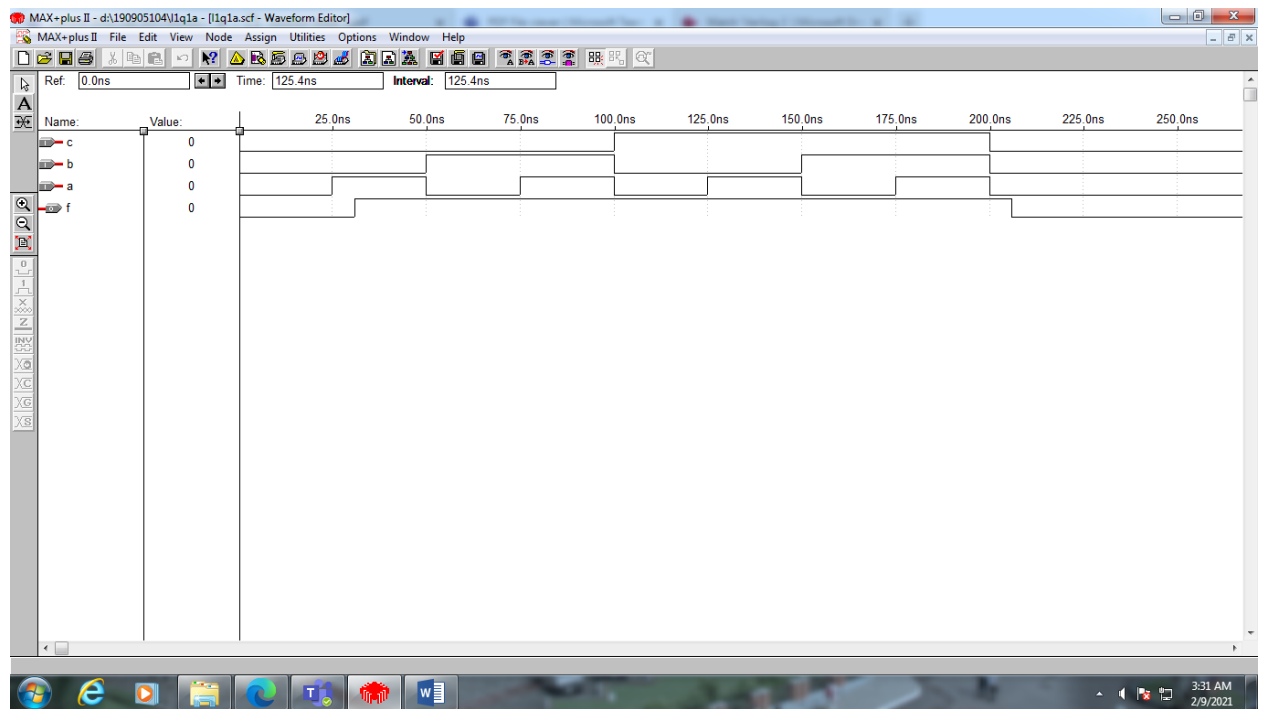


- 1) $f1 = ac' + bc + b'c'$
 $f2 = (a + b' + c)(a + b + c')(a' + b + c')$

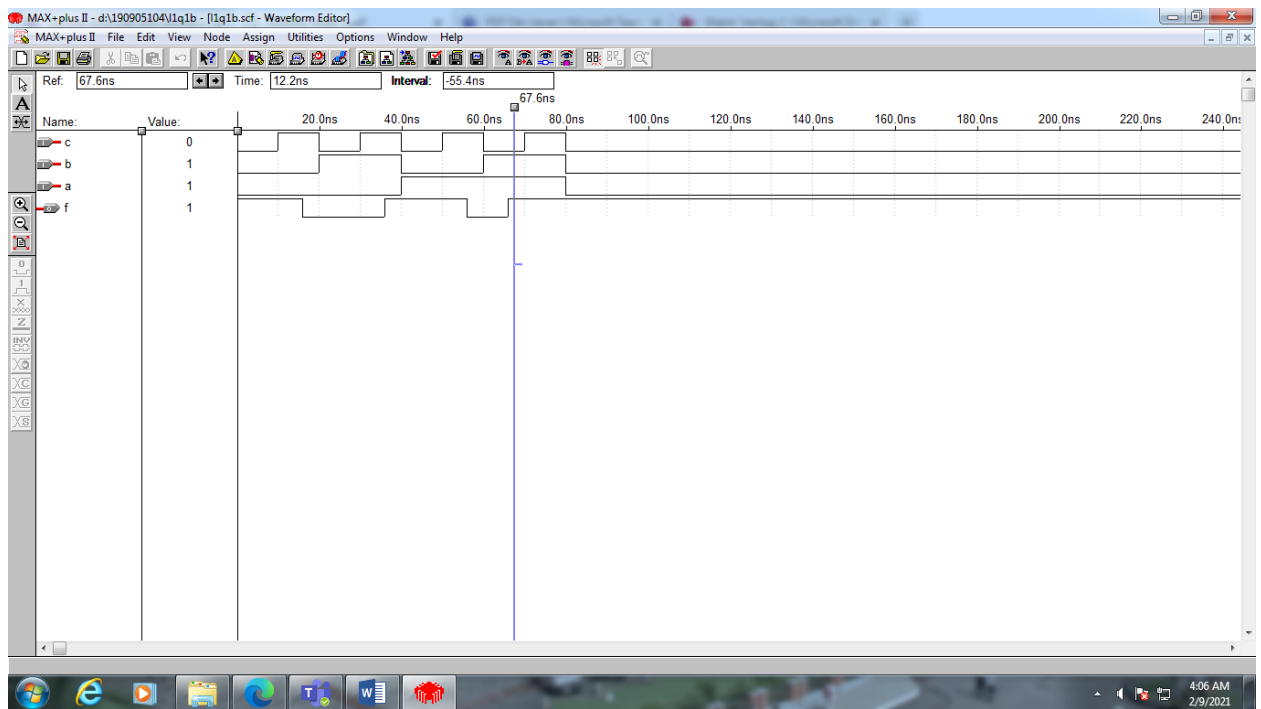
Part 1

```
//f1 = ac' + bc + b'c'
module l1q1a(a, b, c, f);
input a, b, c;
output f;
and(x1, a, ~c);
and(x2, b, c);
and(x3, ~b, ~c);
or(f, x1, x2, x3);
endmodule
```

