**SS2 COMPUTER FIRST TERM 2024/2025 SESSION**

SCHEME OF WORK

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| --- | --- |
| **WEEK** | **TOPIC** |
| 1 | Introduction/Scheme of work |
| 2 | **Central Processing Unit (CPU)**  ·         The CPU  ·         Components of the CPU  ·         Functions of:  ·         Arithmetic and Logic Unit (ALU)  ·         Control Unit (CU)  ·         Register |
| **3 – 4** | **Memory Unit**  ·         Computer memory  ·         Types of memory  ·         Description of the types of memory  ·         Unit of storage  ·         Conversion from one unit of storage to another |
| **5** | **Logic Circuits I**  ·         Definition of Logic gate  ·         Types of logic gate and their description  ·         Equation and truth table for each logic gate |
| **6-7** | **Logic circuits II**  ·         Types of alternative logic gate  ·         Description of the alternative logic gate  ·         Equation and truth table for each alternative logic gate  ·         Uses of logic gate |
| **8-9** | **Computer data conversion**  ·         Definition of register, address and bus  ·         Types of registers and their functions  ·         Fetch – execute cycle  ·         Factors affecting speed of data transfer |
| **10** | **REVISION** |

**TOPIC ONE: THE CENTRAL PROCESSING UNIT**

The Central Processing Unit (CPU) is the computer component that's responsible for interpreting and executing most of the commands from the computer's other hardware and software. Whenever you press a key, click the mouse, or start an application, you're sending instructions to the CPU.

Devices that make use of CPU include: desktop, laptop, tablet computers, and smartphones

Intel and AMD are the two most popular CPU manufacturers for desktops, laptops, and servers, while [NVIDIA](http://www.nvidia.com/content/global/global.php) and Qualcomm are big smartphone and tablet CPU makers.

CPU has different names including processor, microprocessor or the “brain of the computer”.

A modern CPU is usually small and square, with short, rounded, metallic connectors on its underside. Some have pins instead of metallic connectors.

The CPU attaches directly to a CPU ‘socket’ (or sometimes a ‘slot’) on the motherboard. The CPU is inserted into the socket pin-side-down.

The clock speed of a processor is the number of instructions it can process in any given second, measured in hertz (Hz).

A processor's speed is measured in megahertz (MHz), or millions of instructions per second; and gigahertz (GHz), or billions of instructions per second. A faster processor can execute instructions more quickly. However, the actual speed of the computer depends on the speed of many different components—not just the processor.

A CPU with a clock speed of 3.0 GHz can process 3 billion instructions each /per second.

Some devices have a single-core processor while others may have a dual-core (or quad-core, etc.) processor.

**COMPONENTS OF THE CPU**

The components of the CPU work together to achieve its functions. The three components are:

1.      Arithmetic Logic Unit

2.      Control Unit

3.      Registers

**Functions of Arithmetic Logic Unit (ALU)**

1. Executes all arithmetic operations such as ADD, SUBTRACT, DIVIDE etc.
2. Executes logical operations (i.e. making comparison) such as AND, OR, XOR etc.
3. The arithmetic and logic unit performs comparison operations test such as equal to, less than, greater than

**Functions of Control Unit (CU)**

·         It directs the flow of data and information in the computer.

·         It oversees the operation of the input and output (I/O) devices.

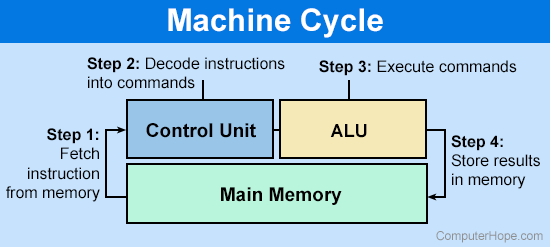
·         Interprets instructions

**Registers:** Register are temporary storage location used to quickly accept, store, and transfer data and instructions that are being used immediately by the CPU. They are special purpose memory which resides within the CPU.

