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Computer Fundamentals and ICT

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Computer Fundamentals and ICT

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We dedicate this book to
Our wives,
Parents, families, colleagues

But above all
Our students

Without the support of everyone mentioned above, it would have been impossible to write
this book

Preface

We welcome the readers to the very dynamic fields of Computer Science and Engineering (CSE) as well as Information and Communication Technology (ICT). ICT incorporates computers, electronic communications and the Internet as well as the various services and applications of computers and communications for numerous applications. On the other hand, Computer Science and Engineering mainly focuses on computer hardware, software and creating applications of computers.

This book is mainly based on the authors' classroom experience. Clear and friendly texts, simple and step-by-step presentations of topics aid easy comprehension of the subject matter. With all the latest information and several key pedagogical attributes, the book is an invaluable learning tool for the students of engineering, technology, natural sciences, business, social sciences, arts and humanity. The book covers basic ideas of computers, hardware, software, computer networks, information security, computer graphics, ICT and social networking.

Approach

The book, "Computer Fundamentals and ICT", covers two fundamental issues: computer fundamentals with applications, and ICT with social networking. Readers of different disciplines will learn fundamentals of computers and hardware components, fundamentals of software engineering, common application software, networking principle, elementary network security threats with protection, ICT services and applications and social networking.

Organization

The book consists of 22 chapters. Chapter 1 focuses on the basic components of a computer, its classification, applications and ICT fundamentals. Chapter 2 includes number systems and codes, and Chapter 3 covers fundamentals of digital logic, shift registers and counters. Microcomputer and its organization and architecture are included in Chapter 4 while Chapter 5 covers mostly used input and output devices. Chapter 6 covers microprocessors, arithmetic logic unit and the evolution of microprocessors. Memory and storage devices are included in Chapter 7. Introduction to software with classification, basics of programming languages, application packages are discussed in Chapter 8. System software and basics of software development are covered in Chapter 9 and 10 respectively. Chapter 11 focuses on popular word processors with their features and desktop publishing. Chapter 12 includes worksheets and working with formulas and macros. Database and database management systems are presented in Chapter 13. The presentation packages and programming language C are discussed in Chapters 14 and 15 respectively. Chapter 16 includes the basics of computer networks, and Chapter 17 covers Internet services and protocols. Chapter 18 includes Graphics and Multimedia, and Chapter 19 discusses computer and information security. Chapter 20 includes E-Commerce and E-Governance. Information systems, social networking and mobile apps are covered in Chapters 21and 22.

Instructor's Resources

Instructor's teaching material has been prepared to assist teaching with the book. This material includes power point presentations for each lesson, which are available at www.compfunds.info. The website is regularly updated with new features and contents.

Acknowledgments

Without the support of many people and web-resources, it would have been impossible to develop this book. We are grateful to the authors and publishers of the resources. We would like to acknowledge the contributions of Shamim Al Mamum, Nusrat Zenia and Fariha Afsana of Jahangirnagar University, and Syed Nazmus Sakib of Institute of Energy, University of Dhaka for reviewing some materials of the book.

Our thanks go to a number of people of Daffodil International University (DIU). We are grateful to Professor Dr. Yusuf Mahbubul Islam, Vice Chancellor, Dr. S.M. Mahbub Ul Haque Majumder, Pro-Vice Chancellor, Professor Dr. Engr. A. K. M. Fazlul Hoque, Registrar, Mr. Mohamed Emran Hossain, Director of Administration, and Dr. Md. Milan Khan, Librarian and Director of DIU Press for their help and cooperation. Special thanks are for Mr. Md. Sabur Khan, Chairman, Board of Trustees of DIU for his enthusiasm and encouragement for publication of the book from the DIU Press.

Last and most obviously not the least, is the brace of our friends and families who really supported us during the preparation of the manuscript. We are sure that they will be happy to see the published work and feel that their sacrifice is worth it. We are grateful to them.

Authors
December 2016

Authors' Biography

Professor M. Lutfar Rahman is Emeritus Professor and Former Vice Chancellor of Daffodil International University, Dhaka, Bangladesh. He was founding Vice-Chancellor of Begum Rokeya University, Rangpur, Bangladesh and founding Chairman of the Department of Computer Science and Engineering, University of Dhaka. Professor Rahman obtained MSc in Physics in Bangladesh and MSc and PhD in Electronic and Electrical Engineering in England. He has teaching and research experience in Microprocessor Applications, Computer Networks, Information Security and Bangla Language Processing. He has over 100 research papers to his credit and he authored/co-authored sixteen books on Electronics, Communications and Computer Engineering. Professor Rahman has contributions for expansion of Computer Science education and research in Bangladesh. He initiated a number of national and international conferences and worked as Editor of a number of research journals. He received awards from several national and international institutions and societies for contributions to education and research. He is member of a number of professional societies and is currently President of Bangladesh Electronics Society.

Dr. M. Shamim Kaiser received the B.Sc (Honors) and M. S degrees in Applied Physics Electronics and Communication Engineering from the University of Dhaka, Bangladesh 2002 and 2004 respectively, and the Ph.D. degree in Telecommunications from the Asian Institute of Technology (AIT) Pathumthani, Thailand, in 2010. In 2005, he joined in the Department of ETE, Daffodil International University as a Lecturer, in 2010 he worked in the Department of EEE, Eastern University of Bangladesh and the Department of MNS, BRAC University, Dhaka as Assistant Professor. Since 2011, he has been with Institute of Information Technology of Jahangirnagar University, Dhaka as Assistant Professor and became an Associate Professor in 2015. His current research interests include Multi-hop cellular network; Wireless sensor network; Cognitive radio network, Renewable Energy, Big Data Analytics and Cyber Security. He has authored more than 90 papers in different peer-reviewed journals and conferences. Dr. Kaiser is a Life Member of Bangladesh Electronic Society; Bangladesh Physical Society; Bangladesh Computer Society. He is also a member of IEEE, USA and IEICE, Japan and volunteer of IEEE Bangladesh Section.

Dr. M. Arifur Rahman is an Assistant Professor of Jahangirnagar University, Bangladesh and a researcher at ML@SITraN, University of Sheffield, UK. He pursued his Ph.D. from the Department of Computer Science, University of Sheffield. Earlier he completed his Masters in Human Language Technology and Interfaces from University of Trento, Italy and B.Sc. from the Department of Computer Science and Engineering, Jahangirnagar University. He received two gold medals; one from The President and another from the Prime Minister of Bangladesh for his outstanding performance at the undergraduate level. He is working towards Machine Learning in Computational Biology and major area of interest includes Data Science, Genomic Data Analysis and Gaussian process. He also authored a book titled "Fundamentals of Communication" and a number of international journal and conference papers. Dr. Rahman was also serving as a visiting Assistant Professor at Daffodil International University, Dhaka, Bangladesh. He is a life member of Bangladesh Electronics Society and International Society for Computational Biology.

