***Karnaugh Map***

1.    Design a circuit with inputs x, y, z and w. When the binary input is 0, 1, 2, 3,4,5,6, and 7 the binary output is one greater than the input.  When the binary input is 8, 9, 10, 11, 12,13,14, and 15 the binary output is one less than the input.

A = WZ + WY + XYZ + WXY’

B = W’XY’ + XY’Z + WXY + XYZ’ + WX’Y’Z’ + W’X’YZ

C = WY’Z’ + W’Y’Z + WYZ + W’YZ’

D = Z’

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| A |  |  |  |  |  |  |  |  |
|  | YZ |  |  |  |  |  |  |  |
| WX | 00 | 01 | 11 | 10 |  |  |  |  |
| 00 | 0 | 0 | 0 | 0 |  |  |  |  |
| 01 | 0 | 0 | 1 | 0 |  |  |  |  |
| 11 | 1 | 1 | 1 | 1 |  |  |  |  |
| 10 | 0 | 1 | 1 | 1 |  |  |  |  |
|  |  |  |  |  |  |  |  |  |
| B |  |  |  |  |  |  |  |  |
|  | YZ |  |  |  |  |  |  |  |
| WX | 00 | 01 | 11 | 10 |  |  |  |  |
| 00 | 0 | 0 | 1 | 0 |  |  |  |  |
| 01 | 1 | 1 | 0 | 1 |  |  |  |  |
| 11 | 0 | 1 | 1 | 1 |  |  |  |  |
| 10 | 1 | 0 | 0 | 0 |  |  |  |  |
|  |  |  |  |  |  |  |  |  |
| C |  |  |  |  |  |  |  |  |
|  | YZ |  |  |  |  |  |  |  |
| WX | 00 | 01 | 11 | 10 |  |  |  |  |
| 00 | 0 | 1 | 0 | 1 |  |  |  |  |
| 01 | 0 | 1 | 0 | 1 |  |  |  |  |
| 11 | 1 | 0 | 1 | 0 |  |  |  |  |
| 10 | 1 | 0 | 1 | 0 |  |  |  |  |
|  |  |  |  |  |  |  |  |  |
| D |  |  |  |  |  |  |  |  |
|  | YZ |  |  |  |  |  |  |  |
| WX | 00 | 01 | 11 | 10 |  |  |  |  |
| 00 | 1 | 0 | 0 | 1 |  |  |  |  |
| 01 | 1 | 0 | 0 | 1 |  |  |  |  |
| 11 | 1 | 0 | 0 | 1 |  |  |  |  |
| 10 | 1 | 0 | 0 | 1 |  |  |  |  |
|  |  |  |  |  |  |  |  |  |
| W | X | Y | Z | A | B | C | D |  |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |  |
| 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 |  |
| 0 | 0 | 1 | 0 | 0 | 0 | 1 | 1 |  |
| 0 | 0 | 1 | 1 | 0 | 1 | 0 | 0 |  |
| 0 | 1 | 0 | 0 | 0 | 1 | 0 | 1 |  |
| 0 | 1 | 0 | 1 | 0 | 1 | 1 | 0 |  |
| 0 | 1 | 1 | 0 | 0 | 1 | 1 | 1 |  |
| 0 | 1 | 1 | 1 | 1 | 0 | 0 | 0 |  |
| 1 | 0 | 0 | 0 | 0 | 1 | 1 | 1 |  |
| 1 | 0 | 0 | 1 | 1 | 0 | 0 | 0 |  |
| 1 | 0 | 1 | 0 | 1 | 0 | 0 | 1 |  |
| 1 | 0 | 1 | 1 | 1 | 0 | 1 | 0 |  |
| 1 | 1 | 0 | 0 | 1 | 0 | 1 | 1 |  |
| 1 | 1 | 0 | 1 | 1 | 1 | 0 | 0 |  |
| 1 | 1 | 1 | 0 | 1 | 1 | 0 | 1 |  |
| 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 |  |

2. Design a 4bits combinational circuit 2’s complementer (Unsigned system)

A = W’Z + W’Y + W’XY’ + WX’Y’Z’

B = XY'Z' + W'X'Z + W'X'Y + WX'Z + WX'Y

C = Y’Z + YZ’

