**Assignment 2**

**Question1**

a)

Truth table

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Decimal | x | y | z | A | B | C |
| 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| 1 | 0 | 0 | 1 | 0 | 1 | 0 |
| 2 | 0 | 1 | 0 | 0 | 1 | 1 |
| 3 | 0 | 1 | 1 | 1 | 0 | 0 |
| 4 | 1 | 0 | 0 | 0 | 1 | 0 |
| 5 | 1 | 0 | 1 | 0 | 1 | 1 |
| 6 | 1 | 1 | 0 | 1 | 0 | 0 |
| 7 | 1 | 1 | 1 | 1 | 0 | 1 |

b) logic circuit(Logisim .circ file submitted)

Diagram, schematic

Description automatically generated

c)

Using minterms, the Boolean function is:

d)

Using maxterms, the Boolean function is:

e) the Boolean function of =

the circuit is as follow using NAND gates

Diagram

Description automatically generated

**Question 2**

﻿ Implement the following Boolean function with a multiplexer. (Just logic circuit)

1. ﻿𝐹(𝐴, 𝐵, 𝐶, 𝐷) = ∑(0,2,5,8,10,14)= A'B'C'D'+ A'B'CD'+ A'BC'D+ AB'C'D'+ AB'CD'+ ABCD'

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| A | B | C | D | F |  |  |
| 0 | 0 | 0 | 0 | 1 | D' | A'B'C'D' |
| 0 | 0 | 0 | 1 | 0 |  |
| 0 | 0 | 1 | 0 | 1 | D' | A'B'CD' |
| 0 | 0 | 1 | 1 | 0 |  |
| 0 | 1 | 0 | 0 | 0 | D |  |
| 0 | 1 | 0 | 1 | 1 | A'BC'D |
| 0 | 1 | 1 | 0 | 0 | 0 |  |
| 0 | 1 | 1 | 1 | 0 |  |
| 1 | 0 | 0 | 0 | 1 | D' | AB'C'D' |
| 1 | 0 | 0 | 1 | 0 |  |
| 1 | 0 | 1 | 0 | 1 | D' | AB'CD' |
| 1 | 0 | 1 | 1 | 0 |  |
| 1 | 1 | 0 | 0 | 0 | 0 |  |
| 1 | 1 | 0 | 1 | 0 |  |
| 1 | 1 | 1 | 0 | 1 | D' | ABCD' |
| 1 | 1 | 1 | 1 | 0 |  |

1. ﻿𝐹(𝐴, 𝐵, 𝐶, 𝐷) = ∏(2,6,11)= (A+B+C'+D)( A+B'+C'+D)( A'+B+C'+D')

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| A | B | C | D | F |  |  |
| 0 | 0 | 0 | 0 | 1 | 1 |  |
| 0 | 0 | 0 | 1 | 1 |  |
| 0 | 0 | 1 | 0 | 0 | D | A+B+C'+D |
| 0 | 0 | 1 | 1 | 1 |  |
| 0 | 1 | 0 | 0 | 1 | 1 |  |
| 0 | 1 | 0 | 1 | 1 |  |
| 0 | 1 | 1 | 0 | 0 | D | A+B'+C'+D |
| 0 | 1 | 1 | 1 | 1 |  |
| 1 | 0 | 0 | 0 | 1 | 1 |  |
| 1 | 0 | 0 | 1 | 1 |  |
| 1 | 0 | 1 | 0 | 1 | D' |  |
| 1 | 0 | 1 | 1 | 0 | A'+B+C'+D' |
| 1 | 1 | 0 | 0 | 1 | 1 |  |
| 1 | 1 | 0 | 1 | 1 |  |
| 1 | 1 | 1 | 0 | 1 | 1 |  |
| 1 | 1 | 1 | 1 | 1 |  |

**Question3**

a)

﻿Simplify the Boolean function 𝐹(𝐴, 𝐵, 𝐶, 𝐷) = ∏(3,4,6,7,11,12,13,14,15).

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| A | B | C | D | F |
| 0 | 0 | 0 | 0 | 1 |
| 0 | 0 | 0 | 1 | 1 |
| 0 | 0 | 1 | 0 | 1 |
| 0 | 0 | 1 | 1 | 0 |
| 0 | 1 | 0 | 0 | 0 |
| 0 | 1 | 0 | 1 | 1 |
| 0 | 1 | 1 | 0 | 0 |
| 0 | 1 | 1 | 1 | 0 |
| 1 | 0 | 0 | 0 | 1 |
| 1 | 0 | 0 | 1 | 1 |
| 1 | 0 | 1 | 0 | 1 |
| 1 | 0 | 1 | 1 | 0 |
| 1 | 1 | 0 | 0 | 0 |
| 1 | 1 | 0 | 1 | 0 |
| 1 | 1 | 1 | 0 | 0 |
| 1 | 1 | 1 | 1 | 0 |

﻿Karnaugh map for F

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

b) Simplification using ﻿sum-of-products form of F:

F = B'C'+B'D'+A'C'D

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

c) Obtain simplified product-of-sums form of F

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

F= (C'+D')(B'+D)(A'+B')

**Question 4**

![Diagram

Description automatically generated]()

Part2

Part1

From the circuit

Lest's get the Boolean expression from the ciruit.

