Numerical Representation and Codes

Exercises Digital Design

1 NUM - Number systems

1.1 Determine up to what value you can count with numbers coded on:

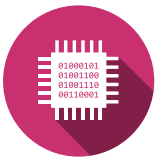
a) 4 bits
b) 8 bits
c) 10 bits
c) 16 bits
d) 32 bits

num/number-systems-01

1.2 Determine up to which value can be counted, with hexadecimal numbers encoded on:

a) 4 Digits
b) 8 Digits

num/number-systems-02



2 | NUM - Converting from one numbering system to another

2.1 Perform the conversion of the following pure binary numbers in decimal format:

a) $110_2 = ?_{10}$
b) $1111_2 = ?_{10}$
c) $01001010_2 = ?_{10}$
d) $1011_2 = ?_{10}$
e) $11111111_2 = ?_{10}$

num/conversion-01

2.2 Perform the conversion of the following decimal numbers in binary format:

a) a) $125_{10} = ?_2$
b) $16_{10} = ?_2$
c) $65113_{10} = ?_2$
d) $256_{10} = ?_2$
e) $9_{10} = ?_2$

num/conversion-02

2.3 Perform the conversion of the following hexadecimal numbers in binary format:

a) $E_{16} = ?_2$
b) $15C_{16} = ?_2$
c) $\mathrm{AB3D}_{16} = ?_2$
d) $\mathrm{9F7}_{16} = ?_2$
e) $2346_{16} = ?_2$

num/conversion-03

2.4 Perform the conversion of the following binary numbers in hexadecimal format:

a) $1010_2 = ?_{16}$
b) $110_2 = ?_{16}$
c) $11101011_2 = ?_{16}$
d) $0101111_2 = ?_{16}$
e) $1100_2 = ?_{16}$

num/conversion-04

2.5 Perform the conversion of the following hexadecimal numbers in decimal format:

a) $D_{16} = ?_{10}$
b) $15C_{16} = ?_{10}$
c) $234_{16} = ?_{10}$
d) $\mathrm{FE}_{16} = ?_{10}$
e) $\mathrm{A6B9}_{16} = ?_{10}$

num/conversion-05

2.6 Perform the conversion of the following decimal numbers in hexadecimal format:

1. $128_{10} = ?_{16}$
2. $16_{10} = ?_{16}$
3. $65113_{10} = ?_{16}$
4. $209_{10} = ?_{16}$
5. $9_{10} = ?_{16}$

num/conversion-06

3 NUM - Operation on logical numbers

3.1 Perform the following additions in the binary system:

1. $0000\ 1100_2 + 0001\ 1110_2$
2. $0000\ 1111_2 + 0101\ 1010_2$
3. $0011\ 0100_2 + 0111\ 1111_2$
4. $0111\ 1111_2 + 0000\ 0001_2$

num/operation-01

3.2 Perform the following subtractions in the binary system:

1. $0100\ 0011_2 - 0000\ 1001_2$
2. $1010\ 0110_2 - 0110\ 1100_2$
3. $0011\ 0100_2 - 0010\ 1000_2$
4. $1000\ 0000_2 - 0000\ 0001_2$

num/operations-02

3.3 Perform the following multiplications in binary:

1. $1010_2 * 0110_2$
2. $0110_2 * 1010_2$
3. $1000_2 * 0110_2$
4. $0111_2 * 1110_2$

num/operation-03

3.4 Perform the following additions in the hexadecimal system:

1. $1234_{16} + \mathrm{CC}_{16}$
2. $8888_{16} + \mathrm{FC}_{16}$
3. $1234_{16} + \mathrm{FF}_{16}$
4. $89\mathrm{AB}_{16} + \mathrm{AB89}_{16}$

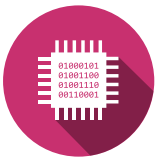
num/operation-04

3.5 Determine the binary value of:

1. $(11_2)^2$
2. $(111_2)^2$
3. $(1111_2)^2$

By analogy, estimate the binary value of $(111111_2)^2$ and use it to check the formula: $(2^n - 1)^2 = 2^{2n} - 2 * 2^n + 1$.

num/operation-05



4 NUM - Codes

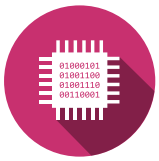
4.1 Perform the following additions on BCD encoded numbers:

1. $0001\ 0010\ 0011_{\text{BCD}} + 0011\ 0010\ 0001_{\text{BCD}}$
2. $0011\ 0110\ 1001_{\text{BCD}} + 0010\ 0110\ 0100_{\text{BCD}}$
3. $1000\ 0101_{\text{BCD}} + 0000\ 0111_{\text{BCD}}$
4. $1001\ 1001_{\text{BCD}} + 0000\ 0001_{\text{BCD}}$

num/codes-01

4.2 Perform the conversion of the Gray code 1001_{Gray} using the recursion formula in the script.

num/codes-02



5 | NUM - Representation of signed numbers

5.1 Represent the following decimal and pure binary numbers encoded to 8 bits using the sign-size, one's complement, and two's complement methods:

1. $+18_{10}$
2. -3_{10}
3. 0_{10}
4. $0001\ 1010_2$
5. 1010_2
6. -100_{10}

num/representation-01

1. $0000\ 0001_2$
2. $0111\ 1000_2$
3. $1111\ 0000_2$
4. 01_{16}
5. 44_{16}
6. 81_{16}

num/representation-02

5.2 Given the numbers 0001_2 and 1001_2 expressed as two's complement encoded on 4 bits. Represent the same numbers encoded as two's complement on 8 bits.

num/representation-03