D = Z

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| A |  |  |  |  |  |  |  |  |
|  | YZ |  |  |  |  |  |  |  |
| WX | 00 | 01 | 11 | 10 |  |  |  |  |
| 00 | 0 | 1 | 1 | 1 |  |  |  |  |
| 01 | 1 | 1 | 1 | 1 |  |  |  |  |
| 11 | 0 | 0 | 0 | 0 |  |  |  |  |
| 10 | 1 | 0 | 0 | 0 |  |  |  |  |
|  |  |  |  |  |  |  |  |  |
| B |  |  |  |  |  |  |  |  |
|  | YZ |  |  |  |  |  |  |  |
| WX | 00 | 01 | 11 | 10 |  |  |  |  |
| 00 | 0 | 1 | 1 | 1 |  |  |  |  |
| 01 | 1 | 0 | 0 | 0 |  |  |  |  |
| 11 | 1 | 0 | 0 | 0 |  |  |  |  |
| 10 | 0 | 1 | 1 | 1 |  |  |  |  |
|  |  |  |  |  |  |  |  |  |
| C |  |  |  |  |  |  |  |  |
|  | YZ |  |  |  |  |  |  |  |
| WX | 00 | 01 | 11 | 10 |  |  |  |  |
| 00 | 0 | 1 | 0 | 1 |  |  |  |  |
| 01 | 0 | 1 | 0 | 1 |  |  |  |  |
| 11 | 0 | 1 | 0 | 1 |  |  |  |  |
| 10 | 0 | 1 | 0 | 1 |  |  |  |  |
|  |  |  |  |  |  |  |  |  |
| D |  |  |  |  |  |  |  |  |
|  | YZ |  |  |  |  |  |  |  |
| WX | 00 | 01 | 11 | 10 |  |  |  |  |
| 00 | 0 | 1 | 1 | 0 |  |  |  |  |
| 01 | 0 | 1 | 1 | 0 |  |  |  |  |
| 11 | 0 | 1 | 1 | 0 |  |  |  |  |
| 10 | 0 | 1 | 1 | 0 |  |  |  |  |
|  |  |  |  |  |  |  |  |  |
| W | X | Y | Z | A | B | C | D |  |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |  |
| 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 |  |
| 0 | 0 | 1 | 0 | 1 | 1 | 1 | 0 |  |
| 0 | 0 | 1 | 1 | 1 | 1 | 0 | 1 |  |
| 0 | 1 | 0 | 0 | 1 | 1 | 0 | 0 |  |
| 0 | 1 | 0 | 1 | 1 | 0 | 1 | 1 |  |
| 0 | 1 | 1 | 0 | 1 | 0 | 1 | 0 |  |
| 0 | 1 | 1 | 1 | 1 | 0 | 0 | 1 |  |
| 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 |  |
| 1 | 0 | 0 | 1 | 0 | 1 | 1 | 1 |  |
| 1 | 0 | 1 | 0 | 0 | 1 | 1 | 0 |  |
| 1 | 0 | 1 | 1 | 0 | 1 | 0 | 1 |  |
| 1 | 1 | 0 | 0 | 0 | 1 | 0 | 0 |  |
| 1 | 1 | 0 | 1 | 0 | 0 | 1 | 1 |  |
| 1 | 1 | 1 | 0 | 0 | 0 | 1 | 0 |  |
| 1 | 1 | 1 | 1 | 0 | 0 | 0 | 1 |  |

* Simplify the following functions, using K map
* F(A,B,C,D,E)=m0,m1.m4,m5,m16,m17,m21,m25,m29
* F(w,x,y,z) = Σ (2,3,10,11,12,13,14,15)
* F(x,y,z) = Σ (0,2,6,7)
* F(A,B,C ) = Σ (0,2,3,4,6)
* F(a,b,c) = Σ (0,1,2,3,7)
* F(x,y,z) = Σ (3,5,6,7)
* F(A,B,C,D,E)=m0,m1.m4,m5,m16,m17,m21,m25,m29

(E’)

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | CD |  |  |  |
| AB | 00 | 01 | 11 | 10 |
| 00 | 1 | 1 | 0 | 0 |
| 01 | 1 | 1 | 0 | 0 |
| 11 | 0 | 0 | 0 | 0 |
| 10 | 0 | 0 | 0 | 0 |

(E)

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | CD |  |  |  |
| AB | 00 | 01 | 11 | 10 |
| 00 | 1 | 1 | 0 | 0 |
| 01 | 0 | 1 | 0 | 0 |
| 11 | 0 | 1 | 0 | 0 |
| 10 | 0 | 1 | 0 | 0 |

F(A,B,C,D,E) = A’C’E’ + C’DE + A’B’C’

* F(w,x,y,z) = Σ (2,3,10,11,12,13,14,15)

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | yz |  |  |  |
| wx | 00 | 01 | 11 | 10 |
| 00 | 0 | 0 | 1 | 1 |
| 01 | 0 | 0 | 0 | 0 |
| 11 | 1 | 1 | 1 | 1 |
| 10 | 0 | 0 | 1 | 1 |

F(w,x,y,z) = WY + W’X’Y + WXY’

* F(x,y,z) = Σ (0,2,6,7)

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | YZ |  |  |  |
| X | 00 | 01 | 11 | 10 |
| 0 | 1 | 0 | 0 | 1 |
| 1 | 0 | 0 | 1 | 1 |

F(x,y,z) = XY + YZ’ + X’Y’

* F(A,B,C ) = Σ (0,2,3,4,6)

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | BC |  |  |  |
| A | 00 | 01 | 11 | 10 |
| 0 | 1 | 1 | 1 | 1 |
| 1 | 1 | 0 | 0 | 1 |

F(A,B,C) = A’ + C’

* F(a,b,c) = Σ (0,1,2,3,7)

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | BC |  |  |  |
| A | 00 | 01 | 11 | 10 |
| 0 | 1 | 1 | 1 | 1 |
| 1 | 0 | 0 | 1 | 0 |

F(a,b,c) = A’ + BC

* F(x,y,z) = Σ (3,5,6,7)

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | YZ |  |  |  |
| X | 00 | 01 | 11 | 10 |
| 0 | 0 | 0 | 1 | 0 |
| 1 | 0 | 1 | 1 | 1 |

F(x,y,z) = XZ + YZ + XY