EXPERIMENT4 REPORT

BBM233
LOGIC DESIGN LAB

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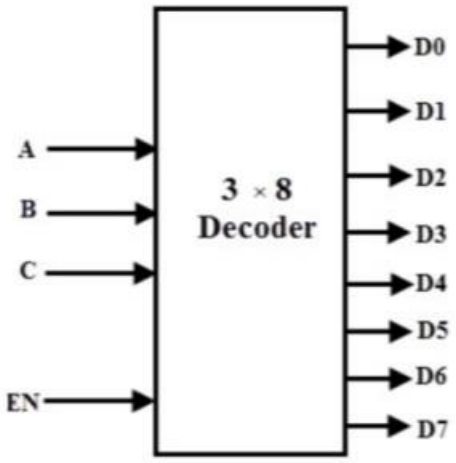
PART0

PROBLEM STATEMENT

Obtaining Boolean equations for the outputs D_0 through D_7 from the given truth table and implement the 3x8 decoder with enable input using behavioral design approach in Verilog HDL.



Inputs				Outputs							
EN	A	B	C	D7	D6	D5	D4	D3	D2	D1	D0
0	×	×	×	0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0	0	0	0	1
1	0	0	1	0	0	0	0	0	0	1	0
1	0	1	0	0	0	0	0	0	1	0	0
1	0	1	1	0	0	0	0	1	0	0	0
1	1	0	0	0	0	0	1	0	0	0	0
1	1	0	1	0	0	1	0	0	0	0	0
1	1	1	0	0	1	0	0	0	0	0	0
1	1	1	1	1	0	0	0	0	0	0	0

decoder_3x8.v

```
1  `timescale 1ns / 1ps
2
3  module decoder_3x8(
4
5      input A,B,C,EN, // EN -> enable input
6      output [7:0] D
7
8   );
9      //assigning outputs D0 to D7
10
11     assign D[0] = EN & ~A & ~B & ~C;
12     assign D[1] = EN & ~A & ~B & C;
13     assign D[2] = EN & ~A & B & ~C;
14     assign D[3] = EN & ~A & B & C;
15     assign D[4] = EN & A & ~B & ~C;
16     assign D[5] = EN & A & ~B & C;
17     assign D[6] = EN & A & B & ~C;
18     assign D[7] = EN & A & B & C;
19 endmodule
20
```

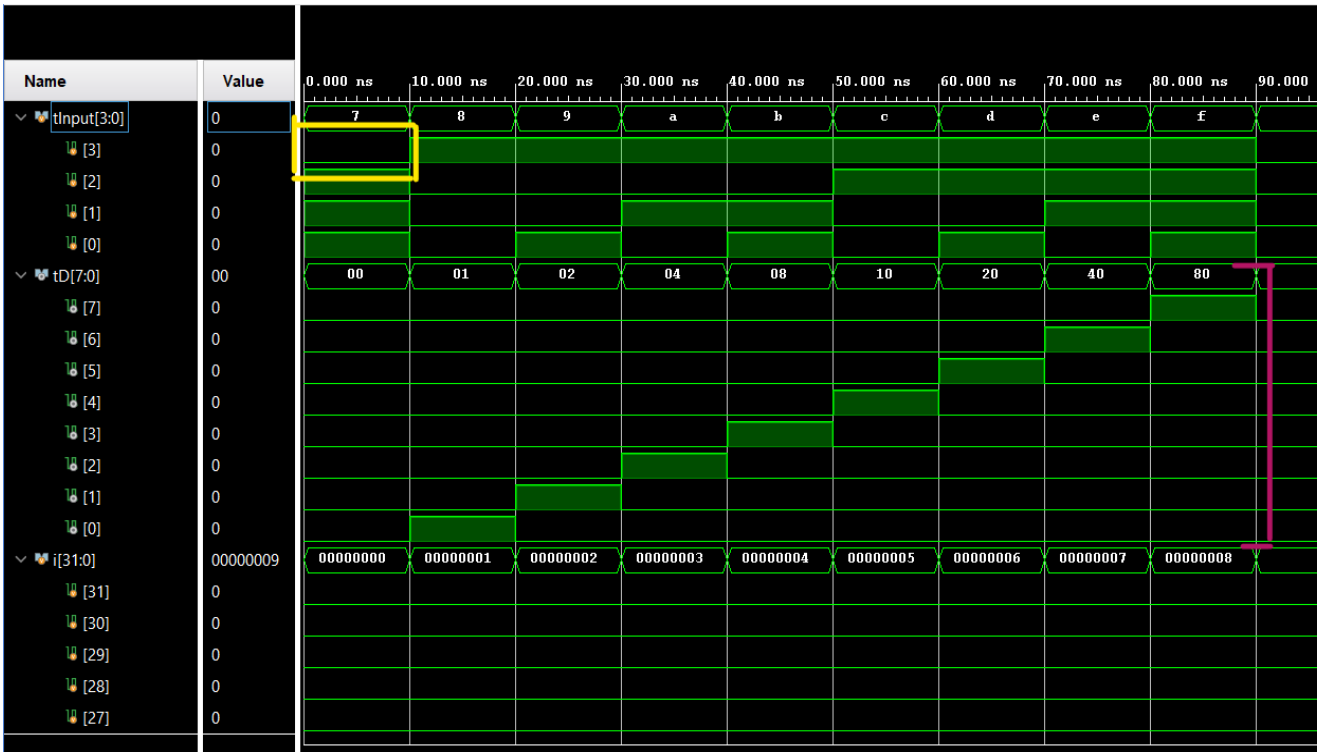
I declared 4 input and 8 output to implement a 3x8 decoder with enable input. Then, I assigned the values of each output from D0 to D7.

