Hexadecimal Numbers

- **Hexademical number system**: number system based on number 16

    - Has **16** digits: 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, A, B, C, D, E, F
    - Value of digits increase by **16** for each position

    ```
    Example:

        BAD(16) = 11 x 16² + 10 x 16¹ + 13 x 8⁰
                = 2816 + 160 + 13 = 2989₁₀
    ```

- Finding the representation of a value in the hexadecimal number system:

    - Divide the value repeated by 16
    - Collect the remainders in the reverse order

    (The procedure is exactly the same as the one to find the representation for a value in the binary number system, except you need to divide by 8 instead of 2)

    ```
     Example:

         value = 30

     Find the representation in the octal number system:

            30
      16 ------ 14   (= E)
             1
      16 ------ 1
             0

        representation is ----> 1E(16)
    ```

- Hexadecimal numbers are also mainly used to show binary code because hexadecimal number can be converted easily to binary numbers and vice versa.

- **Converting hexadecimal numbers to binary numbers:**

    - Convert each octal digit to 4 binary digits using:

    ```
            Hex digit            Binary digits
            -----------          -------------
                0       -->          0000
                1       -->          0001
                2       -->          0010
                3       -->          0011
                4       -->          0100
                5       -->          0101
                6       -->          0110
                7       -->          0111
                8       -->          1000
    ```

```
                    9      -->       1001
                    A      -->       1010
                    B      -->       1011
                    C      -->       1100
                    D      -->       1101
                    E      -->       1110
                    F      -->       1111
```

Example:

BAD$_{(16)}$ = **1011**10101101
901$_{(16)}$ = **1001**00000001

- **Converting binary numbers to hexadecimal numbers:**

  - Convert (starting from the right) each **group** of **4 binary digits** into **one hexadecimal digit** using:

```
        Binary digits      Hex digit
        -------------      -----------
           0000      -->        0
           0001      -->        1
           0010      -->        2
           0011      -->        3
           0100      -->        4
           0101      -->        5
           0110      -->        6
           0111      -->        7
           1000      -->        8
           1001      -->        9
           1010      -->        A
           1011      -->        B
           1100      -->        C
           1101      -->        D
           1110      -->        E
           1111      -->        F
```

Example:

1101**0101** = **D5**$_{(16)}$
1001**0001** = **91**$_{(16)}$ (Note: this is NOT equal to 91 decimal !)

- NOTE: we prefer to use hexadecimal number to represent binary numbers because 2 hexadecimal digits is equal to 1 byte !