2025

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Summer Activities for Prospective Students

2025

A Level Computer Science

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Number Systems

We need to define different number and data representations in computing.

Task 1.

Use the Internet and make notes using paper and pen or an open a Word document to complete the following. Please give a definition of each type of number representation and an example of each.

1. A natural number
2. An integer
3. A rational number
4. An irrational number
5. An ordinal number
6. A real number

7. What are the different number bases we can use in computing?

8. What does counting and measurement mean in computing and what data types are best for each?

Binary

Our decimal system is called denary and it uses the digits of 0 through to 9. This means that it has a base of 10.

Binary uses only 2 digits and these are 0 and 1.

Binary has a base of 2.

Hexadecimal uses a base of 16, using digits form 0-9 and using letters from A to F for 10 – 16.

Number bases can be written as a subscript to show its value in a number system.

For example, 610₁₀ means number 6 in decimal.

 112₂ means a binary value

 1116₁₆ means a hex value

A binary number such as 01010111 is a series of 0’s and 1’s.

We can convert binary numbers to decimal numbers by using the following method:

1. Moving from **right to left**, write down the ‘value headers’ as follows:

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **128** | **64** | **32** | **16** | **8** | **4** | **2** | **1** |

1. If we needed to convert the following binary number 00110011 to decimal we would place the binary number under the equivalent ‘value headers’ as such

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **128** | **64** | **32** | **16** | **8** | **4** | **2** | **1** |
| 0 | 0 | 1 | 1 | 0 | 0 | 1 | 1 |

1. We add up the values from the ‘value headers’ under the binary digits that take the value of 1.
2. By using the example above the decimal number = 51

(1 +2 + 16 + 32)

Task 2.

Convert the following binary numbers to decimal:

1. 01010101
2. 00001111
3. 11110000
4. 11001111
5. 11100111

Converting Decimal to Binary

When converting decimal to binary, once again write the ‘value headers’ from right to left and place a binary digit of 1 under the ‘value headers’ as required.

For example, imagine we wanted to write the binary number for 20. We would use the following method:

1. Write out the ‘value headers’ from right to left:

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **128** | **64** | **32** | **64** | **8** | **4** | **2** | **1** |

1. Look at the ‘value headers’ and find the largest number that is less than the number 20.
2. Place a binary digit (1) underneath that number. In our example it would be the number 16 and find a ‘value header’ that we could use to increase the number value (by adding) to 20. In this example we could use the number 4.
3. This means that our binary number would be:

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **128** | **64** | **32** | **16** | **8** | **4** | **2** | **1** |
| 0 | 0 | 0 | 1 | 0 | 1 | 0 | 0 |

So, the answer for 20 = 00010100 in binary.

Task 3

Convert the following decimal numbers to binary numbers:

1. 3
2. 15
3. 132
4. 17
5. 224

**Question to think about**: What is the largest decimal number that can be calculated using 8 bits ( 8 binary digits)?

The Hexadecimal Number System

Hexadecimal (hex), using a base of 16:

|  |  |  |
| --- | --- | --- |
| Decimal | Hexadecimal | Binary |
| 0 | 0 | 0 |
| 1 | 1 | 1 |
| 2 | 2 | 10 |
| 3 | 3 | 11 |
| 4 | 4 | 100 |
| 5 | 5 | 101 |
| 6 | 6 | 110 |
| 7 | 7 | 111 |
| 8 | 8 | 1000 |
| 9 | 9 | 1001 |
| 10 | A | 1010 |
| 11 | B | 1011 |
| 12 | C | 1100 |
| 13 | D | 1101 |
| 14 | E | 1110 |
| 15 | F | 1111 |
| 16 | 10 | 10000 |

We may need to convert from binary to hexadecimal and from hexadecimal to binary when needed.

The method to binary to hexadecimal (hex) uses the following method and using the binary place values as before:

Binary 0101 1111 0110 0001

Hex 5 F 6 1 = 5F61

We may also need to hexadecimal (hex) to binary. To do this we use this method:

1. Group the bits into groups of 4
2. Translate each group into binary

Hex 3 4

Binary 0011 0100 = 00110100

Task 4

1. Convert the following binary numbers into hexadecimal:
2. 1111000010101100
3. 0000111101010001
4. 0011001100110011
5. 1010101010101010
6. Convert the following hexadecimal (hex) numbers into binary
7. 23
8. 12
9. 10
10. 55

Binary Addition

The rules for binary addition are as follows:

0 + 0 = 0

0 + 1 = 1

1 + 0 = 1

1 + 1 = 0 carry 1

1 + 1 + 1 = 1 carry 1

Example:

 1100 +

 1110

11010

Task 5:

*Add the following binary numbers*

1. 0001 + 0100
2. 1110 + 0001
3. 0011 + 1100

Binary Subtraction

Use the following method for binary subtraction:

Example 011101 – 000111

011101 is the Minuend

000111 is the Subtrahend

1. Convert the subtrahend to two’s complement (flip the bits – 0’s to 1’s and 1’s to 0’s) and add 1

 111000 +

 1

 111001

1. Add the Minuend to the now two’s complemented subtrahend

 011101 +

 111001

 1010110

(ignore the carried bit)

The example above should illustrate 29 - 7 = 22

Task 6:

Using the method above, attempt the following binary subtraction :

1. 1111 – 0001
2. 0111 – 0011

Calculating the Range

With 8 bits, the maximum decimal range that can be represented is -128 to 127.

The leftmost bit (most significant bit) is used as a sign bit to indicate if the number is negative.

If the leftmost (most significant bit) is a 1 it is negative.

If the leftmost (most significant bit) is a 0 it is positive

10000000 = -128

-(2 (n-1) … 2 (n-1) – 1

Means:

-128 …. 127

With 8 bits, the maximum decimal range that can be represented by two’s complement is -128 - 127

Binary Multiplication

Use the following method for binary multiplication.

Example: multiply the following binary words together - using the rules of binary multiplication:

1 x 1 = 1

1 x 0 = 0

0 x 1 = 0

0 x 0 = 0

1001 x 101

 1001 x

 101

1. Take each digit of the first number and multiply is separately by each digit of the second number
2. In our example we are going to multiply every digit of the number 1001 – by firstly 1, then 0 and finally 1. (The values of the second number)

The lines of multiplication should be as follows:

1. 1001 x

 101

 1001  ( 1 x 1, 0 x 1, 0 x 1, 1 x 1)

 00000  ( fill in with a 0 and then 1 x 0, 0 x 0, 0 x 0, 1 x 0)

 100100  (fill in with 2 0s and then 1 x 1, 0 x 1, 0 x 1, 1 x 1)

1. Add the 3 rows of binary digits together:

 1001

 00000

 100100 +

 **101101**

Task 7:

Convert the following decimal values **to** **4 bit binary words and multiply together**.

1. 4 x 2
2. 3 x 10
3. 15 x 2
4. 15 x 15

**End of Questions**