

# ECE M16 Homework 2

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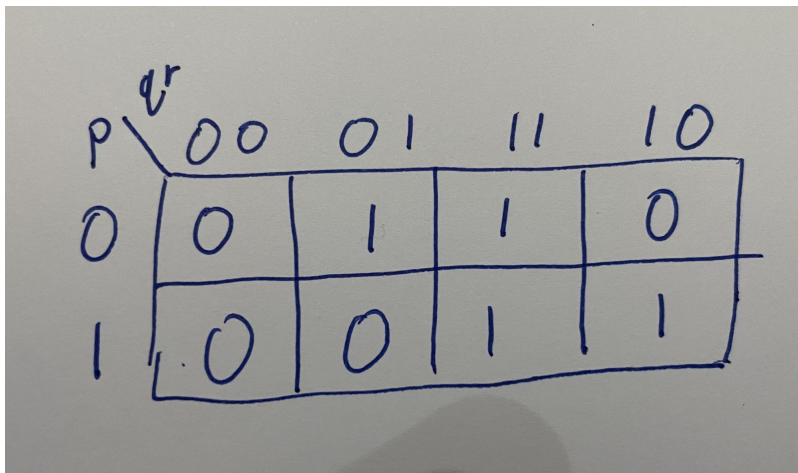
July 14, 2022

## HW1

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### Problem 4

part b



A handwritten truth table for a 2-input function. The inputs are labeled  $p$  and  $q$ . The outputs are labeled 0 and 1. The table is a 2x4 grid with columns for input pairs (00, 01, 11, 10) and rows for output values (0, 1).

$p \backslash q$	00	01	11	10
0	0	1	1	0
1	0	0	1	1

## Problem 7

(a)

Month	m3	m2	m1	m0	output
1	0	0	0	1	1
2	0	0	1	0	0
3	0	0	1	1	1
4	0	1	0	0	0
5	0	1	0	1	1
6	0	1	1	0	0
7	0	1	1	1	1
8	1	0	0	0	1
9	1	0	0	1	0
10	1	0	1	0	1
11	1	0	1	1	0
12	1	1	0	0	1

(b)

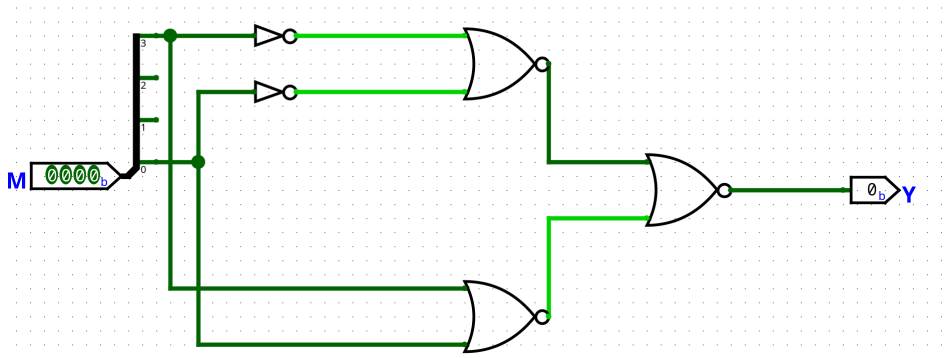
m3 \ m0	00	01	10	11
00	1	0	1	0
01	1	1	0	0
10	0	0	1	0
11	0	0	0	1

Therefore the equation is:

$$m_0 \cdot \overline{m_3} + \overline{m_0} \cdot m_3$$

(c)

$$\begin{aligned}
 m_0 \cdot \overline{m_3} + \overline{m_0} \cdot m_3 &= (m_0 + m_3) \cdot (\overline{m_0} \cdot \overline{m_3}) \\
 &= \overline{\overline{(m_0 + m_3)} \cdot (\overline{m_0} + \overline{m_3})} \\
 &= \overline{\overline{(m_0 + m_3)} + (\overline{m_0} + \overline{m_3})}
 \end{aligned}$$