**TYPES OF REGISTERS:**

1. The current Instruction register holds the instruction that is to be executed.
2. The memory address register is used to hold the memory address that contains either the next piece of data or an instruction that is to be used.
3. The memory data register acts like a buffer and holds anything that is copied from the memory ready for the processor to use it.
4. The accumulator:  a memory location used to store the intermediate results of arithmetic and logical operations.
5. The Floating point register (FPRs) store floating point numbers in many architectures.
6. The Instruction registers store the instruction currently being executed.
7. The conditional registers hold truth values often used to determine whether some instruction should or should not be executed.
8. The constant registers hold read –only values such as zero, one, or pi.
9. The index registers are used for modifying operand addresses during the run of a program.

**CPU INSTURC**



Your CPU processes many instructions from different programs every second. Some of these instructions involve simple arithmetic, while others are more complicated. The clock speed measures the number of cycles your CPU executes per second, measured in GHz (gigahertz).

In this case, a “cycle” is the basic unit that measures a CPU’s speed. During each cycle, billions of transistors within the processor open and close. This is how the CPU executes the calculations contained in the instructions it receives.

**TOPIC TWO:   COMPUTER MEMORY**

Computer memory is the storage space in the computer where the data to be processed and the instructions required for processing are stored.

**Types of memory**

There are basically two major types of memory, which includes:

·         Primary memory (main memory)

·         Secondary memory (external storage)

**PRIMARY MEMORY**

Also known as the main memory is the storage in the computer in which data is stored for quick access by the CPU and are connected via a memory bus. The primary memory is divided into two:

**Random Access Memory (RAM)**

The RAM is the volatile memory that temporarily stores data and instruction currently being used by the computer. It is called volatile because the content of it disappears when the computer is turned off or there is loss of power supply.

**Read Only Memory (ROM)**

The ROM is the non-volatile memory that stores small program that the computer can use to perform some of the basic operations required to initiate the boot process. The content of the ROM are often times stored by the manufacturer of the system and always permanent. Since the content of it can only be read, they are called **Read Only**. Have you ever seen the black/blue background with some information during the booting process? That’s the content of the ROM being displayed.

**SECONDARY MEMORY**

This is the permanent, non-volatile memory that is not directly accessed by the computer/processor. Before the content of the secondary memory can be used by the computer, it must be copied into the RAM. It has the capacity to store huge amount of data. The secondary storage is the slowest and cheapest form of memory. Examples of secondary storage include Hard Disk (Local Disk), Optical disk (CD, DVD), Floppy Disk, USB flash drive, memory card etc.

**Differences between primary and secondary memory**

|  |  |
| --- | --- |
| **Primary** | **Secondary** |
| It is the internal memory | It is the external memory |
| It is under the direct control of the CPU | It is not directly under the control of the CPU |
| It cannot be used for massive data storage | It can be used for massive data storage |
| It is faster than the secondary storage | It is slower than the primary storage |
| It does not supplement the secondary storage | It supplements the primary storage |

**Assignment 1:**

1.      Write the difference(s) between CD-R and CD-RW, DVD-R and DVD-RW

2.      Write the size, and technology of the following storage devices:

·         Hard disk

·         Floppy disk

·         USB flash drive

·         Magnetic tape

·         Compact Disc

**Unit of storage**

The storage capacity is the amount of space available for the storage of data in a particular storage media. The storage unit includes:

·         Bits: a bit is a contraction of the word “binary digit” and is denoted with either 1 or 0. A bit is the simplest unit of data storage.

·         Nibble: a nibble is a collection of 4 bits

·         Byte: a byte is a collection of 8 bits

·         Word: a word is 2 bytes

·         Kilobyte: a kilobyte is 1024 bytes (1000 bytes approximately)

·         Megabyte: a megabyte is 1048576 bytes i.e. 10242bytes (1 million bytes approximately)

·         Gigabyte: a gigabyte is 1073741824bytes i.e. 10243bytes (1 billion bytes approximately)

·         Terabyte: a terabyte is 1099511627776 bytes i.e. 10244bytes (1 trillion bytes approximately)

