

a. Write the boolean equation:

a.  $\text{assign } X = (L \& (T \& P)) \mid (\sim L \& (T \& W)) \mid (\sim L \& (\sim T \& P)) \mid (\sim L \& (\sim W \& T));$

b. Write the truth table

| L | T | P | W | L & (T&P) | $\sim L \& (T\&W)$ | $\sim L \& (\sim T\&P)$ | $\sim L \& (\sim W\&T)$ | X |
|---|---|---|---|-----------|--------------------|-------------------------|-------------------------|---|
| 0 | 0 | 0 | 0 | 0         | 0                  | 0                       | 0                       | 0 |
| 0 | 0 | 0 | 1 | 0         | 0                  | 0                       | 0                       | 0 |
| 0 | 0 | 1 | 0 | 0         | 0                  | 1                       | 0                       | 1 |
| 0 | 0 | 1 | 1 | 0         | 0                  | 1                       | 0                       | 1 |
| 0 | 1 | 0 | 0 | 0         | 0                  | 0                       | 1                       | 1 |
| 0 | 1 | 0 | 1 | 0         | 1                  | 0                       | 0                       | 1 |
| 0 | 1 | 1 | 0 | 0         | 0                  | 0                       | 1                       | 1 |
| 0 | 1 | 1 | 1 | 0         | 1                  | 0                       | 0                       | 1 |
| 1 | 0 | 0 | 0 | 0         | 0                  | 0                       | 0                       | 0 |
| 1 | 0 | 0 | 1 | 0         | 0                  | 0                       | 0                       | 0 |
| 1 | 0 | 1 | 0 | 0         | 0                  | 0                       | 0                       | 0 |
| 1 | 0 | 1 | 1 | 0         | 0                  | 0                       | 0                       | 0 |
| 1 | 1 | 0 | 0 | 0         | 0                  | 0                       | 0                       | 0 |
| 1 | 1 | 0 | 1 | 0         | 0                  | 0                       | 0                       | 0 |
| 1 | 1 | 1 | 0 | 1         | 0                  | 0                       | 0                       | 1 |
| 1 | 1 | 1 | 1 | 1         | 0                  | 0                       | 0                       | 1 |

c. Write the Boolean equation using the minterms

$\sim L \& (\sim T \& P) \& \sim W + \sim L \& (\sim T \& P) \& W + \sim L \& (\sim W \& T) + \sim L \& (T \& W) \& P + \sim L \& (\sim W \& T) + \sim L \& (T \& W) \& P + L \& (T \& P) \& \sim W + L \& (T \& P) \& W$

d. Simplify

$P \& T + P \& \sim L + T \& \sim L$

e. K-map

*Handwritten: LT, PW*

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

$\sim LT + \sim L \& P + P \& T$

f. Full expression for truth table

```

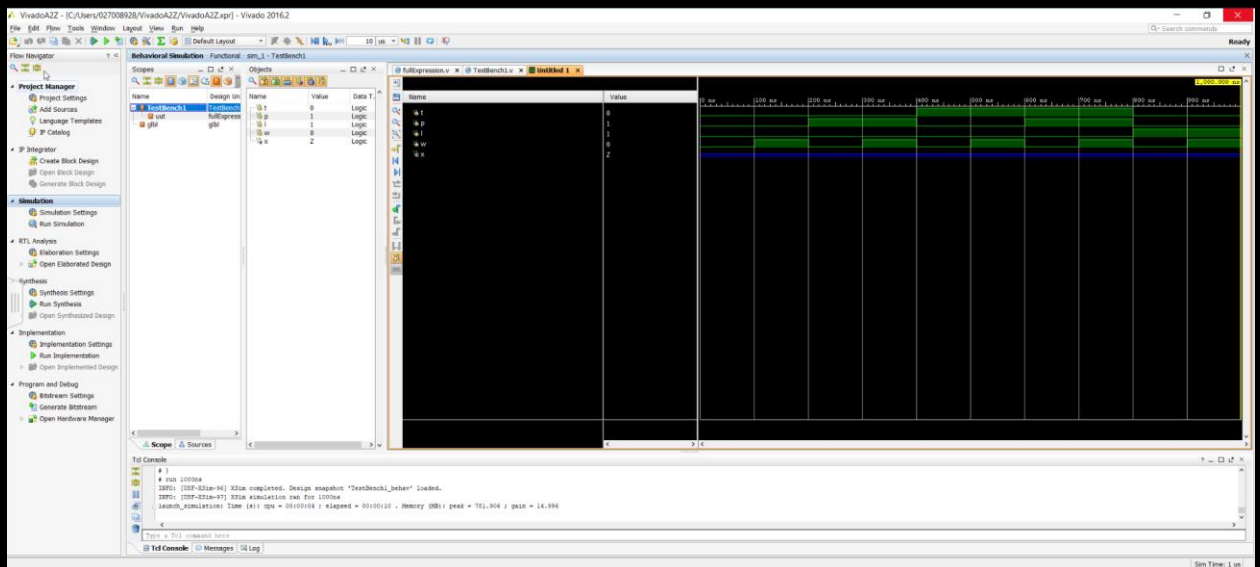
module fullExpression(
    input L,
    input P,
    input T,
    input W,
    output X
):
    assign X = (!L & (!T & P) & !W) | (!L & (!T & P) & W) | (!L & (!W & T)) | (!L & (T & W) & !P) | (!L & (!W & T)) | (!L & (T & W) & P) | (L & (T & P) & !W) | (L & (T & P) & W);
endmodule

