# Lab 2: The Design Hierarchy

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## Part I

1. If the truth table in Table 2.1 of the handout was given in full, how many rows would it have?

   Since we have 2 selection lines ($s_0$ and $s_1$) and we also have 4 inputs (u,v,w,x) we will have a total of 6 lines to consider. Since each line can be either a 0 or a 1, we have in total $2^6 = 64$

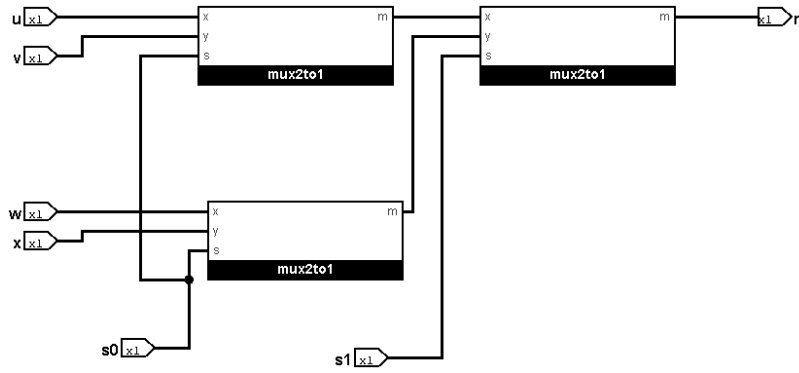2. Export the schematic of the mux4to1 subcircuit as an image and include it in your report.



Figure 1: A schematic of the 4-to-1 multiplexer

## Part II

1. Derive seven truth tables, one for each segment of the 7-segment decoder.

| $D_{3:0}$ | Character | $S_0$ | $S_1$ | $S_2$ | $S_3$ | $S_4$ | $S_5$ | $S_6$ |
|-----------|-----------|-------|-------|-------|-------|-------|-------|-------|
| 0000 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 0 |
| 0001 | 1 | 0 | 1 | 1 | 0 | 0 | 0 | 0 |
| 0010 | 2 | 1 | 1 | 0 | 1 | 1 | 0 | 1 |
| 0011 | 3 | 1 | 1 | 1 | 1 | 0 | 0 | 1 |
| 0100 | 4 | 0 | 1 | 1 | 0 | 0 | 1 | 1 |
| 0101 | 5 | 1 | 0 | 1 | 1 | 0 | 1 | 1 |
| 0110 | 6 | 1 | 0 | 1 | 1 | 1 | 1 | 1 |
| 0111 | 7 | 1 | 1 | 1 | 0 | 0 | 0 | 0 |
| 1000 | 8 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| 1001 | 9 | 1 | 1 | 1 | 0 | 0 | 1 | 1 |
| 1010 | A | 1 | 1 | 1 | 0 | 1 | 1 | 1 |
| 1011 | b | 0 | 0 | 1 | 1 | 1 | 1 | 1 |
| 1100 | c | 1 | 0 | 0 | 1 | 1 | 1 | 0 |
| 1101 | d | 0 | 1 | 1 | 1 | 1 | 0 | 1 |
| 1110 | E | 1 | 0 | 0 | 1 | 1 | 1 | 1 |
| 1111 | F | 1 | 0 | 0 | 0 | 1 | 1 | 1 |

Table 1: Your Table Caption

2. Use Karnaugh maps to write seven Boolean functions for each segment so that they are optimized.

$$S_0 = (\overline{B} \cdot \overline{D}) + (\overline{A} \cdot C) + (B \cdot C) + (A \cdot \overline{D}) + (\overline{A} \cdot B \cdot D) + (A \cdot \overline{B} \cdot \overline{C})$$
$$S_1 = (\overline{A} \cdot \overline{B}) + (\overline{D} \cdot \overline{B}) + (\overline{D} \cdot \overline{C} \cdot \overline{A}) + (\overline{A} \cdot C \cdot D) + (A \cdot \overline{C} \cdot D)$$
$$S_2 = (\overline{A} \cdot \overline{C}) + (\overline{A} \cdot D) + (\overline{C} \cdot D) + (\overline{A} \cdot B) + (A \cdot \overline{B})$$
$$S_3 = (\overline{A} \cdot \overline{B} \cdot \overline{D}) + (\overline{B} \cdot C \cdot D) + (B \cdot \overline{C} \cdot D) + (B \cdot C \cdot \overline{D}) + (A \cdot \overline{C} \cdot \overline{D})$$
$$S_4 = (\overline{B} \cdot \overline{D}) + (C \cdot \overline{D}) + (A \cdot C) + (A \cdot B)$$
$$S_5 = (\overline{C} \cdot \overline{D}) + (B \cdot \overline{D}) + (A \cdot \overline{B}) + (A \cdot C) + (\overline{A} \cdot B \cdot \overline{C})$$
$$S_6 = (\overline{B} \cdot C) + (C \cdot \overline{D}) + (A \cdot \overline{B}) + (A \cdot D) + (\overline{A} \cdot B \cdot \overline{C})$$

