INDRAPRASTHA INSTITUTE *of*
INFORMATION TECHNOLOGY
DELHI

Department
of
Electronics & Communication Engineering

ECE111|Digital Circuits

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Lab_6:
Combinational Circuit Design

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Part A. Decoder Circuit for generating BCD Code from Encrypted code

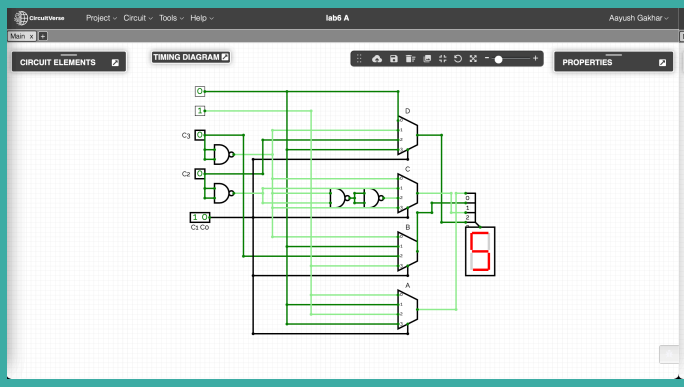
Aim: Designing and testing of a circuit for decryption/decoding of an incoming digital signal which is encrypted by some set of rules which are:

An encrypted communication system sends decimal digits encoded by a 4-bit binary code C3 C2 C1 C0 according to the following scheme, where N denotes the value of the digit:

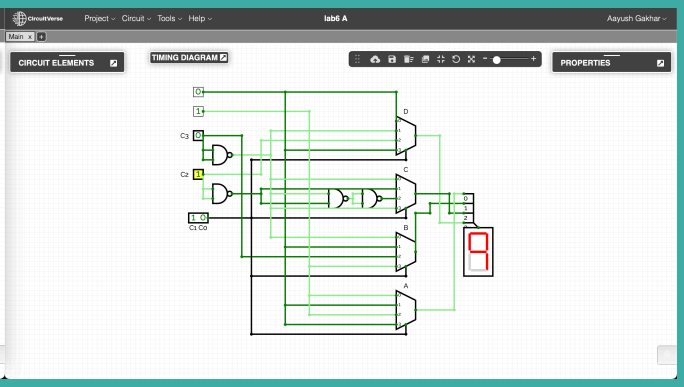
For $4 \geq N \geq 0$, C3 C2 C1 C0 = 13 – N (in decimal), and
for $9 \geq N \geq 5$, C3 C2 C1 C0 = N – 3 (in decimal).

Components/ICs Used: Input, ConstantVal, Nand gate, Wire, splitter(Bitwidth=4), Hexdisplay

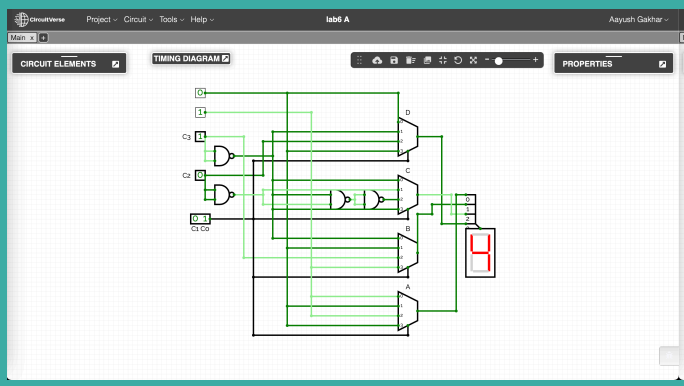
Circuit Diagram:



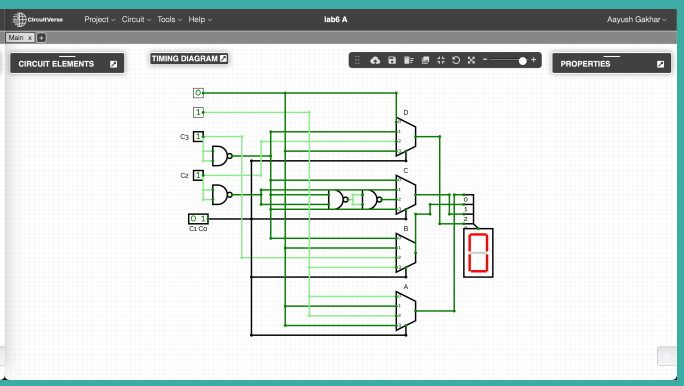
Input = 2(0010) Output = 5



Input = 6(0110) Output = 9



Input = 9(1001) Output = 4



Input = 13(1101) Output = 0

Truth Table:

