-post all pre-lab stuff in preliminary design - put at least 1 k-map in the wiki - do the k-maps on the computer

-explain how everything works in lab notebook

-answer lab questions

Chose Spartan 100 instead of 500 – had to regenerate bit file – wrong package was also selected ☹ (something other than FG320)

-requires an active-low input, and the switches set it to high

-explain how LUTS, decoders, etc. work in lab notebook

1. a. Figure – This diagram shows you which segments should be turned on for each hex digit.

Pre-Lab Question 1.

a.

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Hexadecimal Digit | Inputs | | | | Outputs | | | | | | | (in hex) |
| **D3** | **D2** | **D1** | **D0** | **Sg** | **Sf** | **Se** | **Sd** | **Sc** | **Sb** | **Sa** |
| 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 40 |
| 1 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 1 | 79 |
| 2 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 24 |
| 3 | 0 | 0 | 1 | 1 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 30 |
| 4 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 1 | 19 |
| 5 | 0 | 1 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 12 |
| 6 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 02 |
| 7 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 78 |
| 8 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 00 |
| 9 | 1 | 0 | 0 | 1 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 18 |
| A | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 08 |
| B | 1 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 03 |
| C | 1 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 1 | 1 | 27 |
| D | 1 | 1 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 21 |
| E | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 06 |
| F | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 1 | 1 | 1 | 0 | 0E |

b. For each output (Sa, Sb, Sc, etc.), if I had to implement either the SOP or POS in hardware, I would choose to use a sum of products. This is because the majority of the outputs to the 7-segment display in each column are 0’s. When the SOP equation is written, it will only be necessary to look at the ‘1’ outputs, so there will be a smaller number of terms in the equation to look at, making a more simplified equation and a smaller amount of gates necessary to use.

c.

Sum of Products Method:

Sa = D0D1’D2’D3’ + D0’D1’D2D3’ + D0D1D2’D3 + D0’D1’D2D3 + D0D1’D2D3

Sa = D0D1’D2’D3’ + D0’D1’D2D3’ + D0D1D2’D3 + D0’D1’D2D3 + D0D1’D2D3 + D0’D1’D2D3

Sa = D0D1’D2’D3’ + D0’D1’D2 (D3 + D3’)+ D0D1D2’D3 + D1’D2D3(D0 + D0’)

Sa = D0D1’D2’D3’ + D0’D1’D2 + D0D1D2’D3 + D1’D2D3

K-Map Method:

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **D3D2/D1D0** | **00** | **01** | **11** | **10** |
| **00** | 0 | 1 | 0 | 0 |
| **01** | 1 | 0 | 0 | 0 |
| **11** | 1 | 1 | 0 | 0 |
| **10** | 0 | 0 | 1 | 0 |

Sa = D0’D1’D2 + D1’D2D3 + D0D1’D2’D3’ + D0D1D2’D3

The K-Map method appears to be easier to get the simplified form, so it will be used for the rest of the equations.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **D3D2/D1D0** | **00** | **01** | **11** | **10** |
| **00** | 0 | 0 | 0 | 0 |
| **01** | 0 | 1 | 0 | 1 |
| **11** | 1 | 0 | 1 | 1 |
| **10** | 0 | 0 | 1 | 0 |

Sb = D0’D2D3 + D0D1D3 + D0’D1D2 + D0D1’D2D3’

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **D3D2/D1D0** | **00** | **01** | **11** | **10** |
| **00** | 0 | 0 | 0 | 1 |
| **01** | 0 | 0 | 0 | 0 |
| **11** | 1 | 0 | 1 | 1 |
| **10** | 0 | 0 | 0 | 0 |

Sc = D1D2D3 + D0’D2D3 + D0’D1D2’D3’

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **D3D2/D1D0** | **00** | **01** | **11** | **10** |
| **00** | 0 | 1 | 0 | 0 |
| **01** | 1 | 0 | 1 | 0 |
| **11** | 0 | 0 | 1 | 0 |
| **10** | 0 | 1 | 0 | 1 |

Sd = D0D1’D2’ + D0D1D2 + D0’D1’D2D3’+ D0’D1D2’D3

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **D3D2/D1D0** | **00** | **01** | **11** | **10** |
| **00** | 0 | 1 | 1 | 0 |
| **01** | 1 | 1 | 1 | 0 |
| **11** | 0 | 0 | 0 | 0 |
| **10** | 0 | 1 | 0 | 0 |

Se = D1’D2D3’ + D0D1’D2’ + D0D3’

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **D3D2/D1D0** | **00** | **01** | **11** | **10** |
| **00** | 0 | 1 | 1 | 1 |
| **01** | 0 | 0 | 1 | 0 |
| **11** | 1 | 1 | 0 | 0 |
| **10** | 0 | 0 | 0 | 0 |

Sf = D1’D2D3 + D1D2’D3’ + D0D1D3’ + D0D1’D2’D3’

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **D3D2/D1D0** | **00** | **01** | **11** | **10** |
| **00** | 1 | 1 | 0 | 0 |
| **01** | 0 | 0 | 1 | 0 |
| **11** | 0 | 0 | 0 | 0 |
| **10** | 0 | 0 | 0 | 0 |

Sg = D1’D2’D3’ + D0D1D2D3’

d. Simplified Boolean Equations

Sa = D0’D1’D2 + D1’D2D3 + D0D1’D2’D3’ + D0D1D2’D3

Sb = D0’D2D3 + D0D1D3 + D0’D1D2 + D0D1’D2D3’

Sc = D1D2D3 + D0’D2D3 + D0’D1D2’D3’

Sd = D0D1’D2’ + D0D1D2 + D0’D1’D2D3’+ D0’D1D2’D3

Se = D1’D2D3’ + D0D1’D2’ + D0D3’

Sf = D1’D2D3 + D1D2’D3’ + D0D1D3’ + D0D1’D2’D3’

Sg = D1’D2’D3’ + D0D1D2D3’