***Section 1 – The Big Picture***

Part 1: A Computing System

* A computing system: Hardware, Software, Data
* Layers of a Computing System:

+ Information Layer

+ Hardware Layer

+ Programming Layer

+ Operation Systems Layer

+ Applications Layer

+ Communications Layer

A diagram of a onion

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Part 2: The History of Computing

Hardware

* First Generation Hardware (1951-1959)

+ Vacuum Tubes

+ Magnetic Drum

+ Card Readers → Magnetic Tape Drives

* Second Generation Hardware

+ Transistor

+ Magnetic Cores

+ Magnetic Disks

* Third Generation Hardware

+ Integrated Circuits

+ Transistors

+ Terminal

* Fourth Generation Hardware (1971-?)

+ Large-scale Integration

+ PCs, the Commercial Market, Workstations

Software

* First Generation Software (1951-1959)

+ Machine Language: Computer programs were written in **binary** (1s and 0s)

+ Assembly Languages and translators: Programs were written in **artificial programming** languagesand were then translated into machine language

+ Programmer Changes: Programmers divide into **application programmers** and**systems programmers**

* Second Generation Software

+ High Level Languages

* Third Generation Software

+ Systems Software

+ Separation between Users and Hardware

A diagram of software components

Description automatically generated

* Fourth Generation Software

+ Structured Programming: Pascal, C, C++

+ New Application Software for Users: Spreadsheets, wordprocessors, database management systems

* Fifth Generation Software (1990 - present)

+ Microsoft

+ Object-Oriented Design

+ World Wide Web

+ New Users

Part 3: Computing as a Tool & a Discipline

- Four Necessary Skills:

1. Algorithmic Thinking

2. Representation

3. Programming

4. Design

***Section 2 – The Information Layer***

PART 1: Binary Values and Number Systems

**NUMBER AND COMPUTING**

* All types of information: stored as **number**
* Natural, negative, rational, irrational numbers and manyothers

+ Natural Numbers: Zero and any number obtained by repeatedly addingone to it

+ Negative Numbers: A value less than 0, with a – sign

+ Integers: A natural number, a negative number, zero

+ Rational Numbers: An integer or the quotient of two integers

* Converting Octal to Decimal
* Converting Hexadecimal to Decimal
* Converting Binary to Decimal
* Arithmetic in Binary (Carry 1)
* Subtracting Binary Numbers
* Subtracting Octal Numbers
* Converting Binary to Octal
* Converting Binary to Hexadecimal
* Converting Decimal to Other Bases
* Converting Decimal to Hexadecimal
* Converting Binary to Decimal

**BINARY AND COMPUTERS**

* Byte 8 bits

PART 2: Data Representation

**DATA AND COMPUTERS**

* Computers store, present, and help us modify:

 Numbers

 Text

 Audio

 Images and graphics

 Video

* Data compressionz: Reduction in the amount of space needed to store a piece of data
* Bandwidth: The number of bits or bytes that can be transmitted from one place to another in a fixed amount of time.
* Compression ratio: The size of the compressed data divided by the size of the original data
* A data compression techniques can be:

+ lossless, which means the data can be **retrieved** without any **loss** of the original information

+ lossy, which means some **information** may be **lost** in the process of compaction

**ANALOG AND DIGITAL INFORMATION**

* Analog data: A **continuous** representation, analogous to the actual information it represents
* Digital data: A **discrete** representation, breaking the information up into separate elements
* Computers cannot work well with **analog** data, so we digitize the data
* **Digitize**: Breaking data into pieces and representing those pieces separately
* An **analog** signal continually fluctuates in voltage up and down
* A **digital** signal has only a high or low state, corresponding to the two binary digits
* All **electronic** signals (both analog and digital) degrade as they move down a line
* The **voltage** of the signal fluctuates due to environmental effects

**BINARY REPRESENTATIONS**

* One bit can be either 0 or 1

**TEXT COMPRESSION**

* Assigning 16 bits to each character in a document uses too much file space
* We need ways to store and transmit text efficiently

**THE UNICODE CHARACTER SET**

* The first 32 characters in the ASCII character chart do not have a simple character representation to print to the screen
* Extended ASCII is not enough for international use
* Unicode uses 16 bits per character

**VECTOR GRAPHICS**

* A format that describes an image in terms of lines and geometric shapes
* The file sizes tend to be smaller because not every pixel is described
* The **good** side and the **bad** side…

+ Vector graphics can be **resized** mathematically and changes can be calculated dynamically as needed

+ Vector graphics are not good for representing real-world **images**

**REPRESENTING VIDEO**

* Video codec COmpressor/DECompressor: Methods used to shrink the size of a movie to allow it to be played on a computer or over a network
* Almost all video codecs use lossy compressions to minimize the huge amounts of dataassociated with video
* Temporal compression
* Spatial compression

***Section 3 – Hardware***

Part 1: Gates & Circuits

 Computers & Electricity

 Gates

 Constructing Gates

 Circuits

 Circuits as Memory

 Integrated Circuits

 CPU Chips

**COMPUTERS AND ELECTRICITY**

* Any given electronic signal has a level of voltage.

+ 0-2V: low  bit 0.+ 2-5V/: high  bit 1.

* Gate: A device that performs a basic operation on electrical signals
* Circuits: Gates combined to perform more complicated tasks
* Boolean expressions: Uses Boolean algebra, a mathematical notation for expressing two-valued logic
* Logic diagrams: A graphical representation of a circuit; each gate has its own symbol
* Truth tables: A table showing all possible input value and the associated output values
* Six types of gates

 NOT

 AND

 OR

 XOR

 NAND

 NOR

* Transistor: A device that acts either as a wire that conducts electricity or as a resistor that blocks the flow of electricity, depending on the voltage level of an input signal
* It is made of a semiconductor material, which is neither a particularly good conductor ofelectricity nor a particularly good insulator

**CIRCUITS**

* Combinational circuit
* Sequential circuit

**CPU CHIPS**

* The most important integrated circuit in any computer is the **Central ProcessingUnit**, or CPU

Part 2: Computing Components

 Individual Computer Components

 The Stored-Program Concept

 Embedded Systems

 Parallel Architectures

* Memory: A collection of cells, each with a unique physical address;both addresses and contents are in binary
* Control Unit:

+ Control unit: The organizing force in the computer+ Instruction register (IR): Contains the instruction that is being executed+ Program counter (PC): Contains the address of the next instruction to beexecuted

* Flow of Information: Bus A set of wires that connect all major section

A diagram of a memory control unit

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***Section 4 – Programming Layer***

**Methodology**

* For designing algorithms

 Analyze the problem

 List the main Tasks

 Write the remaining Modules

 Re-sequence and revise as necessary

* Algorithm operations: sequential operations, conditional operations, iterative operations (loops)
* An algorithm with repetition (count controlled and event controlled):

Count controlled loops: repeats a process a specified number of times.Event controlled loops: the number of repetition is controlled by an event that occurs within the body of the loop itself.

- Algorithms with arays:

1. Searching2. Sorting3. Processing