Encr. Code	C3	C2	C1	C0	DE of N	D	C	B	A
0	0	0	0	0	X	X	X	X	X
1	0	0	0	1	X	X	X	X	X
2	0	0	1	0	5	0	1	0	1
3	0	0	1	1	6	0	1	1	0
4	0	1	0	0	7	0	1	1	1
5	0	1	0	1	8	1	0	0	0
6	0	1	1	0	9	1	0	0	1
7	0	1	1	1	X	X	X	X	X
8	1	0	0	0	X	X	X	X	X
9	1	0	0	1	4	0	1	0	0
10	1	0	1	0	3	0	0	1	1
11	1	0	1	1	2	0	0	1	0
12	1	1	0	0	1	0	0	0	1
13	1	1	0	1	0	0	0	0	0
14	1	1	1	0	X	X	X	X	X
15	1	1	1	1	X	X	X	X	X

K maps (If Applicable):

D		C1 C0			
		0 0	0 1	1 1	1 0
C3 C2	0 0	X	X	0	0
	0 1	0	1	X	1
	1 1	0	0	X	X
	1 0	X	0	0	0

C1 C0	0 0	0 1	1 1	1 0
I/O OF MUX FOR D	0	C3'	0	C2

C		C1 C0			
		0 0	0 1	1 1	1 0
C3 C2	0 0	X	X	1	1
	0 1	1	0	X	0
	1 1	0	0	X	X
	1 0	X	1	0	0

C1 C0	0 0	0 1	1 1	1 0
I/O OF MUX FOR C	C3'	C2'	C3'	C3' C2'

B		C1 C0			
		0 0	0 1	1 1	1 0
C3 C2	0 0	X	X	1	0
	0 1	1	0	X	0
	1 1	0	0	X	X
	1 0	X	0	1	1

C1 C0	0 0	0 1	1 1	1 0
I/O OF MUX FOR B	C3'	0	1	C3

A		C1 C0			
		0 0	0 1	1 1	1 0
C3 C2	0 0	X	X	0	1
	0 1	1	0	X	1
	1 1	1	0	X	X
	1 0	X	0	0	1

C1 C0	0 0	0 1	1 1	1 0
I/O OF MUX FOR A	1	0	0	1

FINAL				
C1 C0	0 0	0 1	1 0	1 1
D	0	C3'	C2	0
C	C3'	C2'	C3' C2'	C3'
B	C3'	0	C3	1
A	1	0	1	0

Observations/Results: The hex display works according to the truth table

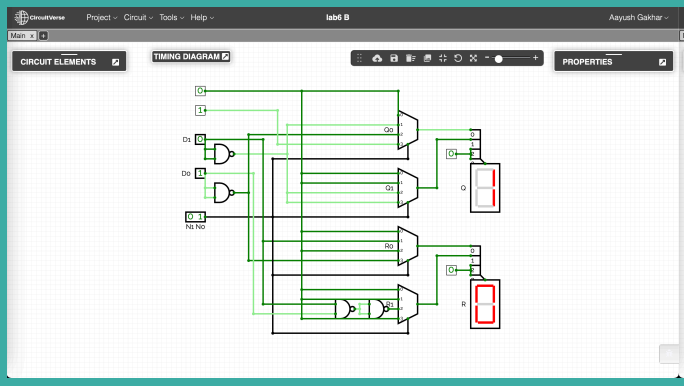
Applications:Decoders are greatly used in applications where the particular output or group of outputs to be activated only on the occurrence of a specific combination of input levels. Specific output is provided for specific input.

Part B. Divider Circuit for 2-bit Binary Numbers

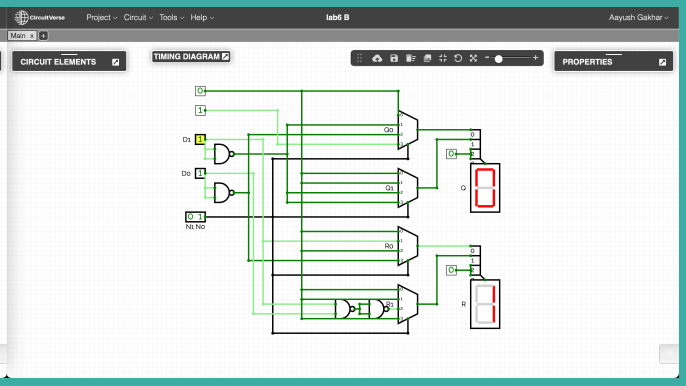
Aim: Designing and testing a circuit for dividing a 2-bit number N1 N0 by another 2-bit number D1 D0 (D1 D0 ≠ 0) to generate a 2-bit quotient Q1 Q0 and a 2-bit remainder R1 R0.

