



Numerical Representation and Codes

Exercises Digital Design

Solution vs. Hints:



While not every response provided herein constitutes a comprehensive solution, some serve as helpful hints intended to guide you toward discovering the solution independently. In certain instances, only a portion of the solution is presented.

1 | NUM - Number systems

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

- | | |
|--------------|--------------------------------|
| a) 0 to 15 | d) 0 to 65535 |
| b) 0 to 255 | e) 0 to 4'294'967'295 (4 Gbit) |
| c) 0 to 1023 | |

num/number-systems-01

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

- | | |
|---------------|--------------------------------|
| a) 0 to 65535 | b) 0 to 4'294'967'295 (4 Gbit) |
|---------------|--------------------------------|

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) 6_{10} | c) 74_{10} | e) 255_{10} |
| b) 15_{10} | d) 11_{10} | |

num/conversion-01

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

- | | | |
|------------------|-------------------------------|-------------|
| a) $111\ 1101_2$ | c) $1111\ 1110\ 0101\ 1001_2$ | e) 1001_2 |
| b) $1\ 0000_2$ | d) $1\ 0000\ 0000_2$ | |

num/conversion-02

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

- | | | |
|----------------------|-------------------------------|-----------------------------|
| a) 1110_2 | c) $1010\ 1011\ 0011\ 1101_2$ | e) $10\ 0011\ 0100\ 0110_2$ |
| b) $1\ 0101\ 1100_2$ | d) $1001\ 1111\ 0111_2$ | |

num/conversion-03

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

- | | | |
|-------------|--------------|-------------|
| a) A_{16} | c) EB_{16} | e) C_{16} |
| b) 6_{16} | d) $2F_{16}$ | |

num/conversion-04

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

- | | | |
|---------------|---------------|-----------------|
| a) 13_{10} | c) 564_{10} | e) 42681_{10} |
| b) 348_{10} | d) 254_{10} | |

num/conversion-05

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

- | | | |
|--------------|----------------|-------------|
| 1. 80_{16} | 3. $FE59_{16}$ | 5. 9_{16} |
| 2. 10_{16} | 4. $D1_{16}$ | |

num/conversion-06



3 | NUM - Operation on logical numbers

3.1 Perform the following additions in the binary system:

- | | |
|-------------------|-------------------|
| 1. $0010\ 1010_2$ | 3. $1011\ 0011_2$ |
| 2. $0110\ 1001_2$ | 4. $1000\ 0000_2$ |

num/operation-01

3.2 Perform the following subtractions in the binary system:

- | | |
|-------------------|-------------------|
| 1. $0011\ 1010_2$ | 3. $0000\ 1100_2$ |
| 2. $0011\ 1010_2$ | 4. $0111\ 1111_2$ |

num/operations-02

3.3 Perform the following multiplications in binary:

- | | |
|-------------------|-------------------|
| 1. $0011\ 1100_2$ | 3. $0011\ 0000_2$ |
| 2. $0011\ 1100_2$ | 4. $0110\ 0010_2$ |

num/operation-03

3.4 Perform the following additions in the hexadecimal system:

- | | |
|----------------|-----------------|
| 1. 1300_{16} | 3. 1333_{16} |
| 2. 8984_{16} | 4. 13534_{16} |

num/operation-04

3.5 Determine the binary value of:

- | | |
|---------------|---|
| 1. 1001_2 | 3. 11100001_2 |
| 2. 110001_2 | 4. $111110000001_2 ; (2^{n-1} - 1) * 2^{n+1} + 1$ |

num/operation-05



4 | NUM - Codes

4.1 Perform the following additions on BCD encoded numbers:

1. $0100\ 0100\ 0100_{\text{BCD}}$
2. $0110\ 0011\ 0011_{\text{BCD}}$

3. $1001\ 0010_{\text{BCD}}$
4. $0001\ 0000\ 0000_{\text{BCD}}$

num/codes-01

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

1110_2

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. 0001 0010 _s | 4. 0001 1010 _s |
| 0001 0010 _{1cl} | 0001 1010 _{1cl} |
| 0001 0010 _{2cl} | 0001 1010 _{2cl} |
| 2. 1000 0011 _s | 5. 0000 1010 _s |
| 1111 1100 _{1cl} | 0000 1010 _{1cl} |
| 1111 1101 _{2cl} | 0000 1010 _{2cl} |
| 3. 0000 0000 _s ; 1000 0000 _s | 6. 1110 0100 _s |
| 0000 0000 _{1cl} ; 1111 1111 _{1cl} | 1001 1011 _{1cl} |
| 0000 0000 _{2cl} | 1001 1100 _{2cl} |

num/representation-01

- | | | |
|---------------------------|---------------------------|---------------------|
| 1. 1111 1111 ₂ | 3. 0001 0000 ₂ | 5. BC ₁₆ |
| 2. 1000 1000 ₂ | 4. FF ₁₆ | 6. 7F ₁₆ |

num/representation-02

5.2 Given the numbers 0001₂ and 1001₂ expressed as two's complement encoded on 4 bits. Represent the same numbers encoded as two's complement on 8 bits.

0000 0001; 1111 1001

num/representation-03