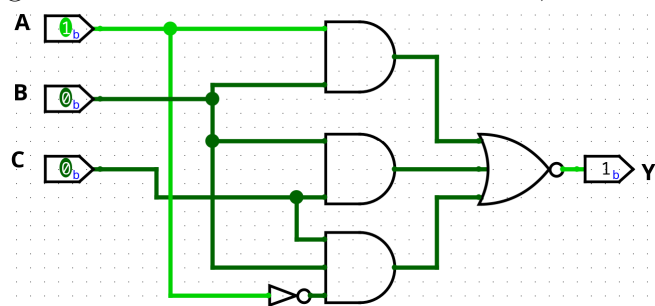
I checked my solution with the checker py file that I wrote, it is attached below

## HW 2

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### Problem 1

There would be a static 0 hazard between  $b = 1, c = 1, a = 0$  and  $b = 1, c = 1, a = 1$ . We can fix it with the following circuit. We can fix this by adding an And gate between  $b$  and  $c$  before the nor, so the resulting function would look like this



### Problem 2

Let the inputs be  $M[0 : 3]$  then we have the following truth table

decimal	M3	M2	M1	M0	q2	q5
0	0	0	0	0	1	1
1	0	0	0	1	0	1
2	0	0	1	0	1	1
3	0	0	1	1	0	1
4	0	1	0	0	0	1
5	0	1	0	1	0	0
6	0	1	1	0	1	0
7	0	1	1	1	0	1
8	1	0	0	0	1	1
9	1	0	0	1	0	1

Therefore we will have the following Kmap for q2

		$q2$ $M1, M0$			
		00	01	11	10
$M3, M2$	00	1	0	0	1
	01	0	0	0	1
	11	-	-	-	-
	10	1	0	-	-

Therefore the equation for q2 is:

$$q2 = \overline{M2} \cdot \overline{M0} + M1 \cdot \overline{M0}$$

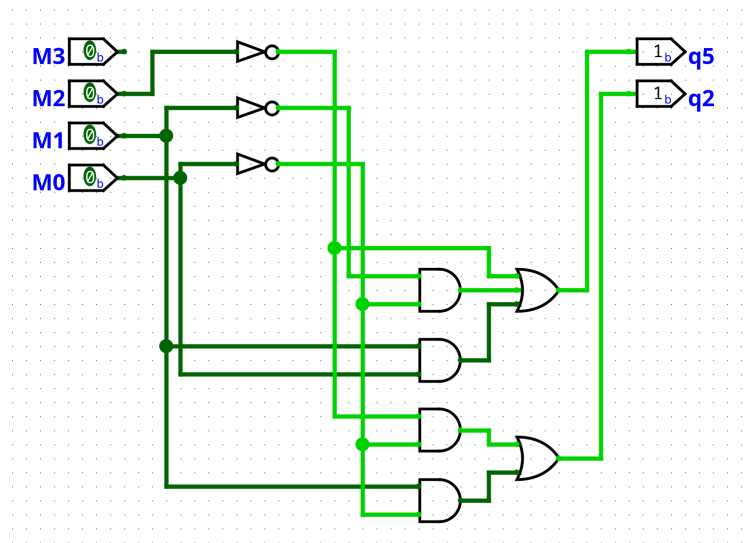
Likewise, the Kmap for q5 is

		$q5$ $M1, M0$			
		00	01	11	10
$M3, M2$	00	1	1	1	1
	01	1	0	1	0
	11	-	-	-	-
	10	1	1	-	-

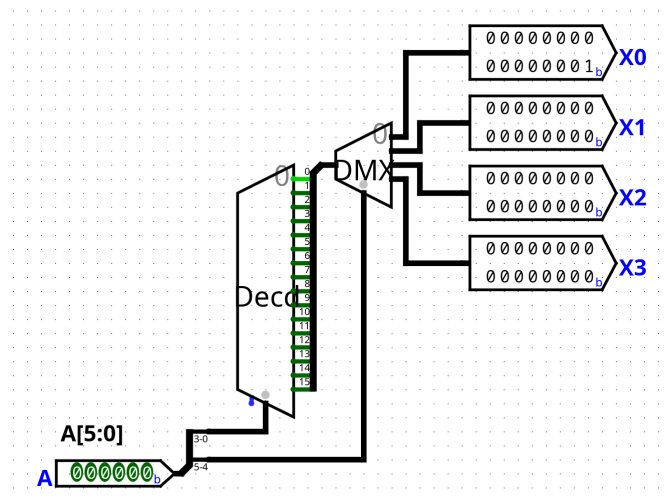
Therefore the equation for q5 is:

$$q5 = \overline{M2} + \overline{M1} \cdot \overline{M0} + M1 \cdot M0$$

Therefore the resulting circuit is

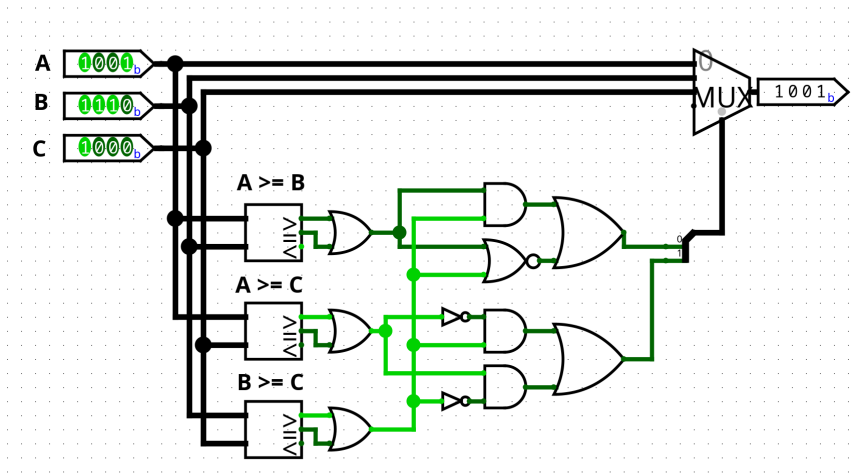


### Problem 3



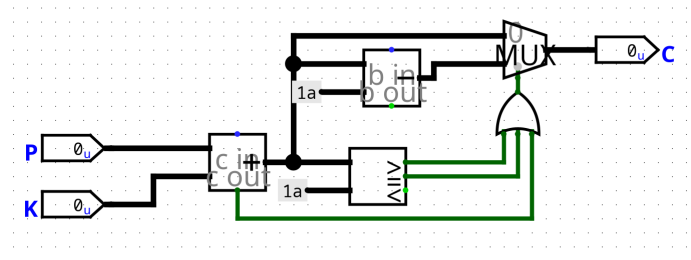
I checked my solution with the checker py file that I wrote, it is attached below

## Problem 4



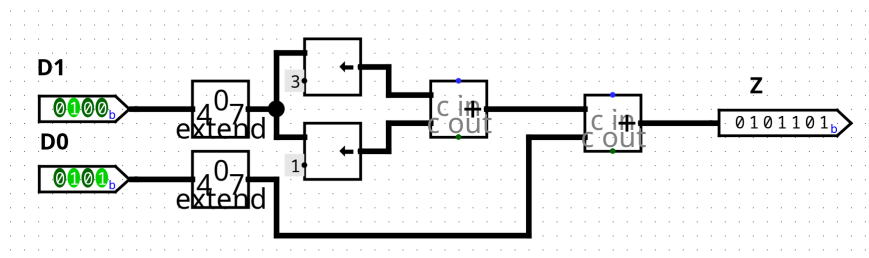
I checked my solution with the checker py file that I wrote, it is attached below

## Problem 5



I checked my solution with the checker py file that I wrote, it is attached below

## Problem 6



I checked my solution with the checker py file that I wrote, it is attached below

