Autonomous Systems

Exercise 1

1. Write the numbers in Binary, Gray, Hexadecimal, Octa, and Quaternary code (Base 4).

$$59,\ 71,\ 21,\ 98,\ 44,\ 33,\ 50,\ 19,\ 5,\ 32,\ 204,\ 504,\ 256,\ 124.$$

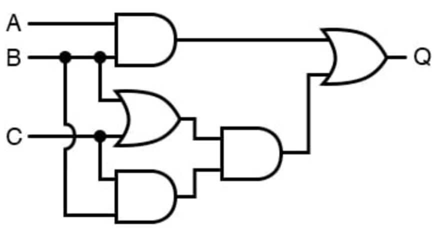
2. How many bits do we need in order to represent:
   - All the elements of the sets $\{-71, -70, ..., 23, 24\}$ and $\{3n + 1 : -5 < n < 11, n \in \mathbb{N}\}$.
   - 9 Unique Symbols. 17 Unique Symbols. 60 Unique Symbols. 1325 Unique Symbols.

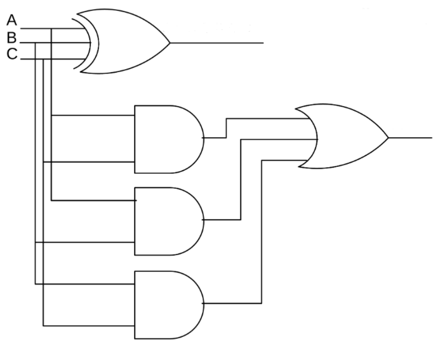
3. Simplify the following functions:

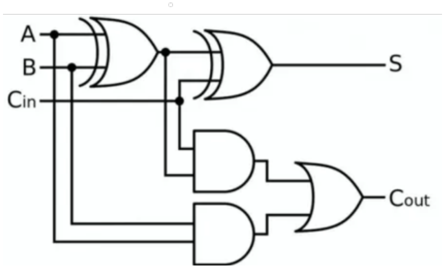
$$\begin{aligned}
F_1(X, Y) &= X\overline{Y} + Y.\\
F_2(X, Y, Z) &= X \cdot Z + Y \cdot (\overline{X} \cdot Z + \overline{Y}).\\
F_3(A, B, C) &= B \cdot (A \cdot B + A \cdot \overline{B}) \cdot (\overline{A \cdot C} + C).\\
F_4(A, B, C, D) &= \overline{(C + A \cdot B \cdot \overline{C} + \overline{B} \cdot \overline{C} \cdot D)} + \overline{(C + \overline{(C \cdot B + D)})}.\\
F_5(X, Y, Z, W) &= W \cdot X \cdot Y \cdot Z + W \cdot X \cdot Y \cdot \overline{Z} + W \cdot X \cdot \overline{Y} \cdot Z + W \cdot X \cdot \overline{Y} \cdot \overline{Z}\\
&\quad + \overline{W} \cdot X \cdot Y \cdot \overline{Z} + W \cdot \overline{X} \cdot Y \cdot \overline{Z} + \overline{W} \cdot \overline{X} \cdot \overline{Y} \cdot \overline{Z} + \overline{W} \cdot X \cdot \overline{Y} \cdot Z.
\end{aligned}$$

Exercise 2

1. Turn each of the circuits into boolean expressions.







2. Find the algebric function of the following truth tables using 3 methods.

A	B	C	F
0	0	0	0
0	0	1	1
0	1	0	0
0	1	1	1
1	0	0	1
1	0	1	1
1	1	0	1
1	1	1	1

x	y	z	F
0	0	0	0
0	0	1	1
0	1	0	0
0	1	1	0
1	0	0	1
1	0	1	1
1	1	0	1
1	1	1	1

A	B	C	F
0	0	0	1
0	0	1	0
0	1	0	0
0	1	1	1
1	0	0	1
1	0	1	0
1	1	0	1
1	1	1	0

Exercise 3

- A 4-bit binary number is represented as $A_3A_2A_1A_0$, where A_0 is the LSB. Design a logic circuit that will produce a HIGH output whenever the binary number is greater than 0010 and less than 1000.
- Design a combinatorial circuit that detects the parity of a 4-bits sequence coded on the inputs A, B, C and D. The output $F(A, B, C, D)$ is equal to 0 if the number of 1's is even and 1 otherwise.
- Design the combinational circuit that converts a 3-bit binary number to its gray code.

Bonus Question

Examine the sequential circuit below. First, give a complete truth table, then describe conceptually what the circuit does.