BOOLEAN EQUATION TABLE FOR the DIGITAL DISPLAY

1) Complete the truth table

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| X1 | X2 | X3 | X4 | Decimal  Digit |  | Z7 | Z6 | Z5 | Z4 | Z3 | Z2 | Z1 |
| 0 | 0 | 0 | 0 | 0 |  | 1 | 1 | 1 | 0 | 1 | 0 | 1 |
| 0 | 0 | 0 | 1 | 1 |  | 0 | 1 | 0 | 0 | 1 | 0 | 0 |
| 0 | 0 | 1 | 0 | 2 |  | 1 | 0 | 1 | 1 | 1 | 0 | 1 |
| 0 | 0 | 1 | 1 | 3 |  | 1 | 1 | 0 | 1 | 1 | 0 | 1 |
| 0 | 1 | 0 | 0 | 4 |  | 0 | 1 | 0 | 0 | 1 | 1 | 0 |
| 0 | 1 | 0 | 1 | 5 |  | 1 | 1 | 0 | 1 | 0 | 1 | 1 |
| 0 | 1 | 1 | 0 | 6 |  | 1 | 1 | 1 | 1 | 0 | 1 | 0 |
| 0 | 1 | 1 | 1 | 7 |  | 0 | 1 | 0 | 0 | 1 | 0 | 1 |
| 1 | 0 | 0 | 0 | 8 |  | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| 1 | 0 | 0 | 1 | 9 |  | 0 | 1 | 0 | 1 | 1 | 1 | 1 |

**Implementation of Boolean Functions**

Any Boolean function can be implemented in electronic form as a network of gates.

For any given function, there are a number of alternative realizations.

Consider the Boolean function represented by the truth table above.

We can express this function by simply itemizing the combinations of values of X1, X2, X3 and X4 that cause Z1 to Z7 to be 1:

There are seven combinations of input values that cause Z1 to be 1, and if any one of these combinations occurs, the result is 1.

This form of expression, for self-evident reasons, is known as the *sum of products* (SOP) form.

The SOP form expresses that the output is 1 if any of the input combinations that produce 1 is true.

2) Display Z1 thru Z7 in SOP format:

Z1= !(X1)!(X2)!(X3)!(X4) + !(X1)!(X2)(X3)!(X4) + !(X1)!(X2)(X3)(X4) + !(X1)(X2)!(X3)(X4) + !(X1)(X2)(X3)(X4) + (X1)!(X2)!(X3)!(X4) + (X1)!(X2)!(X3)(X4)

Z2= !(X1)(X2)!(X3)!(X4) + !(X1)(X2)!(X3) (X4) + !(X1)(X2)(X3)!(X4) + (X1)!(X2)!(X3)!(X4) + (X1)!(X2)!(X3)(X4)

Z3= !(X1)!(X2)!(X3)!(X4) + !(X1)!(X2)!(X3)(X4) + !(X1)!(X2)(X3)!(X4) + !(X1)!(X2)(X3)(X4) + !(X1)(X2)!(X3)!(X4) + !(X1)(X2)(X3)(X4) + (X1)!(X2)!(X3)!(X4) + (X1)!(X2)!(X3)(X4)

Z4= !(X1)!(X2)(X3)!(X4) + !(X1)!(X2)(X3)(X4) + !(X1)(X2)!(X3)(X4) + !(X1)(X2)(X3)!(X4) + (X1)!(X2)!(X3)!(X4) + (X1)!(X2)!(X3)(X4)

Z5= !(X1)!(X2)!(X3)!(X4) + !(X1)!(X2)(X3)!(X4) + !(X1)(X2)(X3)!(X4) + (X1)!(X2)!(X3)!(X4)

Z6= !(X1)!(X2)!(X3)!(X4) + !(X1)!(X2)!(X3)(X4) + !(X1)!(X2)(X3)(X4) + !(X1)(X2)!(X3)!(X4) + !(X1)(X2)!(X3)(X4) + !(X1)(X2)(X3)!(X4) + !(X1)(X2)(X3)(X4) + (X1)!(X2)!(X3)!(X4) + (X1)!(X2)!(X3)(X4)

Z7= !(X1)!(X2)!(X3)!(X4) + !(X1)!(X2)(X3)!(X4) + !(X1)!(X2)(X3)(X4) + !(X1)(X2)!(X3)(X4) + !(X1)(X2)(X3)!(X4) + (X1)!(X2)!(X3)!(X4)