# Python Checker

```
1 import numpy as np
2 import pandas as pd
3 import os
4 from calendar import monthrange
5
6 def RunCircuit(logisim_jar : str, circuit : str):
7     """
8     This function runs the logisim simulator and returns the output of
9     the circuit as
10     a pandas dataframe.
11     """
12     output=os.popen(f"java -jar {logisim_jar} {circuit} -tty table").
13     read()
14     output=[o.split() for o in output.split("\n")[:-1]]
15     return pd.DataFrame(output[1:], columns=output[0])
16
17 def Check_Hw1Q7(truth_table:pd.DataFrame)->bool:
18     """
19     This function checks the output of the circuit for the truth table
20     and returns
21     weather the output is correct or not.
22     """
23     for i,row in truth_table.iterrows():
24         month=int(row.M,2)
25         if month in range(1,13):
26             if bool(int(row.Y))!=(monthrange(2022, month)[1]==31):
27                 return False
28     return True
29
30 def Check_Hw2Q3(truth_table:pd.DataFrame)->bool:
31     """
32     This function checks the output of the circuit for the truth table
33     and returns
34     weather the output is correct or not.
35     """
36     for i,row in truth_table.iterrows():
37         A=row.A
38         X=[int(row[f"X{i}"],16) for i in range(4)]
39         i=int(A[:2],2)
40         val=2**int(A[2:],2)
41         for j in range(4):
42             if j!=i:
43                 if X[j]!=0:
44                     return False
45         if X[i]!=val:
46             return False
47     return True
48
49 def Check_Hw2Q4(truth_table:pd.DataFrame)->bool:
50     """
51     This function checks the output of the circuit for the truth table
```

```

and returns
48 weather the output is correct or not.
49 """
50 for i,row in truth_table.iterrows():
51     if np.median([int(row[c],2) for c in ["A","B","C"]])!=int(row.M
,2):
52         return False
53     return True
54
55 def Check_Hw2Q5(truth_table:pd.DataFrame)->bool:
56     """
57     This function checks the output of the circuit for the truth table
and returns
58 weather the output is correct or not.
59     """
60     for i,row in truth_table.iterrows():
61         P=int(row.P,2)
62         K=int(row.K,2)
63         C=int(row.C,2)
64         if P<26 and K<26:
65             if C!=(P+K)%26:
66                 print()
67                 print(f"P={P}")
68                 print(f"K={K}")
69                 print(f"C={C}")
70                 print(f"expected C={(P+K)%26}")
71                 return False
72     return True
73
74 def Check_Hw2Q6(truth_table:pd.DataFrame)->bool:
75     """
76     This function checks the output of the circuit for the truth table
and returns
77 weather the output is correct or not.
78     """
79     for i,row in truth_table.iterrows():
80         D1=int(row.D1,2)
81         D0=int(row.D0,2)
82         Z=int(row.Z,16)
83         if D1<10 and D0<10:
84             if Z!=D1*10+D0:
85                 print("Z=",Z)
86                 print("D1=",D1)
87                 print("D0=",D0)
88                 return False
89     return True
90
91
92 if __name__=="__main__":
93     logisim_jar="../logisim-evolution.jar"
94
95     #check HW1Q7
96     circuit="Logisim/HW1Q7.circ"

```



```

97     print("Checking HW1Q7...",end="")
98     truth_table=RunCircuit(logisim_jar,circuit)
99     if Check_Hw1Q7(truth_table):
100         print("PASSED")
101     else:
102         print("FAILED")
103
104     #check HW2Q3
105     circuit="Logisim/HW2Q3.circ"
106     print("Checking HW2Q3...",end="")
107     truth_table=RunCircuit(logisim_jar,circuit)
108     if Check_Hw2Q3(truth_table):
109         print("PASSED")
110     else:
111         print("FAILED")
112
113     #check HW2Q4
114     circuit="Logisim/HW2Q4.circ"
115     print("Checking HW2Q4...",end="")
116     truth_table=RunCircuit(logisim_jar,circuit)
117     if Check_Hw2Q4(truth_table):
118         print("PASSED")
119     else:
120         print("FAILED")
121
122     #check HW2Q5
123     circuit="Logisim/HW2Q5.circ"
124     print("Checking HW2Q5...",end="")
125     truth_table=RunCircuit(logisim_jar,circuit)
126     if Check_Hw2Q5(truth_table):
127         print("PASSED")
128     else:
129         print("FAILED")
130
131     #check HW2Q6
132     circuit="Logisim/HW2Q6.circ"
133     print("Checking HW2Q6...",end="")
134     truth_table=RunCircuit(logisim_jar,circuit)
135     if Check_Hw2Q6(truth_table):
136         print("PASSED")
137     else:
138         print("FAILED")

```

I have the files in the following format:

ECEM16

```

|- .git
|- HW1
|- HW2
| |- Logisim
| | |- old
| | |- HW1Q7.circ
| | |- HW2Q3.circ

```

```
| | |- HW2Q4.circ
| | |- HW2Q5.circ
| | |- HW2Q6.circ
| :
| :
| |- checker.py
|- .gitignore
|- logisim-evolution.jar
```

In order to use modifications may be need to be made to the file paths