decoder_3x8_tb.v

```
1  `timescale 1ns / 1ps
2  `include "decoder_3x8.v"
3
4  module decoder_3x8_tb;
5
6      reg [3:0] tInput;
7      wire [7:0] tD;
8      integer i;  //used for iterating for loop.
9      decoder_3x8 UUT(.EN(tInput[3]),.A(tInput[2]),.B(tInput[1]),.C(tInput[0]),.D(tD)); //explicit association
10
11 initial begin
12     tInput = 4'b0111;
13     for(i = 0; i<9; i = i+1) begin  //iterates 10 times to produce output
14         #10 //delaying time before testing
15         tInput = tInput + 1;  //increasing tInput
16     end
17 end
18 endmodule
19
```

For loop iterates 10 times to testing the decoder. Each time tInputs is increased by 1 to produce to expected results.

WAVEFORM OBTAINED FROM 3X8 DECODER

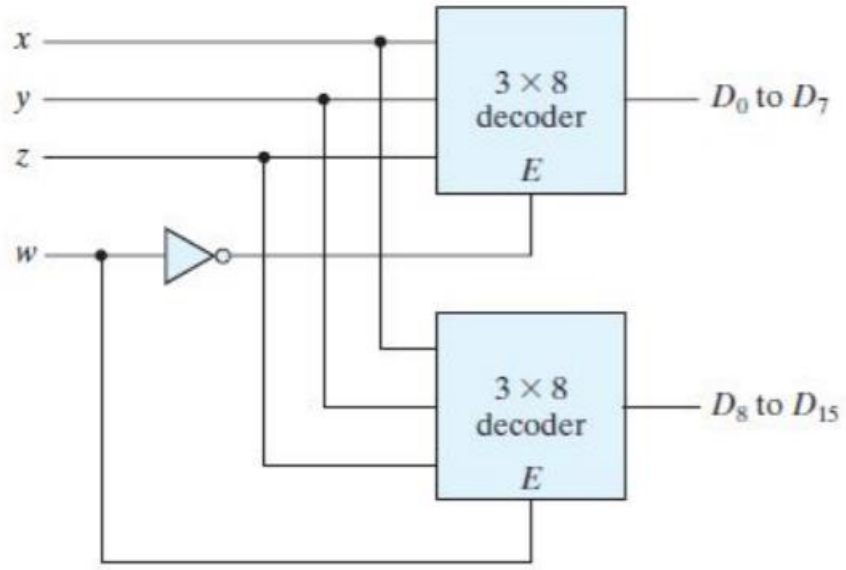


Pointed area with yellow color shows the output equals "0" while Enable Input equals zero. From 10.000 to 80.000ns , waves shows output of D_0 -D_7 which are equal to "1" while enable input equals 1.Also we can check the correctness of obtained waveform by looking the area pointed with pink. D_0 equals "0" within 0-10.000ns, the others are equal "1" within related time scales.

PART1

PROBLEM STATEMENT

Implementing a 4x16 decoder by using two 3x8 decoders with enable input. When w = 0, the top decoder is enabled and the other is disabled. When w = 1, the enable conditions are reversed.



VERILOG CODE SOLUTIONS

decoder_4x16.v

```
1  `timescale 1ns / 1ps
2  `include "decoder_3x8.v"
3
4  module decoder_4x16(
5      input [3:0] inputs,
6      output [15:0] outputs
7  );
8  //explicit association
9   decoder_3x8 Decoder1(.B(inputs[1]),.D(outputs[15:8]),.C(inputs[0]),.EN(inputs[3]),.A(inputs[2])); // D15-D8
10  decoder_3x8 Decoder2(.B(inputs[1]),.D(outputs[7:0]),.C(inputs[0]),.EN(~inputs[3]),.A(inputs[2])); // D7-D0
11
12
13
14
15 endmodule
16
```