**Conversion from one unit of storage to another**

1.      Convert 64 bits to byte

Solution:          8 bits make 1 byte

                                    1 bit makes 1/8 byte

64 bits make 1/8 x 64 = 8 bytes

2.      Convert 16384 bits to byte and kilobyte

Solution:          **a**. 8 bits = 1 byte

                        1 bit     = 1/8 byte

                        16384 bits = 1/8 x 16384

                                    = 2048 bytes

**b.** 1024 bytes = 1 KB

                        1 byte = 1/1024 KB

                        2048 bytes = 1/1024 x 2048

                                    = 2KB

**Assignment 2:**

**a.**      Explain the following units of storage

·         Petabyte

·         Zettabyte

·         Yottabyte

**b.**      Convert 0.5 Terabyte to megabyte

**TOPIC THREE:  LOGIC GATE**

A logic gate is the fundamental building block of digital integrated circuits. Most logic gate takes an input of two binary values, and output a single value of 1 or 0. Some circuits may have only a few logic gates, while others, such as microprocessors, may have millions of them. Logic gates are primarily implemented using diodes or transistors acting as electronic switches, but can also be constructed using vacuum tube, fluidic logic, optics, molecules or even mechanical elements.

Logic circuit includes such devices as registers, arithmetic logic units, and computer memory, all the way up through complete microprocessors, which may contain more than 100 million gates.

Types of logic circuit

There are mainly 3 logic gates, they are:

·         OR gate

·         AND gate

·         NOT gate

**1.**      **OR gate:** the OR gate is a circuit that has two or more inputs and operates in such a way that:

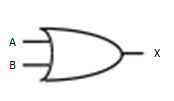
·         Its output is 1 when any of the input variables is 1

·         Its output is 0 if when all of the input variables are 0

·         Its output is 1 when all of the input variables are 0

The algebraic symbol of the OR operation is the plus sign (+).

The OR gate is represented graphically below.

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The OR is represented in the truth table below

|  |  |  |
| --- | --- | --- |
| **A** | **B** | X=A + B |
| **0** | 0 | 0 |
| **0** | 1 | 1 |
| **1** | 0 | 1 |
| **1** | 1 | 1 |

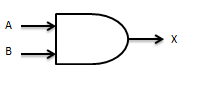
        It can also be generated using the equation : X=A+B

**2.**      **AND gate:** The AND gate is a circuit that has two or more inputs and operates in such a way that:

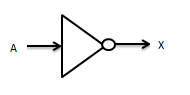
·         Its output is 1 if and only if the two inputs are 1

·         Its output is 0 if any of the inputs is either 0 or 1 or both are 0

The algebraic symbol of the AND gate is \* or .. The AND gate is represented graphically below.

[](https://blogger.googleusercontent.com/img/b/R29vZ2xl/AVvXsEi_3OkGnmT8_rlCdY9yJkKZL6JBwp_r-a7vMIEU7-JQq70qsAjq6i01QrB1Su57iZ3Pmb6UejZKuo5XKXRPUZMN-5iR9mWpEMQlupe2PgY0bW77uJn0Wrc_Yh7ZaRedSxDnhh4KUPAbnPc/s1600/ANDgate.png)

**3.**      **NOT gate:** This is the logic gate that has one input and one output such that when the input is true (1), the output is false and when the input is false, the output is true.

[](https://blogger.googleusercontent.com/img/b/R29vZ2xl/AVvXsEhLeYxittZGWV5U4rml4KHlgg5oYyYrSzTnLtC41PRDkfyAst7AiEzDpCEdI57_dvJqVC61Y9f2ky8XF7UjX6PZL6agnVvam-uBUsKBdK1p69eE9n_DlYosImorAJcgGta6nPCHRowtx2E/s1600/NOTgate.png)

**Equation and truth table for each logic gate**

The truth table is the table that shows the possible combinations of variable values in the equation and the result (output) for each of the logic gates.