3. Use the naming scheme HEX0, HEX1, ..., HEX6 for each subcircuit. Export each subcircuit schematic as an image and include it in your report.
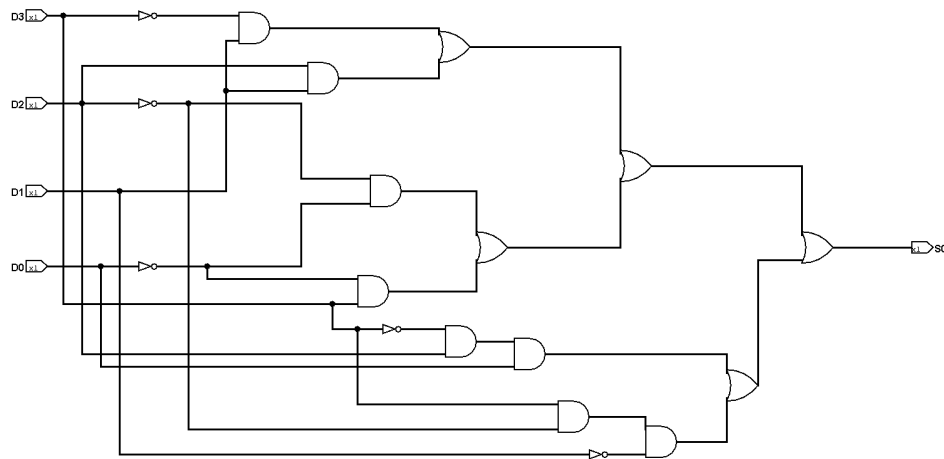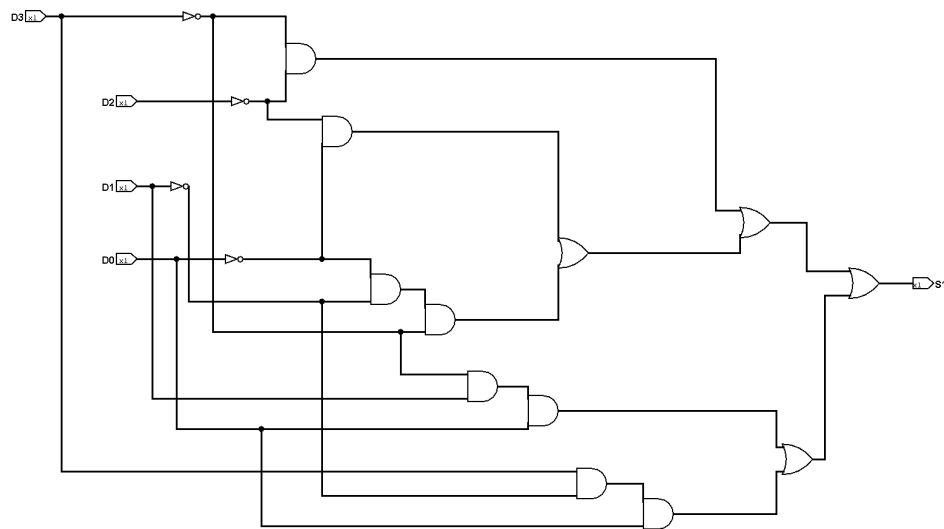