Professor M. Alamgir Hossain received his PhD degree in 1995 from the Department of Automatic Control and Systems Engineering, University of Sheffield, UK. He is currently serving as the Director of the Anglia Ruskin IT Research Institute in Anglia Ruskin University, Cambridge, UK. Prior to this he also served in Northumbria University at Newcastle, University of Bradford, Sheffield University, Sheffield Hallam University and University of Dhaka (as Chairman of the CSE). He has extensive research experience in computational intelligence, cyber security, decision support systems, digital diagnosis, real-time and adaptive algorithm design. Prof. Hossain has led many large EU funded projects as an International lead investigator, worth over £14 million. He acted as a conference/programme chair and IPC member of over 30 international conferences. With a publication in Nature, he has published over 275 refereed research articles, contributed in 12 books, received the "F C Williams 1996" award for an IET journal and 'Best Paper Awards' for five conference papers (CSBio2010, IEEE CIS2012, SKIMA 2012, PACBB 2013 and SKIMA 2014) as an author/co-author.

Contents at a glance

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Chapter 4
Microcomputer System

Lesson 4.1
Microcomputer Fundamentals

4.1.0 Learning Objectives

On completion of this lesson, you will know

- ✓ *Main components of a microcomputer*
- ✓ *Functions and characteristics of processor, memory and I/O devices*
- ✓ *Types of programs and basic input/output system (BIOS)*
- ✓ *Personal computers, clones, servers and workstations*
- ✓ *Chronological events for the developments of microcomputers*

4.1.1 Microcomputer Components

A microcomputer is a computer in which a microprocessor is used as its central processing unit (CPU). Compared to mainframes and minicomputers, microcomputers are small in size. A microcomputer consists of five key components: microprocessor as its CPU, memory, input/output (I/O) devices, storage (secondary memory) and programs.

Figure 4.1.1 shows the basic components of a microcomputer. Before the advent of integrated circuits (ICs), components of a computer were housed on separate boards or even in separate units made up of many boards. Today, the majority of the circuits of the microcomputer are housed on a single printed circuit board called the motherboard.

The usual components on the motherboard include the main processor and its support circuits, memory, I/O interface and a bus system which enables the CPU to communicate with the other components that are not integrated with the motherboard.

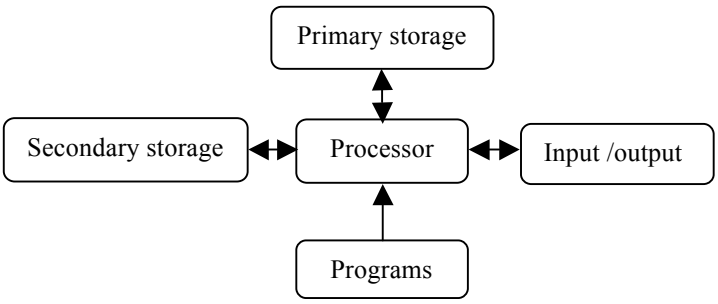

Figure 4.1.1: Basic components of a microcomputer.

The processor is the brain of the microcomputer. It executes instructions of the programs. The processor performs arithmetic and logical operations. In the microcomputer, the main processor is a microprocessor. Memory is the workspace of the microcomputer.

The size of the memory sets a practical limit of work that can be undertaken in a microcomputer. The variety of tools that can be used at any time is largely determined by the size of the memory of the microcomputer.

The input/output (I/O) refers to the communication between a microcomputer and its outside world, that is, a human, or another information processing system. The inputs are the signals or data received by the microcomputer, and outputs are the signals or data sent from it. I/O devices are used by a person (or other systems) to communicate to a computer.

A storage device is a hardware device capable of storing information. Two types of storage devices used in computers: a primary storage device such as random-access-memory (RAM) and a secondary storage device such as a hard disk drive. A hard disk drive is the computer's reference library, filing, cabinet and toolbox all in one. The computer keeps data in the secondary memory, when they are not in use in computer RAM.

The programs bring a computer in life, make it go and turn it into a powerful working tool. They tell the computer what to do, when to do and how to do.

4.1.2 Microprocessor

The microprocessor integrates the functions of the central processing unit (CPU) of a computer into one semiconductor chip or integrated circuit (IC). It has the capability of reading and writing information to the computer's memory. Both the program instructions that the processor carries out and the data on which the processor works are stored in the memory. Microprocessor processes a series of commands or instructions and communicates with outside devices, controlling most of the operation of the micro-computer.

When a micro-computer is turned on, the microprocessor gets the first instruction from the basic input/output system (BIOS) that comes with the computer as a part of its memory. After that, either the BIOS, or the operating system, or an application program drives the microprocessor giving it instructions to perform. Figure 4.1.2 and 4.1.3 show Intel 4004 and Intel Core i7 microprocessor chips respectively.

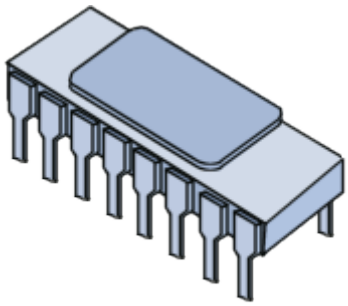

Figure 4.1.2: Intel 4004, the first general-purpose, commercial microprocessor

Figure 4.1.3: Intel Core i7 chip

4.1.3 Memory

The processor finds programs and data from memory when it does its assigned task. The microcomputer's memory is just a temporary space like a chalkboard where the computer scribbles while work is being done. Unlike human memories, computer's main memory is not a permanent repository. The computer's main memory simply provides a place where computing can happen.

The processor makes a vital distinction between programs and data. In memory, there is no difference between programs and data.

Anything can be quickly written to the memory, and the writing can be changed by writing over it. Unlike a chalkboard, the computer's memory does not have to be erased before

something new can be written on it; the act of writing automatically erases what was in the memory before. Reading information from the memory is simple and straightforward as reading anything written on paper. Both the processor and the I/O devices have the capability of reading and writing data from and to the main memory. Figure 4.1.4 shows computer memories: RAM and hard disk.

Figure 4.1.4: Computer memory: RAM and hard disk

4.1.4 Input/output (I/O) Devices

In general, the I/O devices are a bridge between a user and a microcomputer. A microcomputer gets what the user types on the keyboard, a user can see what the computer writes on the printer or displays on the screen.

