**Level 1: Presentation Notes**

1. Number systems used in Computer Science

a. List the main features of the Decimal System

* Digits 0,1,2,3,4,5,6,7,8,9
* Used for communicating with human users

b. List the main features of the Binary System

* Digits 0,1 (on or off)
* Binary 10 == Decimal 2
* Used by internal CPU and memory circuits

c. List the main features of the Octal System

* Digits 0,1,2,3,4,5,6,7
* Octal 10 == Decimal 8
* Used by computer scientists for groupings of three binary digits

d. List the main features of the Hexadecimal System

* Digits 0,1,2,3,4,5,6,7,8,9,A,B,C,D,E,F (uses extra letters)
* Hex F == Decimal 15
* Hex 10 == Decimal 16
* Used by computer scientists for groupings of 4 binary digits

2. Compare and contrast the Decimal and Binary systems

|  |  |  |
| --- | --- | --- |
| **Criteria** | **Decimal System** | **Binary System** |
| Digits  Used | 0,1,2,3,4,5,6,7,8,9 | 0,1 (true, false) (+,-) |
| Addition Example | 0+1=1  1+1=2  99+1=100 | 0+1=1  1+1=10  11+1=100 |
| Powers of  Base | 100=1 etc...  101=10  102=100 | 20=1 etc…  21=10 (or 2 decimal)  22=100 (or 3 decimal) |
| Value of  111 | 111=102+101+100  (100+10+1) | 111=22+21+20  (decimal:4+2+1=7) |

3. Convert the following binary numbers to decimal:

1. 11 Binary = 3 Decimal 21+20=11 2+1=3
2. 101 Binary = 5 Decimal 22+20=101 4+1=3
3. 1010 Binary = 10 Decimal 23+21=1010 8+2=10

4. Convert the following decimal numbers to binary:

1. 6 Decimal = 110 Binary 4+2=6 22+21=110
2. 13 Decimal = 1101 Binary 8+4+1=13 23+22+20=1101

5. Add the following binary numbers. (verify your answers using decimal)

|  |  |
| --- | --- |
| 0101 (decimal 5)  +0010 (Decimal 2)  ---------  0111 | 0101 (decimal 5)  +1010 (Decimal 10)  ---------  1111 |
| 1  0011 (decimal 3)  +0010 (Decimal 2)  ---------  0101 | 11  0110 (decimal 6)  +0011 (Decimal 3)  ---------  1001 |

6. List the main features of the following Computer Memory Structures:

a. Bit

* 1 binary digit
* Used for boolean data type
* Building block for all computer data and memory

b. Byte

* 8 binary digits
* Largest value: 1111 1111 (28-1=255 Decimal)
* Used for char (character) data type
* 26 lower case letters + 26 uppercase +10 number symbols + punctuation marks + other stuff equal about 130 distinct characters

c. Word

* 16 binary digits (2 bytes)
* Largest value: 1111 1111 1111 1111 (216-1=65,535 Decimal)

d. Integer Data Type

* is 1 word (16 bits)
* But must represent both positive (+) and negative (-)
* Range: +32767 to -32767
* Larger or smaller numbers require a different data type

e. Double Word

* 32 binary digits (4 bytes or 2 words)
* Largest value:232-1=4 billion (approx)

**Level 2: Research Questions**

1. The Intel 8085 microprocessor was a first generation processor that was used in many early game systems and personal computers. Google “8085 microprocessor architecture” to answer these questions.

a. Year Introduced

The microprocessor was introduced in 1977.

b. Size of data bus (in bits)

The microprocessor was an 8-bit processor.

c. Largest data number (in binary and decimal)

The largest 8-bit number was 255, and in binary it would result as 1111 1111.

d. Size of address bus (in bits)

The address bus was 16 bits, and it is within the microprocessor.

e. Largest memory address (in binary and decimal)

The largest memory will be 1111 1111 1111 1111 and the decimal number will be 1048575.