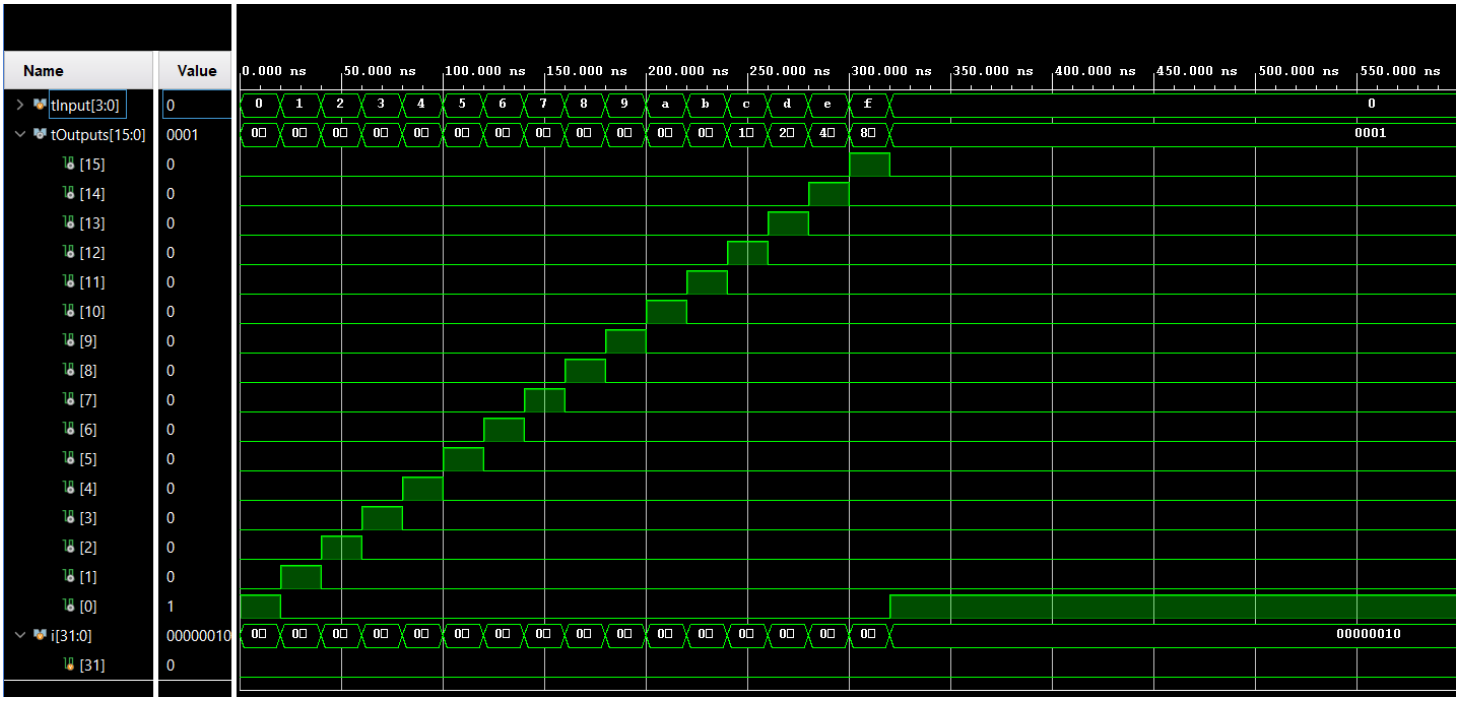
I used Decoder1 with enable input = 1, to declare $outputs_{15}$ -$outputs_{8}$ and Decoder2 with enable input = 0 to declare $outputs_{7}$ -$outputs_{0}$.

decoder_4x16_tb.v

```
1  `timescale 1ns / 1ps
2  `include "decoder_4x16.v"
3
4  module decoder_4x16_tb;
5      reg [3:0] tInput;
6      wire [15:0] tOutputs ;
7      integer i; //needed for iterating for loop
8
9      decoder_4x16 UUT(.outputs(tOutputs),.inputs(tInput));
10
11     initial begin
12     tInput = 4'b0;  //initial input
13     for(i =  0;i <16;i = i+1) begin
14         #20
15         tInput = tInput +1; //increasing input by 1
16
17     end
18 end
19 endmodule
```

For loop iterates to test module by increasing input by 1.

WAVEFORM OBTAINED FROM 4X16 DECODER



Signals are easily seen like ladder. $outputs_{15}$-$outputs_0$ equal "1" within related time scales and there is no signal except $outputs_{15}$-$outputs_0$.

RESOURCES

BBM233 lecture videos
BBM233 lecture notes
TOBB ETU Computer Engineering lecture records
https://www.youtube.com/watch?v=Vxvv-jdOQiU&list=PL36uFMHhtMR5yAVlLJw3GRXTh1BDOSB3f&index=8
https://www.youtube.com/watch?v=EDswcCwq014&list=PLvNq8wrSYGAU8Cf3n9rhL-GB4yMNO1-XC&index=4
https://www.youtube.com/watch?v=G76Bi0Pr2O4&list=PLvNq8wrSYGAU8Cf3n9rhL-GB4yMNO1-XC&index=6
https://www.youtube.com/watch?v=QfrNZQmqLhg