The disk storage is a special category of I/O that is intended for a computer's own use. Information on a disk can be read and written only by the computer and it cannot be read and written directly by users.

The microprocessor and the main memory make up a closed world and the I/O devices open the world to the users. The computer communicates through I/O devices. These devices include keyboard, display screen, mouse, printer, floppy diskette drive, a hard disk drive, compact disk (CD) drive, digital video disc or digital versatile disc (DVD), Blu-ray disc (BD), joystick, scanner bar codes, touch screen and digital camera etc.

4.1.5 Programs

Programs tell a computer what to do. There are two different kinds of programs: system programs and application programs. The system software is designed to operate the computer hardware. It provides and maintains a platform for running application software. The most basic type of system software is: the basic input/output system (BIOS) which provides basic functionality to operate and control the hardware connected to or built into the computer. The operating system (prominent examples being Microsoft Windows,

Mac OS and Linux), allows the parts of a computer to work together by performing tasks like transferring data between memory and disks or rendering output onto a display device. It also provides a platform to run high-level system software and application software. Utility software helps to analyze, configure, optimize and maintain the computer.

The term system software is also used to designate software development tools, such as a compiler, linker, loader and debugger.

Application software, also known as an application program, is computer software designed to help the users to perform singular or multiple related tasks. It helps to solve problems in the real world. Examples of application software include enterprise software, accounting software, office suites, graphics software, media players, etc.

4.1.6 Personal Computers (PCs) and PC Clones

A personal computer (PC) is a general-purpose microcomputer whose capabilities and original sales price make it useful for individuals. It is intended to be operated directly by an end-user with no intervening computer operator. PCs include any type of computer that is used in a "personal" manner. A personal computer may be a desktop computer, a laptop, a notebook, a tablet PC, or a handheld PC (also called a palmtop).

The term “PC” generally refer to computers based on the Intel family of microprocessors and compatible with Apple Computer’s Macintosh and other non-Intel systems. This started with IBM’s original PC which is based on the Intel 8088 processor and labeled the “PC” when it reached the market in the early 1980s.

PCs sold today do not come from IBM at all. Most are designed, build and sold by a number of manufacturers who offer a wide range of PCs for business, education and home use. These machines are called PC clone because they were made to look, like an IBM PC. The name clone seems to stay with these machines, though manufacturers have moved to their own directions.

4.1.7 Servers and Disk Arrays

Servers and disk arrays are the network configurations of personal computers. Networks enable multiple computers and their users to share processing power, disk storage, printers and other peripheral devices.

Most of the computers mentioned before can function as a server or as the controller for a disk array. Personal computers are evolving in such a way that the difference between clients (or workstations) and servers are diminishing. A server is usually a high end PC having a lot of memory and several large disks for storage and is dedicated to managing network traffic,

storing common programs or data for users across the network, or directing communications via telephones or dedicated links outside the local network.

A disk array is a special kind of server that uses a large portion of its processor power simply to manage I/O for a collection of disk drivers. A regular PC may contain one or two hard drives with several gigabytes (GBs) or terabytes (TB) of storages where as a disk array may contain many times more storage space for programs and data.

4.1.8 Key points

- A microcomputer is a computer in which a microprocessor is its central processing unit (CPU).
- A microcomputer consists of five key components: microprocessor, memory, input/output (I/O) devices, storage (secondary memory) and programs
- A personal computer (PC) is a general-purpose microcomputer whose capability and price makes it affordable for individuals.
- A personal computer may be a desktop computer, a laptop, a notebook, a tablet PC, or a handheld PC.
- A disk array is a special kind of server that uses a large portion of its processor power simply to manage I/O for a collection of disk drivers.
- A disk array may contain many times more storage space for programs and data.

4.1.9 Practice Set

Multiple Choice questions

1. When a microcomputer is turned on, microprocessor gets first instructions from_____.
    a. hard disk
    b. cache
    c. keyboard
    d. BIOS
2. The microprocessor integrates the functions of the _____ into a chip or IC.
    a. CPU

b. ALU

c. Keyboard

d. RAM

3. The processor finds programs and data from _____ when it does its assigned task.

   a. ALU

   b. CPU

   c. memory

   d. Permanent program

4. I/O devices are also called

   a. Peripheral devices

   b. Electronic devices

   c. Electro-mechanical devices

   d. Memory devices

Review Questions

1. Explain basic parts of a microcomputer.
2. What is a program? Distinguish between system programs and application programs.
3. Distinguish between PC and PC clone.
4. What are I/O devices? List common I/O devices.
5. What is a disk array? Write down the main application of a disk array.

Analytical Question

1. Briefly describe the functions of the processor, memory and I/O devices of a microcomputer.
2. Write a short note on (a) microprocessor (b) memory.

Lesson 4.2
Microcomputer Organization

4.2.0 Learning Objectives

On completion of this lesson, you will know

- ✓ *The motherboard and its main components*
- ✓ *Adaptor boards and their functions*
- ✓ *Types and characteristics of SCSI adapters*
- ✓ *Other adapters used in microcomputers*

4.2.1 Motherboard and its Components

A motherboard is the main printed circuit board (PCB) in many modern micro-computers. It contains the CPU, support chips, device controllers, memory and also expansion shots and computer's internal bus. All other features and peripherals are plugged into the motherboard. The motherboard is also known as the main board or system board or logic board on Apple computers.

Figure 4.2.1 shows a typical motherboard. Some of its major components are described below.

Integrated Components: The motherboard includes some on-board components. They are integrated into its printed circuitry.

Chipset: The chipset is a collection of integrated electronic circuits. It coordinates data transfers between the various components, including the processor and memory. As the chipset is integrated into the motherboard, it is important to choose a motherboard which includes a recent chipset, in order to maximize the computer's upgradeability.

Some chipsets include a graphic or audio chip. In this case, it is not necessary to install a graphics card or sound card in the microcomputer.