For a two-input truth table, there will be **4 (22)** possible combinations of variable inputs and generally for **n**-input truth table, there will be 2n possible combinations of the input variables. See the examples below:

1.      **OR gate:** The algebraic equation (with two inputs A and B): **x = A+B** , is represented in the truth table below

|  |  |  |
| --- | --- | --- |
| **A** | **B** | **X = A+B** |
| **0** | 0 | 0 |
| **0** | 1 | 1 |
| **1** | 0 | 1 |
| **1** | 1 | 1 |

Check the rules under the OR gate.

2.      **AND gate:** The algebraic equation(with two inputs A and B) **: x = A.B**, is represented in the table below

|  |  |  |
| --- | --- | --- |
| **A** | **B** | **X = A.B** |
| **0** | 0 | 0 |
| **0** | 1 | 0 |
| **1** | 0 | 0 |
| **1** | 1 | 1 |

Check the rules under the AND gate.

3.      **NOT** gate: the truth table for the NOT gate (with input A): x= A’ or x= Ᾱ is shown below

|  |  |
| --- | --- |
| **A** | **X = Ᾱ** |
| **0** | 1 |
| **1** | 0 |

**Assignment 3**: An OR gate has 3 inputs and 1 output. Show the truth table for this OR gate.

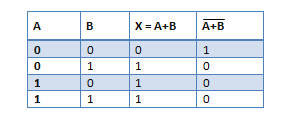
**TOPIC FOUR: LOGIC GATES II**

**1.**      **NAND GATE**

This is a logic gate whose output is **zero (0)** if both of the inputs are 1and 1 otherwise. A NAND gate is equivalent to an AND gate followed by a NOT gate. The NAND gate is the complement of the AND function. The word NAND is got from the abbreviation NOT-AND. The NAND gate is represented graphically below.

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The truth table is shown below

[](https://blogger.googleusercontent.com/img/b/R29vZ2xl/AVvXsEgREQZ8f1FgGXsJLEte_RZb2j0BszcciSm9cjoGOzxDfGSP29QiZzf6FG5S3h5TZJ2b7tkGEa1VNpKyMsW3JBYn9L5jGzIp7uZw2z0rgsqnJvuYeUd1a-wFdpUy82XZXUTW4aLe5xp3B5w/s1600/nandtbl.png)

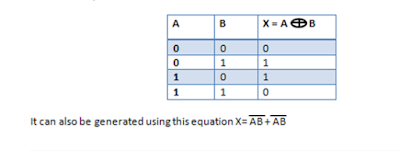
**Construction of a simple comparator using XOR**

A comparator is a circuit that compares two input voltages and indicates which is higher. One of the special logic circuit that occurs quite often in digital system is the **exclusive-OR (XOR)** circuits.

The XOR produces a high voltage when the two inputs are at opposite levels. This means that the XOR yields true (1) if and only if one of the inputs is true (1) and the other is false (0). The XOR gate is graphically represented below.

[](https://blogger.googleusercontent.com/img/b/R29vZ2xl/AVvXsEg2653L5MjVRQPPoyMFUKx0QzmUcEF2xMiDWTmEt9hS0mqaNDBu5ymjIb6D2qC02CnIxRfthTuj2T2VaMImVXh3ZH8jL1Shct0gHkHzsO5iRrCfoNAhcs8IgGf5lf_6BCLaNmoL8pOKRk4/s1600/XOR.png)

The XOR is represented in the truth table below

[](https://blogger.googleusercontent.com/img/b/R29vZ2xl/AVvXsEhzS55a0Q8d9sl0-lTA48_fLFclr0tityPvBXHPkola5nlIvkDt_sn10kLtwKw1AiIgPPMuCdY_S0aYg4Dv3HyC-wO0UFGF-WISNiDI503B8UjTcCOZv3yxuDAdaqzSOT9C31BFamqp0Pg/s1600/xorTBl.png)

**TOPIC FIVE: COMPUTER DATA CONVERSION**

**Register**: the term register can be defined as a high-speed storage location in the Central Processing Unit (CPU), which is used to hold data and addresses to be processed by the computer. A register may hold a computer instruction, a storage address or any kind of data. A register must be large enough to hold an instruction. For example, in a 32-bit instruction computer, the register must be 32-bit wide.