Components/ICs Used: Input, ConstantVal, Nand gate, Wire, splitter(Bitwidth=4), Hexdisplay

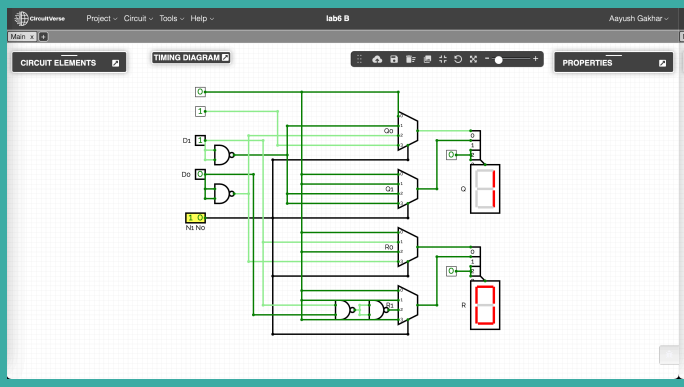
Circuit Diagram:



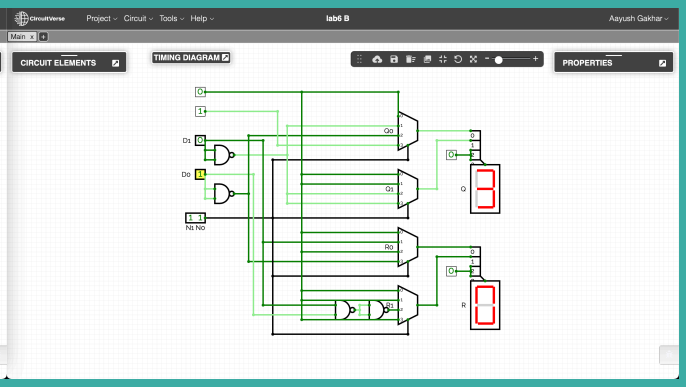
Input(N1 N0 D1 D0) = 0101
Output(Q R) = 1 0



Input(N1 N0 D1 D0) = 0111
Output(Q R) = 0 1



Input(N1 N0 D1 D0) = 1010
Output(Q R) = 1 0



Input(N1 N0 D1 D0) = 1101
Output(Q R) = 3 0

Truth Table:

N1	N0	D1	D0	Q1	Q0	R1	R0
0	0	0	0	X	X	X	X
0	0	0	1	0	0	0	0
0	0	1	0	0	0	0	0
0	0	1	1	0	0	0	0
0	1	0	0	X	X	X	X
0	1	0	1	0	1	0	0
0	1	1	0	0	0	0	1
0	1	1	1	0	0	0	1
1	0	0	0	X	X	X	X
1	0	0	1	1	0	0	0
1	0	1	0	0	1	0	0
1	0	1	1	0	0	1	0
1	1	0	0	X	X	X	X
1	1	0	1	1	1	0	0
1	1	1	0	0	1	0	1
1	1	1	1	0	1	0	0

K maps (If Applicable):

Q1		N1 N0			
		0 0	0 1	1 1	1 0
D1 D0	0 0	X	X	X	X
	0 1	0	0	1	1
	1 1	0	0	0	0
	1 0	0	0	0	0

N1 N0	0 0	0 1	1 1	1 0
I/O OF MUX FOR Q1	0	0	D1'	D1'

Q0		N1 N0			
		0 0	0 1	1 1	1 0
D1 D0	0 0	X	X	X	X
	0 1	0	1	1	0
	1 1	0	0	1	0
	1 0	0	0	1	1

N1 N0	0 0	0 1	1 1	1 0
I/O OF MUX FOR Q0	0	D1'	1	D0'

R1		N1 N0			
		0 0	0 1	1 1	1 0
D1 D0	0 0	X	X	X	X
	0 1	0	0	0	0
	1 1	0	0	0	1
	1 0	0	0	0	0

N1 N0	0 0	0 1	1 1	1 0
I/O OF MUX FOR R1	0	0	0	D1 D0

R0		N1 N0			
		0 0	0 1	1 1	1 0
D1 D0	0 0	X	X	X	X
	0 1	0	0	0	0
	1 1	0	1	0	0
	1 0	0	1	1	0

N1 N0	0 0	0 1	1 1	1 0
I/O OF MUX FOR R0	0	D1	D0'	0

FINAL				
N1 N0	0 0	0 1	1 0	1 1
Q1	0	0	D1'	D1'
Q0	0	D1'	D0'	1
R1	0	0	D1 D0	0
R0	0	D1	0	D0'

Observations/Results: The hex display works according to the truth table.

Applications: Dividers are used in ALU of chips to do basic division operations. This is a combinational circuit and combinational circuits have a wide variety of uses such as calculators, digital measuring techniques, computers, digital processing, automatic control of machines, industrial processing, digital communications, etc.