Synthesis and Analysis

given a problem (statement)
↓
construct a solution
↓
you will tools, approaches, methods

Science (laws, theorems)
Components

Example: software

# problem: Build a game
↓
programming language
Design, implement

hardware:

- problem statement
  ↓
- logic gate circuit

Synthesis

Given an object
↑
find out what it is?
Determine
what does it do?

Code reading
Code reviews
Unit testing

Logic circuit is given
↓
find out what it does?
Function?
Synthesis

Problem statement: Given a 3-input output 1 (true) when there are odd number of 1's in the input; otherwise output a 0. "Even parity generator." 

1. Block diagram

2. Truth Table

<table>
<thead>
<tr>
<th>x</th>
<th>y</th>
<th>z</th>
<th>f</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>0</td>
<td>1</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>0</td>
<td>1</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>1</td>
<td>0</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>1</td>
<td>0</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>

f(x, y, z) = \overline{m_0} m_1 m_2 m_3 m_4 m_5 m_6 m_7

3. Write the function in terms of minterms.

"Sum"

\[ f(x, y, z) = \sum (m_1, m_2, m_4, m_7) \]

\[ = m_1 + m_2 + m_4 + m_7 \]

\[ = \sum (1, 2, 4, 7) \]

\[ = x'y'z + x'y'z' + xy'z' + xy'z \]

4. Simplify or minimize to \( \downarrow \) no. of terms

\( \downarrow \) no. of literals

\[ = x'(y'z + yz') + x(y'z' + yz) \]

\[ = x'(y + z) + x(y + z)' \]

Substitute \( y + z \)

\[ = x' \cdot a + x \cdot a' = x \odot a \]

\[ = x \oplus y \oplus z \]
5. Draw the circuit

\[ f(x, y, z) = x'y'z + x'yz' + xy'z' + xyz \]

\[ f(x, y, z) = \text{OR} \]

\[ \text{AND} \]

\[ \text{AND} \]

\[ \text{AND} \]

\[ \text{AND} \]

\[ \text{XOR} \]

\[ \text{XOR} \]

\[ \text{XOR} \]
\[ f(x, y, z) = xy + y'z \]

1. 1 \text{ NOT gate} \Rightarrow 7404 \Rightarrow 6 \text{ NOT gates}
2. 2 \text{ AND gates} \Rightarrow 7408 \Rightarrow \text{Quad 2-input AND gates}
3. 1 \text{ OR gates} \Rightarrow 7432 \Rightarrow \text{Quad 2-input OR gates}

\begin{align*}
\text{chip} & \quad \underline{\text{16 NOT gates}} \\
7404 & \quad 7408 & \quad 7432 \\
5/6 & \quad 50\% & \quad 50\%
\end{align*}

\[ \text{NAND} \quad \downarrow \quad \text{OR} \quad \text{NOR} \]