**Address**: an address is a name, label or number that identifies a location where data or information is stored within the computer memory. It is a particular location holding a word or a byte. Computer memory is an array of storage boxes; each of these storage boxes is one byte in length. Each box has an address (a unique number) to it.

**Bus**: In digital computing, a bus is a set of physical connections (cables, printed circuits etc.), which can be shared by multiple hardware components in order to communicate with one another. It is a transmission path on which signals are dropped off or picked up at every device attached to the line.

The purpose of buses is to reduce the number of PATHWAYS needed for communication between the components by carrying out all communication over a single data channel.

**There are generally two types of buses:**

**Internal (System) bus**: the internal bus enables communication between internal components such as the memory and the video card. It connects the CPU to the main memory. It is also called Front Side Bus (FSB) or memory bus.

**External/expansion bus**: this bus is capable of communicating with the external components or peripheral devices. These devices connect to the internal bus via a bridge implemented in the processor chipset. It is also called input/output bus.

The lines or pins of a bus are of three types:

**Address** - the components pass memory addresses to one another over the address bus.

**Control** - used to send out signals to coordinate and manage the activities of the motherboard components.

**Data** - transferred between peripherals, memory and the CPU. Obviously, the data bus can be a very busy pathway.

**Types of registers and their functions**

**Memory Data Register (MDR)**

This is the register that contains the *data to be stored in the computer memory* or the *data fetched from memory and ready to be processed by the CPU*. It acts like a buffer and holds anything that is copied from the memory ready for the processor to use it.

**Current Instruction Register (CIR)**

This is part of the CPU’s control unit that *stores the instruction currently being executed or decoded.*

**Memory Address Register (MAR)**

This is the CPU register that either *stores the memory address from which data will be fetched to the CPU or the address to which data will be sent and stored.*

In other words, MAR holds the memory location of the data that need to be accessed. When reading from memory, data addressed by MAR are fed into the MDR and then used by the CPU. When writing to memory, the CPU writes data from MDR to the memory location whose address is stored in MAR.

**Difference between register and main memory**

|  |  |
| --- | --- |
| **Register** | **Main memory** |
| Registers are internal, i.e. they are located inside the processor | Main memory is external, i.e. it is located outside the processor |
| They are very fast | It is slow |

**FETCH-EXECUTE CYCLE**

Most modern processors work on the FETCH-EXECUTE principle. It is based on the Von Newman Architecture.  When a set of instructions is to be executed, the instructions and data are loaded in main memory. The address of the first instruction is copied into the program counter. The execution of an instruction by a processor is divided in three parts. These parts are fetching, decode and execute.

**Fetch the next instruction**

The program counter (PC) contains the address of the next instruction to be executed, so the control unit goes to the address in memory specified in the PC, makes a copy of the contents and places the copy in the Current Instruction Register (CIR).

**Decode the instruction**

The next step is for the CPU to interpret the instruction that has just been fetched and stored in the CIR.  The CPU is designed to understand specific set of commands called “instruction set” of the CPU. Each make of CPU has a different instruction set.

The CPU decodes the instruction and prepares various areas within the chip in readiness of the next step.

**Get data if needed**

It may be that the instruction to be executed requires additional memory accesses in order to complete its task. For example, if the instruction says to add the content of the memory to a register, the control unit must get the content of the memory location.

**Execute the instruction**

Once an instruction has been decoded and any data fetched, the control unit is ready to execute the instruction. If the instruction involves arithmetic operation or involves comparison, the ALU is called upon to handle this and send the result to a special register (Accumulator) before being moved to the memory.

The control unit increment the value in the program counter by 1 and the cycle begins again.

**Factors affecting speed of data transfer**

**Bus speed:** The term "bus speed" refers to how quickly the system bus can move data from one computer component to the other. The faster the bus, the more data it can move within a given amount of time. It is measured in Hertz.

**Bus width:** The size of a bus, known as its width, is important because it determines how much data can be transmitted at one time. For example, a 16-bit bus can transmit 16 bits of data, whereas a 32-bit bus can transmit 32 bits of data.