# **Section 4 Assignment (123 points) – Boolean Functions**

To receive credit, you must either show your work on the worksheet or explain how you got the answer.

1. (12 points) Indicate whether the following Boolean expressions are in conjunctive normal form (CNF), disjunctive normal form (DNF), both (B), or neither (N).
   1. (4 pts) CNF / DNF / B / N

CNF

* 1. (4 pts) CNF / DNF / B / N

DNF

* 1. (4 pts) CNF / DNF / B / N

Neither

1. (10 points) Using the *Simplification Rules for Boolean Variables* and the *Laws of Boolean Algebra,* determine if the two Boolean expressions in each pair are equivalent:

1. (X’ + y’’) + x’y’ = y’
2. (x’ + y) + (x’y’) = y’
3. (y’(x’+y)) (x’(x’+y)) = y’
4. y’x = y’
5. (20 points) Give the Boolean function described by the following digital logic (circuit) diagrams



* 1. (4 pts)





(X’ + y’)’

* 1. (6 pts)



(X \* (x + y))’ + (x+y)



* 1. (10 pts)





(y+x)(x + yz)



((xy) + ((y+x)(x+yz))’



1. (15 pts) For question 3c, use the laws of Boolean algebra to find a simpler circuit that computes the same function (you don’t need to draw it). How many gates would it use?

This is my thought process:

1. ((xy) + ((y+x)(x+yz))’ De Morgans Law
2. (xy)’ \* ((y+x)’ + (x+y+z)’) De Morgans Law
3. (xy)’ \* ((y’x’) + (x’y’z’)) De Morgans Law
4. (x’ + y’) \* (y’x’) Absorptions Law and De Morgans Law
5. This would use 5 gates total: 2 NOT gates, 1 OR gate, and 2 AND gate



1. (18 points) Draw the digital logic (circuit) diagrams for the following Boolean functions
   1. (6 pts)

A picture containing building

Description automatically generated

* 1. (6 pts)

A close up of text on a white background

Description automatically generated

* 1. (6 pts)

A picture containing text, whiteboard

Description automatically generated

1. (18 points) For each Karnaugh map, use the *Kmap Grouping Rules* to group the elements and then list the simplified Boolean expression:
   1. (4 pts)



|  |  |  |
| --- | --- | --- |
|  | *y`* | *y* |
| x` | 1 |  |
| x |  | 1 |

On this one there is no groups. We cannot group diagonally and you cannot group with 0. So there is no group we can include. So I believe F(x) = 0.

* 1. (6 pts)

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | *y`* | *y`* | *y* | *y* |
| x` |  |  |  |  |
| x | 1 | 1 | 1 | 1 |
|  | z` | z | z | z` |

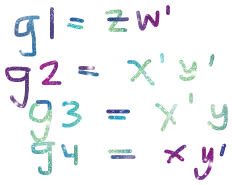
Values that aren’t changing horizontally: x

Values that aren’t changing vertically: (can’t include because of 0)

F(x) = x

* 1. (8 pts)

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | *z`* | *z`* | *z* | *z* |  |
| x` | 1 | 1 | 1 | 1 | y` |
| x` | 1 | 1 | 1 | 1 | y |
| x |  |  |  | 1 | y |
| x | 1 |  |  | 1 | y` |
|  | w` | w | w | w` |  |



1. (30 points) For each truth table, fill in the k-map, use the *Kmap Grouping Rules* to group the elements, and then list the simplified Boolean expression:

|  |  |  |
| --- | --- | --- |
| ***x*** | ***y*** | ***f(x,y)*** |
| 1 | 1 | 0 |
| 1 | 0 | 1 |
| 0 | 1 | 0 |
| 0 | 0 | 1 |

a. (4 pts)

|  |  |  |
| --- | --- | --- |
|  | *y* | *y`* |
| x | 0 | 1 |
| x` | 0 | 1 |

b. (4 pts)

|  |  |  |
| --- | --- | --- |
| ***x*** | ***y*** | ***f(x,y)*** |
| 1 | 1 | 1 |
| 1 | 0 | 0 |
| 0 | 1 | 1 |
| 0 | 0 | 1 |

|  |  |  |
| --- | --- | --- |
|  | *y* | *y`* |
| x | 1 | 0 |
| x` | 1 | 1 |



|  |  |  |  |
| --- | --- | --- | --- |
| ***x*** | ***y*** | ***z*** | ***f(x,y,z)*** |
| 1 | 1 | 1 | 1 |
| 1 | 1 | 0 | 1 |
| 1 | 0 | 1 | 0 |
| 1 | 0 | 0 | 1 |
| 0 | 1 | 1 | 1 |
| 0 | 1 | 0 | 1 |
| 0 | 0 | 1 | 0 |
| 0 | 0 | 0 | 1 |

|  |  |  |
| --- | --- | --- |
|  | *z* | *z`* |
| xy | 1 | 1 |
| x`y | 1 | 1 |
| x`y` | 0 | 1 |
| xy` | 0 | 1 |

c. (6 pts)



d. (6 pts)

|  |  |  |  |
| --- | --- | --- | --- |
| ***x*** | ***y*** | ***z*** | ***f(x,y,z)*** |
| 1 | 1 | 1 | 1 |
| 1 | 1 | 0 | 1 |
| 1 | 0 | 1 | 1 |
| 1 | 0 | 0 | 1 |
| 0 | 1 | 1 | 0 |
| 0 | 1 | 0 | 0 |
| 0 | 0 | 1 | 0 |
| 0 | 0 | 0 | 0 |

|  |  |  |
| --- | --- | --- |
|  | *z* | *z`* |
| xy | 1 | 1 |
| x`y | 0 | 0 |
| x`y` | 0 | 0 |
| xy` | 1 | 1 |

e. (10 pts)

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | *zw* | *z`w* | *z`w`* | *zw`* |
| xy | 1 | 0 | 0 | 1 |
| x`y | 0 | 1 | 1 | 1 |
| x`y` | 0 | 0 | 0 | 1 |
| xy` | 1 | 0 | 0 | 1 |

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| ***x*** | ***y*** | ***z*** | ***w*** | ***f(x,y,z,w)*** |
| 1 | 1 | 1 | 1 | 1 |
| 1 | 1 | 1 | 0 | 1 |
| 1 | 1 | 0 | 1 | 0 |
| 1 | 1 | 0 | 0 | 0 |
| 1 | 0 | 1 | 1 | 1 |
| 1 | 0 | 1 | 0 | 1 |
| 1 | 0 | 0 | 1 | 0 |
| 1 | 0 | 0 | 0 | 0 |
| 0 | 1 | 1 | 1 | 0 |
| 0 | 1 | 1 | 0 | 1 |
| 0 | 1 | 0 | 1 | 1 |
| 0 | 1 | 0 | 0 | 1 |
| 0 | 0 | 1 | 1 | 0 |
| 0 | 0 | 1 | 0 | 1 |
| 0 | 0 | 0 | 1 | 0 |
| 0 | 0 | 0 | 0 | 0 |