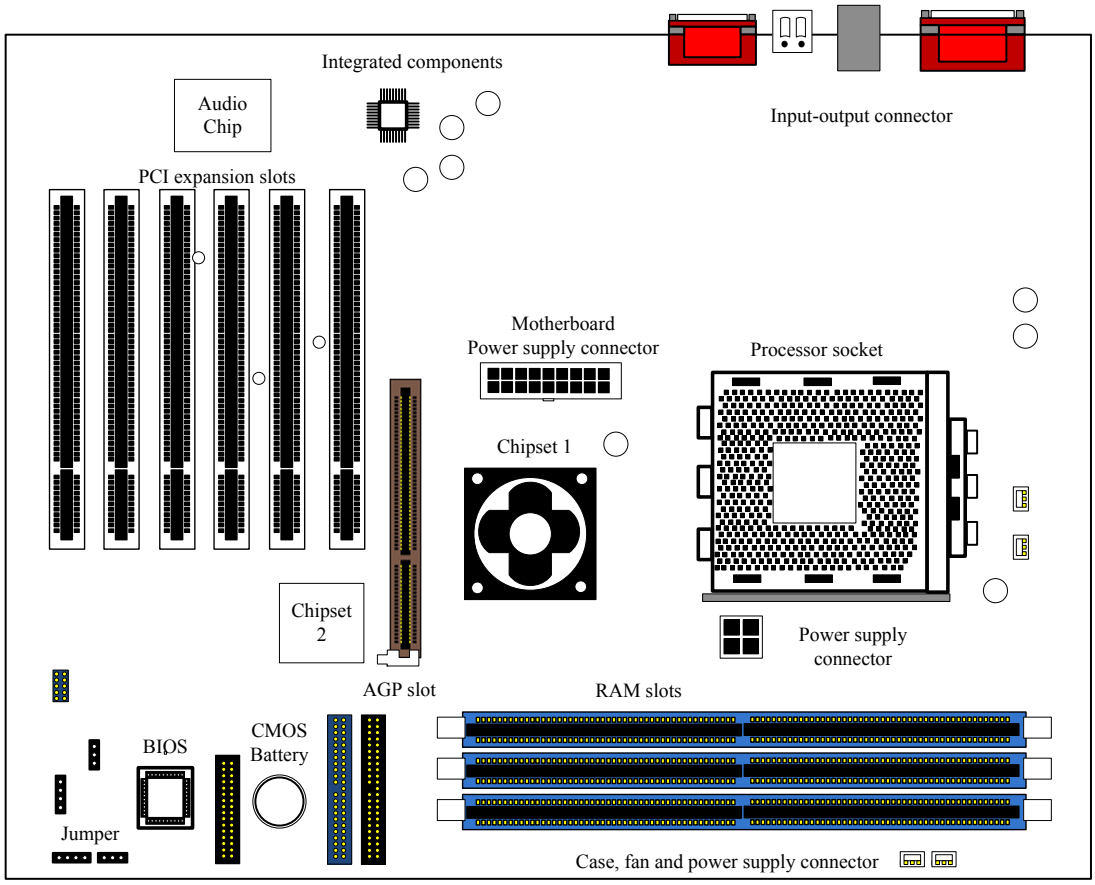

Figure 4.2.1: A typical motherboard.

BIOS: The basic input/output system (BIOS) is the basic program used as an interface between the operating system (OS) and the motherboard. A computer motherboard inevitably contains a BIOS chip in the form of an on-board PROM, EPROM or flash memory. When the computer is powered on, it performs diagnostic tests on the computer hardware devices. It searches for other BIOS's on the plug-in boards, and takes care of them. It then loads the operating system and passes control to the OS.

The BIOS can be configured using an interface called BIOS setup. It can be accessed when the computer is booting just by pressing a key (DEL/F2). In reality, the BIOS setup is only used as an interface for configuration; the data are stored in the CMOS memory.

CMOS, Clock and Battery: The real time clock (RTC) is a circuit which synchronizes system signals. When the computer is turned off, the power supply stops providing

electricity to the motherboard. The complementary metal-oxide semiconductor (CMOS) circuitry, or sometimes called the BIOS CMOS, saves some system information, such as the time, the system date, and a few essential system settings. The CMOS is kept powered by a battery, or a battery located on the motherboard. When the computer is turned on again, the system is still on the right time.

System and Expansion Buses: These are the primary buses (not shown in Figure 4.2.1) of a PC. The system bus allows the processor to communicate with the RAM. The expansion bus allows various motherboard components (USB, serial, and parallel ports, cards inserted in PCI connectors, hard drives, CD-ROM and CD-RW drives, etc.) to communicate with one another.

Recent motherboards generally include a number of onboard multimedia and networking devices such as integrated network card, integrated graphics card, integrated sound card and upgraded hard drive controllers.

Processor Socket: The processor is the computer's brain. It runs programs using a set of instructions. The processor is characterized by its frequency and the rate at which it executes instructions. This means that a 1 GHz processor carries out 1000 million operations per second. The motherboard has a slot into which the processor is inserted. This slot is called the processor socket or slot.

- **Slot:** A rectangular connector into which the processor is mounted vertically.
- **Socket:** In addition to being the general term, it also refers more specifically to a square-shaped connector with many small connectors into which the processor is directly inserted.

Modern CPUs generate a lot of heat and thus require a cooling fan or heat sink.

RAM connectors: Random Access Memory (RAM) is used to store data while the computer is running. However, the contents are wiped out as soon as the computer is switched off or restarted, as opposed to mass storage devices such as hard drives, which keep information safe even while turned off. This is why RAM is called volatile memory. RAM is extremely fast when compared to mass storage devices like hard drives. RAM comes in the form of modules which plug into motherboard connectors.

Expansion slots: Expansion slots are compartments into which expansion cards can be inserted. These are cards which give the features to the PC. There are several types of slots:

- ***ISA (Industry Standard Architecture) slot:*** These are used for inserting ISA cards. The slowest ones are 16-bit.
- ***VLB (Vesa Local Bus) slot:*** Bus formerly used for installing graphics cards.
- ***PCI slot (Peripheral Component Inter Connect):*** It is used for connecting PCI cards, which are much faster than ISA cards and run on 32 bits.
- ***AGP (Accelerated/Advanced Graphic Port) slot:*** A fast port for a graphics card.

- ***PCI Express (Peripheral Component InterConnect Express) slot:*** Faster bus architecture than AGP and PCI buses.
- ***AMR (Audio Modem Riser) slot:*** This type of slot is used for connecting mini-cards to PCs which are built for it.

Standard Computer Ports: The motherboard has same basic sets of input/output ports. Most commonly used ports are:

- **Serial Ports:** Serial port hardware usually consists of a Universal Asynchronous Receiver/Transmitter (UART). It is an asynchronous port which transmits one bit of data at a time. A DB9 serial port adheres to the RS-232 interface standard. It has 9 pins as shown in Figure 4.2.2. The connector is "D" shaped, and easy to recognize.

