design software).

3.4. SUMMARY

- Electronics is a knowledge to study low voltage devices that operated by means of controlling electron current or the particle carried an electric charge.
- Important elements in physical electronics is electric charge (Q), resistance (R), voltage (V) and current (I).
- Digital electronics is electronics systems that use digital signal and build on logic gates.
- Logic gates is the main building block from electronics hardware.
- There are three (3) basic form of truth table and logic gates, namely, AND, OR, and NOT. Moreover the main decedent from these forms are NAND, NOR, and

XOR.

- Computer is an electronics data processing tool that work and controlled by a set of instructions (the program).
- Computer system consists of human, hardware, and software that interacts with each other to get useful information, ease in working, speedup processes and other objectives.
- There are three (3) main components in computer systems, namely, human, hardware and software.

3.5. EXERCISE

1. Explain the term electronics.
2. Explain the relationship between electric charge, resistance, voltage and current.
3. Name electronic components that you know.
4. Explain digital electronics.
5. Draw symbol of various logic gates.
6. Draw an example of a digital circuit.
7. Name components in computer systems.
8. What would be happen if a computer system lack one of its components?