```

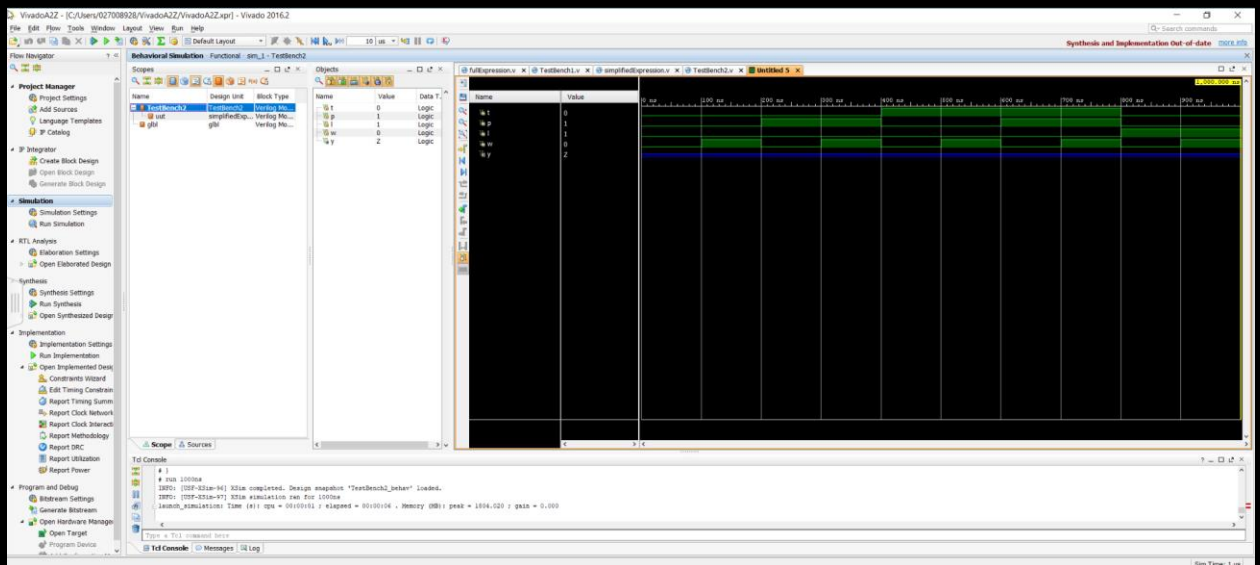
## Simplified expression for truth table

```
module simplifiedExpression(  
    input T,  
    input P,  
    input L,  
    input Y  
);  
    assign Y = !L&T | !L&P | T&P;  
endmodule
```

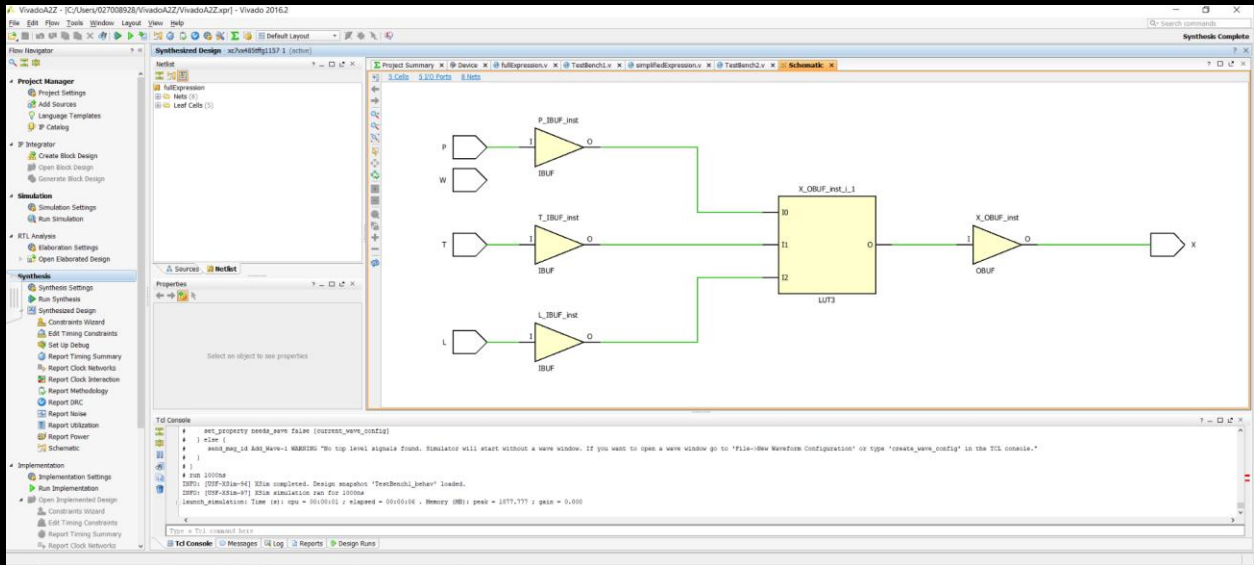
## fullExpression timing Diagram



## simplifiedExpression timing Diagram



## Schematic



Youtube Video:

<https://youtu.be/MMeyKJ4j3CM>