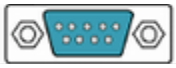

Figure 4.2.2: Serial Port

- **Parallel port:** Parallel port carries data on more than one wire, as opposed to the serial port, which uses only one wire. Parallel ports use a 25-pin female DB connector. Parallel ports are directly supported by the motherboard through a direct connection or through a dangle. A DB25 parallel port adheres to the RS-232C interface standard. It has 25 pins as shown in Figure 4.2.3. The connector is "D" shaped, and easy to recognize. DB-25 is normally used in older computers, and not much used in modern computers.

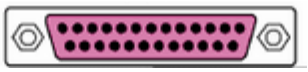

Figure 4.2.3: DB-25 parallel connector

- **USB port** (1.1, low-speed, or 2.0, high-speed): USB stands for Universal Serial Bus. It is very popular because of the features like plug-and-play, i.e., the port is automatically detected by the system. It is possible to insert and unplug a USB device without affecting the functioning of a computer.
- **RJ45 and RJ11 Connectors (Network and Modem Ports)**: RJ-45 connector is commonly used as an Ethernet networking port. Devices that normally use RJ-45 ports include NICs, hubs, switches, and routers. There are basically three types of cable connections. These are straight-through cable (e.g., PC to switch connection cable), crossover cable (e.g., PC to PC connection cable) and rollover cable (e.g., PC to console port connection of a router). The RJ-11 Connector is a 4-wire connector, commonly used with a modem.
- **VGA Connector (called SUB-D15**): It is used for connecting a monitor. This connector interfaces with the built-in graphics.

- **Audio ports:** There are typically three audio ports on modern computers. These are: the green speaker port for headphone or desktop speaker, the pink microphone port for a small microphone and the yellow speaker out for connecting home stereo system. This connector interfaces to the built-in sound card.

- **Keyboard/Mouse Controller and Ports:** A motherboard generally contains a keyboard and a mouse controller device and connection ports. The keyboard is attached to the motherboard through a serial interface cable called PS/2 Interface as shown in Figure 4.2.4. The keyboard clock and data interface signals attach to a micro-controller chip on the motherboard. This chip in turn attaches to the main microprocessor bus.

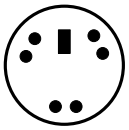

Figure 4.2.4: PS/2 Interface

- **PCM CIA Interface Cards (PC Cards):** PCMCIA stands for Personal Computer Memory Card International Association. Some of the frequently used PC Card types include LAN card; Wireless LAN card; Modem card; ATA flash disk card; IEEE 1394/Firewire; USB etc.

- **FireWire/IEEE1394:** FireWire/IEEE1394 port provides data rates up to 400 Mbps. The standard is most suitable for transferring high volumes of information including video, and voice data. Some of the important features of IEEE 1394 standard are: based on open licensing system, plug and play, digital transmission with data rates of 100, 200, or 400 mega bits per second (Mbps), compatible with lower speed USB. It also supports both asynchronous and isochronous data transfer.

- **Floppy controller:** The floppy drive connects to the computer via a 34-pin ribbon cable, which in turn connects to the motherboard. A floppy controller is used to control the floppy drive.

- **IDE controller:** This industry standard defines two common types of hard drives: EIDE and SCSI. The majority of the PCs use EIDE drives. SCSI drives show up in high end PCs such as network servers or graphical workstations. The EIDE drive connects to the hard drive via a 2-inch-wide, 40-pin ribbon cable, which in turn connects to the motherboard. An IDE controller is responsible for controlling the hard drive.

4.2.2 Adapter Boards

An adapter board is a PCB that plugs into an expansion bus slots to provide added capabilities. The common adapters for the microcomputer include display adapters, memory expansion adapters, input-output adapters and adapters for the other devices such as internal modems, CD-COMs or network interface cards. One adapter can often support different devices. For example, an input-output adapter may support one parallel port, a game or joystick port, and several serial ports. Some microcomputers incorporate many of the functions previously performed by individual adapters on the motherboard.

Multi-I/O Port Adapter Board: The board supports a number of peripheral interface adapters. Typically, all the device adapters and ports on the multi-I/O port boards are integrated into a single chip called a super I/O chip. The adapter functions which may be included in the multi-I/O boards are floppy disk drive (FDD) and port, IDE adapter and port for hard disk drive (HDD), two serial communication (COM) ports for standard asynchronous transfer protocols, game controller adapter and port, and parallel printer adapter and port etc.

Display Adapter: A display adapter card is an expansion card whose function is to interpret the data stream of the system bus and format it into a data stream that a monitor can understand and display. Other modern high performance video cards are used for more graphically demanding purposes, such as PC games. In some microcomputers, display adapter is integrated in the motherboard.

A display adapter can be integrated on the motherboard. However, limitation to this integrated graphics chip often occurs with early machines. Modern low-end to mid-range motherboards often include a graphics chipset. This graphics chip usually has a small quantity of embedded memory and takes some of the system's main RAM, reducing the total RAM available. This is usually called integrated graphics or on-board graphics, and has low-performance and undesirable for 3D applications.

The basic types of video adapters are Video Graphics Array (VGA) and Super VGA (SVGA). They can display information in text-form or in graphical form. Extended Graphics Array (XGA) and its variants can produce high resolution and high color display.

SCSI Host Adapter: A small computer system interface (SCSI) host adapter is a device that is used to connect one or more peripheral device to a computer bus as shown in Figure 4.2.5. Devices connected in this way are said to be daisy chain, and each device must have a unique identifier or priority number.

A SCSI host adapter can be installed in an IBM compatible computer as a single expansion board. SCSI is often used to connect hard disks, tape drives, CD-ROM drives, mass storage media, scanners and printers. Figure 4.2.5 shows an arrangement for the SCSI port on an IBM compatible computer.

There are several different SCSI interface definition, these are

- SCSI-1: An 8-bit interface with a maximum data transfer rate of 5 Mbps.
- SCSI-2: A 16-bit or 32-bit wide interface with a maximum data transfer rate of 10-20 Mbps. It is also called fast SCSI.
- Wide Fast SCSI: A 16-bit data bus with a maximum data transfer rate of 20 Mbps.
- SCSI-3: It has increased the number of connected peripherals from 7 to 127, increased cable lengths, added support for a serial interface, and supports a fiber optic interface. It has a maximum data transfer rate of 100 Mbps