Figure 2: A schematic of HEX0
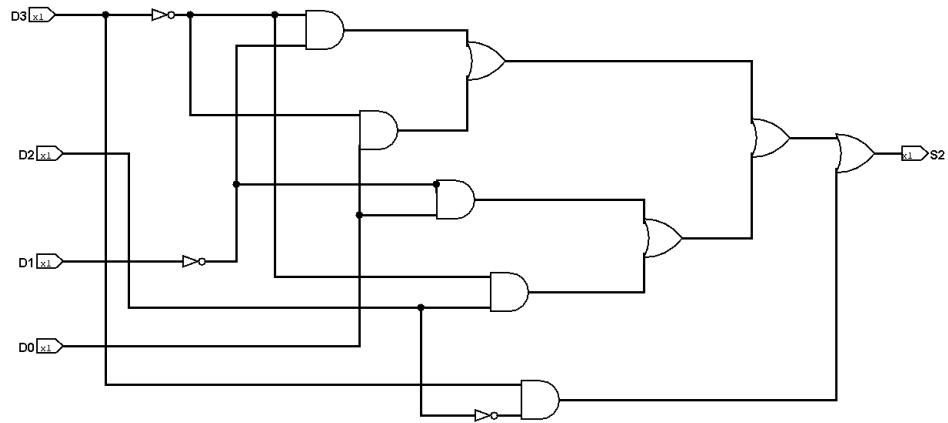


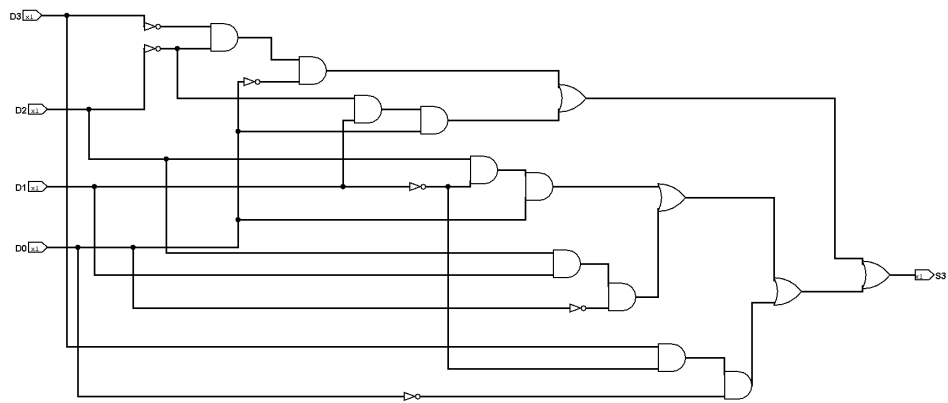Figure 3: A schematic of HEX1

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Figure 4: A schematic of HEX2
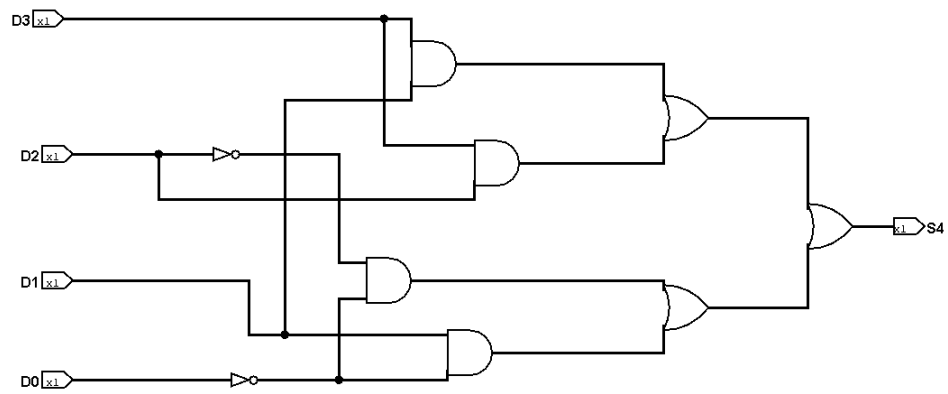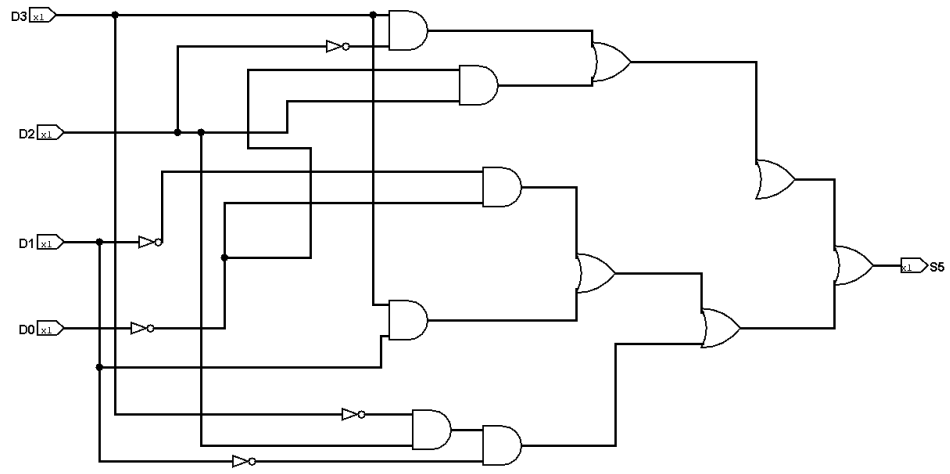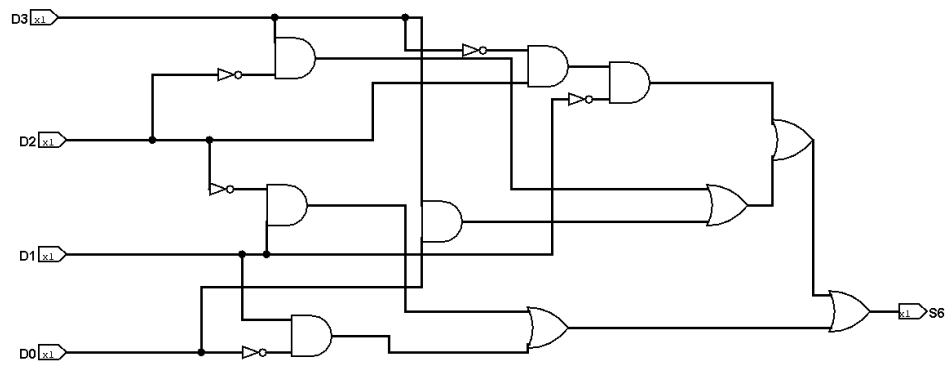


Figure 5: A schematic of HEX3



Figure 6: A schematic of HEX4

Figure 7: A schematic of HEX5

Figure 8: A schematic of HEX6