**Part 1**

((AB')')'+((A'B)')'=AB'+A'B

**Part 2**

(C''+D')=C+D'

So, the final expression is : F= (((AB'+A'B)( C+D'))')'=(AB'+A'B)( C+D')

Truth table for the circuit

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| A | B | C | D | F |
| 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 1 | 0 |
| 0 | 0 | 1 | 0 | 0 |
| 0 | 0 | 1 | 1 | 0 |
| 0 | 1 | 0 | 0 | 1 |
| 0 | 1 | 0 | 1 | 0 |
| 0 | 1 | 1 | 0 | 1 |
| 0 | 1 | 1 | 1 | 1 |
| 1 | 0 | 0 | 0 | 1 |
| 1 | 0 | 0 | 1 | 0 |
| 1 | 0 | 1 | 0 | 1 |
| 1 | 0 | 1 | 1 | 1 |
| 1 | 1 | 0 | 0 | 0 |
| 1 | 1 | 0 | 1 | 0 |
| 1 | 1 | 1 | 0 | 0 |
| 1 | 1 | 1 | 1 | 0 |

a)

﻿K-Map of F

From truth table

b) the sum of the product is

A'BD'+A'BC+AB'D'+AB'C

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

c) the sum of the product is

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

The product of sum is (A+B)(C+D')(A'+B')

**Question5**

a)

﻿ K-Maps for the outputs a

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| D1d0  D3d2 | 00 | 01 | 11 | 10 |
| 00 | 1 | 0 | 1 | 1 |
| 01 | 0 | 1 | 1 | 1 |
| 11 | 1 | 0 | 1 | 1 |
| 10 | 1 | 1 | 0 | 1 |

﻿ K-Maps for the outputs b

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| D1d2  D3d2 | 00 | 01 | 11 | 10 |
| 00 | 1 | 1 | 1 | 1 |
| 01 | 1 | 0 | 1 | 0 |
| 11 | 0 | 1 | 0 | 0 |
| 10 | 1 | 1 | 0 | 1 |

K-Maps for the outputs c

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| D1d0  D3d2 | 00 | 01 | 11 | 10 |
| 00 | 1 | 1 | 1 | 0 |
| 01 | 1 | 1 | 1 | 1 |
| 11 | 0 | 1 | 0 | 0 |
| 10 | 1 | 1 | 1 | 1 |

K-Maps for the outputs d

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| D2d3  D0d1 | 00 | 01 | 11 | 10 |
| 00 | 1 | 0 | 1 | 1 |
| 01 | 0 | 1 | 0 | 1 |
| 11 | 1 | 1 | 0 | 1 |
| 10 | 1 | 1 | 1 | 0 |

K-Maps for the outputs e

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| D1d0  D3d2 | 00 | 01 | 11 | 10 |
| 00 | 1 | 0 | 0 | 1 |
| 01 | 0 | 0 | 0 | 1 |
| 11 | 1 | 1 | 1 | 1 |
| 10 | 1 | 0 | 1 | 1 |

K-Maps for the outputs f

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| D1d0  D3d2 | 00 | 01 | 11 | 10 |
| 00 | 1 | 0 | 0 | 0 |
| 01 | 1 | 1 | 1 | 1 |
| 11 | 1 | 0 | 1 | 1 |
| 10 | 1 | 1 | 1 | 1 |

K-Maps for the outputs g

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| D1d0  D3d2 | 00 | 01 | 11 | 10 |
| 00 | 0 | 0 | 1 | 1 |
| 01 | 1 | 1 | 0 | 1 |
| 11 | 0 | 1 | 1 | 1 |
| 10 | 1 | 1 | 1 | 1 |

b) ﻿logic equations (sum-of-products form)

1) logic equation for a: d2' d0' + d3' d1+d3' d2 d0 + d2 d1 + d3 d2' d1'+d3 d0'

2) logic equation for b: d3' d2'+ d3' d1' d0' + d2' d0'+ d3' d1 d0 + d3 d1' d0

3) logic equation for c: d3' d1' + d3' d0 + d1' d0 + d3' d2 + d3 d2'

4) logic equation for d: d3' d2' d0' + d2' d1 d0 + d2 d1' d0 +d2 d1 d0' + d3 d1'

5) logic equation for e: d2' d0' + d1 d0' + d3 d1+ d3 d2

6) logic equation for f: d1' d0' + d3' d2 + d3 d2' + d3 d1 + d3 d1

7) logic equation for d: d2' d1 + d1 d0' + d3' d2 d1'+ d3 d2'+ d3 d0

c) Logisim circ file submitted.

Diagram, schematic

Description automatically generated