2. The Intel 8086 microprocessor was the processor used in the first IBM PCs running the DOS operating system. Google “8086 microprocessor architecture” to answer these questions.

a. Year Introduced

0The microprocessor was introduced in 1978.

b. Size of data bus (in bits)

The size of the data bus was 16-bits in the microprocessor.

c. Largest data number (in decimal)

The largest data number is a 16-bit number which decimal is 65535.

d. Size of address bus (in bits)

The size of the address bus in bits is 20 -bits.

e. Largest memory address (in decimal)

The largest memory address in decimal is 1048575 with 20-bits.

3. The Intel 80286 microprocessor a common processor used in IBM PCs running the Windows operating system. Google “80286 microprocessor architecture” to answer these questions.

a. Year Introduced

It was first introduced in 1982, and it is a 5th of a i86 microprocessor family. The

microprocessor consisted of a faster clock speed than the previous microprocessor, the

Intel 8086 and 8085.

b. Size of data bus (in bits)

This data bus was 16 bits.

c. Largest data number (in decimal)

The largest number was 65535, and it was a 16bit number.

d. Size of address bus (in bits)

The size of the address bus is 24 bits with the microprocessor.

e. Largest memory address (in decimal)

The highest 24-bit value within the memory address of the microprocessor is 16777215.

4. The modern PCs run either a 32 bit or 64 bit Windows operating system. Google “32 vs 64 bit” to answer these questions.

a. How do these systems differ in data capacity? (explain using bits)

A 64-bit processor with a windows os has much more capacity and is more capable than

a 32-bit processor as it can handle much more incoming data at once.

b. How do these systems differ in memory capacity? (explain using bits)

A 32-bit processor can only have around 4GB or less RAM while 64-bit processors are

capable of working with much more RAM. 4GB of ram is about 32 trillion bits, which

means that the 64-bit processor is much more capable of 32 trillion bits.

c. How do these systems differ in hardware requirements?

The processors have different amounts of GB stored in them, and the 64-bit processor

will have much more RAM than the 32-bit processor. The 64-bit processor will perform

significantly better, and have much more performance and utilize more of the CPU than

a 32-bit operating system.

5. Research and explain how negative (-) numbers are represented using bits and how they are stored in computer memory.

Negative numbers are represented using bits by the Two’s complements in which it’s a mathematical operation which is used on binary numbers. The two’s complement is calculated by inverting the digits and adding one. Two complement is the most common method of representing signed integers on computers and more generally, fixed point binary values.

6. Research and explain how floating point (decimal) numbers are represented using bits and how they are stored in computer memory.

The term floating point is derived from the fact that there is no fixed number of digits before and after the decimal point; that is, the decimal point can float. There are also representations in which the number of digits before and after the decimalpoint is set, called fixed-point representations. Floating point representations are slower and less accurate than fixed-point representations but can handle a larger range of numbers. These are stored in the computer memory by using four bytes which is 32 bits.

**Level 3: Sample Program**

1. Explain the result of the following Ptyhon operations:

a. bin(11)

This function prints the number 11 in binary. The result is 0b1011

b. oct(11)

This function prints the number 11 in octal. The result is 0o13

c. hex(11)

This function prints the number in hexadecimal. The result is 0xb.

2. Explain the following Ptyhon operations:

a. bin(‘11’) - Why does this operation give an error?

You cannot turn a string into a binary number, only integers can be turned into binary

numbers.

b. int(‘11’) - Why does this work?

This works because the function is turning the string which is called 11 into a integer with

a value of 11.

c. bin(int(‘11’)) - Why does this fix the problem?

This fixes the problem because it turns the string into an integer and then it changes to a

binary number.

3. Modify the following sample Python program to print out the digits in:

a. Binary

b. Octal

c. Hexadecimal

number = input("Enter a 4 digit decimal number:")

index = 0

for char in number :

index += 1

print("Digit ", index, " is : ", char)