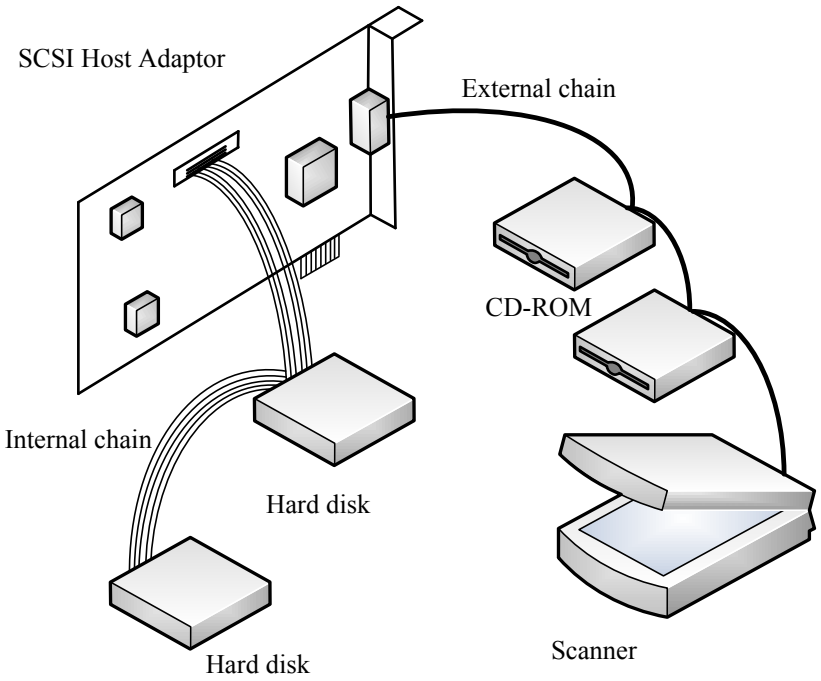

Figure 4.2.5: SCSI Host Adapter

4.2.3 Hardware Organization inside a PC Casing

Casing: The case (or chassis) of a microcomputer is a metallic box which houses various internal components as shown in Figure 4.2.6. Cases also have other uses, such as blocking noise produced by the computer, and protection from electromagnetic radiation. There are norms for guaranteeing such protection in a manner compliant with existing regulation.

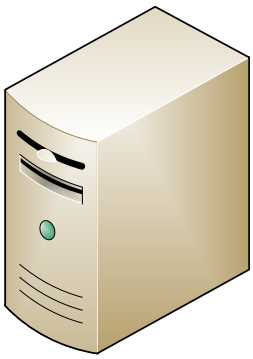

Figure 4.2.6: Casing

A case houses all of the computer's internal electronic components. Sometimes, a computer's electronics can reach very high temperatures. For this reason, a case with good ventilation, has as many fans as possible, as well as air vents are required. It is recommended to choose a case which includes at least an air intake in the front, a removable air filter, and an air outlet in the rear.

4.2.4 PC Power Supply

PC power supplies deliver required DC power to the electronic sub-systems, including Motherboard, Hard drive, CDROM drive, Keyboard, Mouse, and others. PC power supplies work by converting the AC mains power supply to required DC power supplies. The PC power supply always provides a 5 Volt standby (5VSB) voltage to the computer and certain other peripherals.

4.2.5 Key-points

- A motherboard is the central printed circuit board (PCB) in many modern microcomputers.
- The basic input/output system (BIOS) is the basic program used as an interface between the operating system (OS) and the motherboard.
- The chipset is an integrated electronic circuit. It coordinates data transfers between the various components, including the processor and memory.
- The chipset is integrated into the motherboard and a motherboard with a recent chipset is helpful to maximize the computer's upgradeability.
- The real time clock (RTC) is a circuit which synchronizes system signals.
- The system bus allows the processor to communicate with the RAM.
- The microprocessor is the computer's brain. It runs programs using a set of instructions.

- RAM is used to store data while the computer is running.
- VLB slots are used for installing graphics cards.
- PCI slots are used for connecting PCI cards, which are much faster than ISA cards and run on 32 bits.
- AGP slot is a fast port for a graphics card.
- Serial port hardware usually consists of a Universal Asynchronous Receiver/Transmitter (UART).
- Parallel port carries data on more than one wire, as opposed to the serial port, which uses only one wire.
- RJ-45 connector is commonly used for Ethernet networking ports. Devices that normally use RJ-45 ports include NICs, hubs, switches, and routers.
- A motherboard generally contains a keyboard and a mouse controller device and connection ports.
- PCMCIA stands for Personal Computer Memory Card International Association. PCMCIA standards were developed for small, credit card-sized devices, called PC Cards.
- FireWire/IEEE1394 port provides data rates up to 400 Mb/sec. The standard is most suitable for transferring high-volume of information, including video and voice data.
- Floppy drive connects to the computer via a 34-pin ribbon cable, which in turn connects to the motherboard.
- Display card is also known as video card, video adapter, graphics accelerator card, or graphics card.

4.2.6 Practice Set

Multiple Choice questions

1. The hard drive attaches to a microcomputer through _____

    a. IDE port

    b. Parallel port

    c. Centronics Port

    d. COM port

2. Which one is known as modem port?

    a. RJ11

    b. RJ18

    c. RJ34

   d. RJ45

3. Which one is known as network port?
   a. RJ11
   b. RJ18
   c. RJ34
   d. RJ45
4. SCSI means
   a. Small communication system interface
   b. Small computer system interface
   c. Small computer support interface
   d. None of these
5. IDE means
   a. Intelligent drive electronics
   b. Intelligent delay electronics
   c. Intelligent data electronics
   d. None of these

Review Questions

1. Define the terms: computer bus, adapter, port and expansion slots
2. What is a processor socket?
3. Explain two types of power supplies used in microcomputers.
4. Distinguish between serial and parallel ports.
5. What are the main features of USB port and IEEE 1394 port?

Analytical Questions

1. Explain SCSI Host adapter with an illustration.
2. Explain motherboard and its components in details
3. Write a short note on Expansion slot.
4. Explain multi I/O port adaptor board.
5. Write a note on Display adapter cards.

Lesson 4.3
Bus Organized Architecture

4.3.0 Learning Objectives

On completion of this lesson, you will know

- ✓ *Basics of buses.*
- ✓ *Address, data and control buses and their functions.*
- ✓ *Internal bus and expansion bus and their functions.*
- ✓ *Chipset and its functions.*
- ✓ *Types of computer buses.*

4.3.1 Buses

In computing, a bus is a set of physical connections, which can be shared by multiple hardware components for communication with one another. The purpose of a bus is to reduce the number of "pathways" needed for communication between the components, by carrying out all communications over a common data channel.

A bus is characterized by the amount of information that can be transmitted at once. This amount (bits) corresponds to the number of physical lines over which data are sent simultaneously. A 32-wire ribbon cable can transmit 32 bits in parallel. The term "width" is used to refer to the number of bits that a bus can transmit at once.

Additionally, the bus speed is also defined by its frequency (expressed in Hertz), the number of data bits sent or received per second. Each time that data are sent or received is called a cycle.

This way it is possible to find the maximum transfer speed of the bus, the amount of data which it can transport per unit of time, by multiplying its width by its frequency. A bus with a width of 16 bits and a frequency of 133 MHz, therefore, has a transfer speed equal to 16×133.106 = 2128×106 bit/s, or 2128×106/8 or 266×106 bytes/s or 266×106 /1000 = 266×103 KB/s or 259.7×103 /1000, that is, 266 MB/s

4.3.2 Local Bus and Bus Subassembly

The microcomputer has three local buses, these are: Address bus; Data bus and Control bus. The buses connect the CPU to each of the memory and I/O devices. When the CPU sends data to a device or memory it is called WRITE operation and when the CPU receives data is called READ operation. The functions of buses are described now.

Address Bus: The address bus is an internal channel from the CPU to a memory or I/O devices across which the addresses of data (not the data) are transmitted. The number of lines in the address bus determines the amount of memory that can be directly addressed as each line carries one bit of the address. With an *n*-line address bus, a processor can address up to 2^n unique locations. A computer with a 32-bit address bus can directly address 4GB of physical memory, while one with 36 bits can address 64GB.

When the CPU wants to communicate (READ or WRITE) with certain memory location or I/O device, it places the appropriate address on its address output. These addresses are then decoded to select the desired memory location or I/O device. This decoding process usually requires addressing decoder circuits.

Data Bus: The data bus is bidirectional and data can flow to and from the CPU through it. The data bus can be either input or output depending on whether the CPU performs a READ or a WRITE operation. During READ operation the data bus receives data that have been placed on the data bus by the memory or I/O device. During WRITE operation the data bus acts as the output and the data are sent to selected memory location or I/O device.

Control Bus: The control bus consists of a set of lines carrying signals that is used to synchronize the activities of separate microcomputer elements. Some of these control signals are sent by the CPU to the other components to tell them the type of operation in progress. The I/O devices can send control signals to the CPU. READ/WRITE, RESET, INTERRUPT are examples of control signals used in a microcomputer.

4.3.3 Primary Buses

Based on how buses are used for transfer of data, primary buses are divided into two categories: internal bus and expansion bus:

1. The internal bus, sometimes called the front-side bus (FSB), allows the processor to communicate with the system's central memory, i.e., RAM.
2. The expansion bus (sometimes called the input/output bus) allows motherboard components (USB, serial, and parallel ports, cards inserted in PCI connectors, hard drives, CD-ROM and CD-RW drives, etc.) to communicate with one another.

However, it is mainly used to add new devices using expansion slots connected to the input/output bus.

4.3.4 Chipset

A chipset is the component which routes data between the microcomputer's buses, so that all the components can communicate with each other. The chipset originally was made up of a large number of electronic chips, hence the name. It generally has two components: NorthBridge and SouthBridge. Figure 4.3.1 shows a typical bus system.

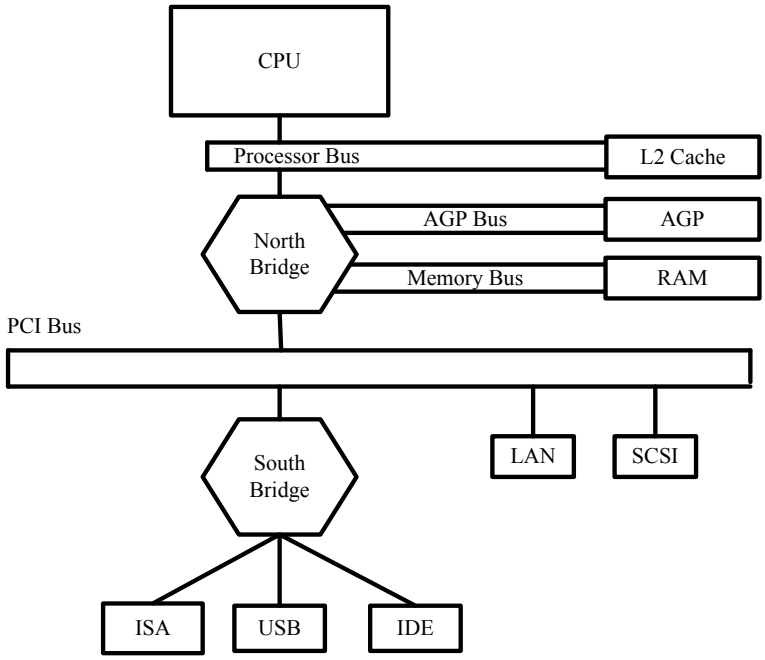

Figure 4.3.1: A typical bus system.

- NorthBridge (also called the memory controller) is in charge of controlling transfers between the processor and the RAM, and it is located physically near the processor. It is sometimes called the Graphic and Memory Controller Hub (GMCH).
- SouthBridge (also called the input/output controller or expansion controller) handles communications between peripheral devices. It is also called the ICH (I/O Controller Hub). The term bridge is generally used to designate a component which connects two buses.

4.3.5 Types of Microcomputer Buses

Processor Bus: The processor bus is a communications path between the CPU and the main bus. It is also used for communications between the CPU and the processor support chipset. The processor support chipset, such as an external memory cache and the bus controller chip found on some microcomputers. The size of the processor bus matches the size of the data words used by the CPU.

Backside Cache Bus: Conventional processors use level 2 cache on the motherboard and connect it using the standard memory bus arrangement. To achieve better performance, many newer processors use a dedicated high-speed bus to connect the processor to the level 2 cache. Such a bus is called backside cache bus.

Memory Bus: The memory bus transfers data between the RAM and the CPU. This bus can be the processor bus or will be implemented by a dedicated chipset that controls the memory bus. In most computers that have another board clock that is faster than 16MHz, a special memory controller chipset controls the memory bus.

Expansion Bus: Expansion buses, also called peripheral buses, are buses that have connectors that allow adding expansion cards (peripherals) to a computer.

ISA Bus: Industry Standard Architecture (ISA) bus was first appeared in 1981. The ISA bus permitted bus mastering, i.e. it enabled controllers connected directly to the bus to communicate directly with the other peripherals without going through the processor. One of the consequences of bus mastering is a direct memory access (DMA). However, the ISA bus only allows hardware to address the first 16 megabytes of RAM.

Up until the end of the 1990s, almost all PC computers were equipped with the ISA bus, but it was progressively replaced by the PCI bus, which offered a better performance.

MCA Bus: The Micro Channel Architecture (MCA) bus is an improved proprietary bus designed by IBM in 1987 to be used in their PS/2 line of computers. This 16 to 32-bit bus was incompatible with the ISA bus and could reach a throughput of 20 Mbps.

EISA Bus: The Extended Industry Standard Architecture (EISA) bus was developed in 1988 by a consortium of companies (AST, Compaq, Epson, Hewlett-Packard, NEC, Olivetti, Tandy, Wyse and Zenith) in order to compete with the MCA proprietary bus that was launched by IBM the previous year. The EISA connectors were deeper and the additional rows of contacts were placed below the rows of ISA contacts. Thus, it was possible to plug an ISA expansion board into an EISA connector.

Local Bus: Traditional I/O buses, such as ISA, MCA our EISA buses, are directly connected to the main bus and are forced to work at the same frequency. However, some I/O peripherals need a very low bandwidth while other needs higher bandwidths. Therefore, there are bottlenecks on the bus. In order to solve this problem, the "local bus" architecture offers to take advantage of the system bus, or front side bus (FSB), by interfacing directly with it.

VLB Bus: In 1992, the VESA local bus (VLB) was developed by the VESA (Video Electronics Standard Association under the aegis of the company NEC) in order to offer a local bus dedicated to graphics systems. The VLB is a 16-bit ISA connector with an added 16-bit connector. The VLB bus is a 32-bit bus initially intended to work with a bandwidth of 33 MHz (the bandwidth of the first PC 486s at that time).

PCI Bus: The Peripheral Component Interconnect (PCI) bus was developed by Intel in 1992. It is an intermediate bus located between the processor bus and the I/O bus. At least 3 or 4 PCI connectors are generally present on motherboards and can generally be recognized by their standardized white color. The PCI interface uses in 32 bits with a 124-pin connector or in 64 bits with a 188-pin connector.

AGP Bus: The AGP bus (short for Accelerated Graphics Port) was released in 1997 for Slot One chipsets, and then was later released for Super 7 chips to manage graphical data flow, which had grown too large to be handled by a PCI bus. The AGP bus is directly linked to the processor's FSB (Front Side Bus) and uses the same frequency, for increased bandwidth. The AGP interface was developed specifically to connect with the video card, by opening a direct memory access (DMA) channel to the graphics board, bypassing the input-output controller. Cards which employ this graphics, bus theoretically require less on-board memory; because they can directly access graphical data stored in central memory, their cost is hypothetically lower. Recent motherboards are built with a general AGP connector which can be identified by its brown color.

The PCI Express Bus

The PCI Express bus (PCI-E) is an interconnect bus that allows to add expansion boards to a microcomputer. It is also called Third Generation I/O (3GIO). The PCI Express bus was developed in 2002. PCI bus runs in parallel interface, whereas PCI Express bus runs in serial interface. The PCI-E bus offers much higher bandwidth than the PCI bus.

PCI-E connectors are not compatible with older PCI connectors. They vary in size and require less electricity. One of the interesting characteristics of the PCI-E bus is that it is hot pluggable, i.e. it can be plugged in or unplugged without turning off or restarting the machine.

USB/Firewire: The Universal Serial Bus (USB) is a way of connecting devices like cameras, scanners and printers to a microcomputer. It uses a thin wire to connect to the devices, and many devices can share that wire simultaneously. Firewire is another bus, used today, mostly for video cameras and external hard drives

4.3.6 Key-points

- The address bus (sometimes called the memory bus) transports memory addresses of the memory location to read or write data. It is a unidirectional bus.

- The data bus transfer instructions coming from or going to the processor; it is a bidirectional bus.
- The control bus transports orders and synchronization signals from the control unit to other hardware components. It is a bidirectional bus.
- The memory controller is also called the Graphic and Memory Controller Hub (GMCH).
- Conventional processors use level-2 cache on the motherboard and connect it using the standard memory bus arrangement.
- Expansion buses, also called peripheral buses, are buses that have connectors that allow adding expansion cards (peripherals) to a computer.
- Traditional I/O buses, such as ISA, MCA our EISA buses, are directly connected to the main bus and they are forced to work at the same frequency.
- Micro Channel Architecture (MCA) bus is an improved proprietary bus designed by IBM in 1987 for its PS/2 line of computer.
- Peripheral Component Interconnect (PCI) bus is an intermediate bus located between the processor bus and the I/O bus.
- The AGP bus is directly linked to the processor's FSB (Front Side Bus) and uses the same frequency, for increased bandwidth.
- The PCI Express bus is an interconnect bus that allows to add expansion boards to a computer.
- Universal Serial Bus (USB) is a way of connecting cameras, scanners and printers to a computer.
- Firewire is another bus used mostly for video cameras and external drives.

4.3.7 Practice Set

Multiple Choice Questions

1. A 32-wire ribbon cable can transmit _____.
    a. 32 bits in series
    b. 32 bits in parallel
    c. 16 bits in parallel
    d. None
2. The _____ is also called _____. It is _____bus.
    a. Control bus; command bus; a bidirectional
    b. Memory bus; command bus; a bidirectional
    c. Control bus; command bus; a unidirectional
    d. Memory bus; command bus; a unidirectional

3. Conventional processors use _____on the motherboard and connect it using the standard memory bus arrangement.
    a. level 2 cache
    b. level 1 cache
    c. level 0 cache
    d. None
4. The memory bus transfers data between the _____and the _____.
    a. CPU; Hard disk
    b. CPU; USB
    c. CPU; RAM
    d. None of above
5. AGP interface was developed specifically to connect the_____.
    a. Audio card
    b. Video card
    c. Sound card
    d. None
6. Firewire is a kind of bus used mostly for _____.
    a. video cameras
    b. external drives
    c. both of above
    d. none of the above

7. The data bus transfers instructions _____ the processor.
    a. only coming from
    b. only going to
    c. coming from or going to
    d. none

8. The full form of USB is _____.
    a. Universal Series Bus
    b. Universal Serial Bus
    c. United Serial Bus
    d. United Series Bus

9. ISA, MCA our EISA buses, which are directly connected to the main bus and they are forced to work at _____.
    a. it's own frequency
    b. same frequency

c. any frequency
d. none of the above

Questions for short answers

1. What do you understand by system bus?
2. List popular system buses for microcomputers.
3. Give the main characteristics of the PCI and PCI Express bus systems.
4. Distinguish among ISA, MCA, EISA.
5. A bus with a width of 16 bits operates at a frequency of 133 MHz. Find its transfer speed.

Analytical questions

1. Draw bus organized architecture of a microcomputer and explain its operation.
2. Give the main characteristic of address bus, data bus and control bus of a microcomputer.
3. Explain PCI/ISA/AGP bus systems.