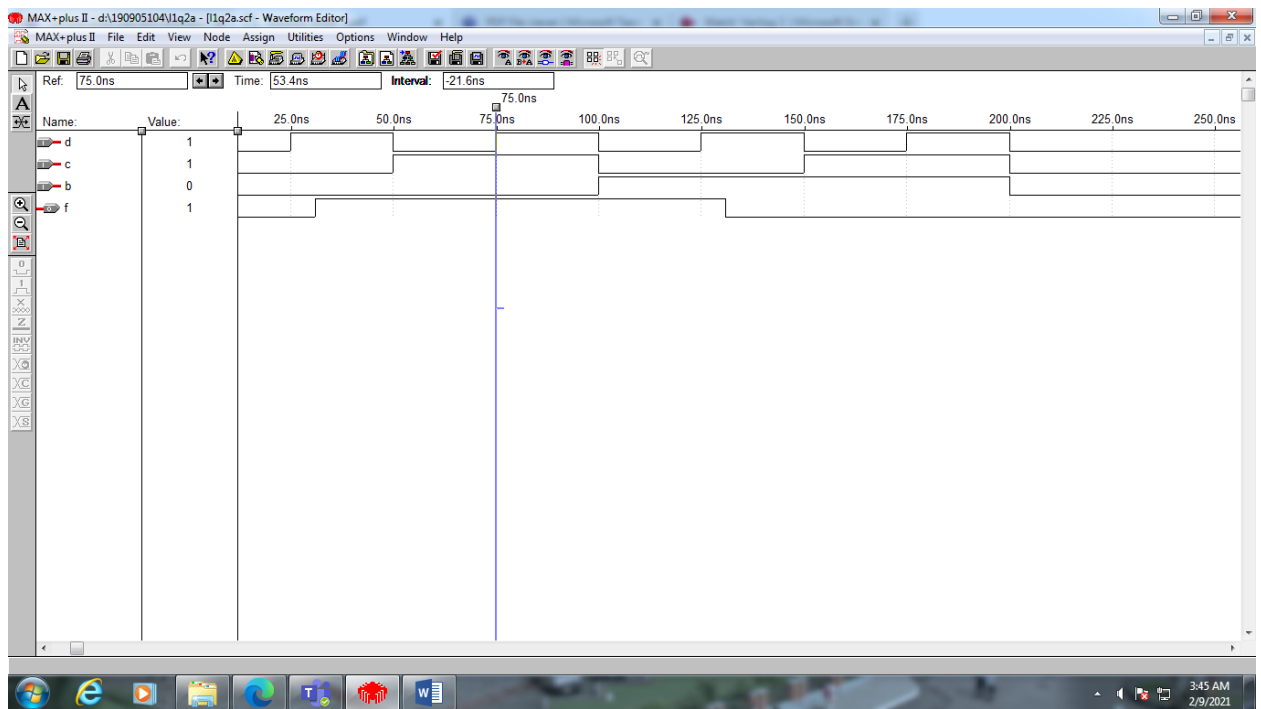


Part 2

```
// f2 = (a + b' + c)(a + b + c')(a' + b + c')
module l1q1b(a, b, c, f);
input a, b, c;
output f;
or(x1, a, ~b, c);
or(x2, a, b, ~c);
or(x3, ~a, b, ~c);
and(f, x1, x2, x3);
endmodule
```



2)
 // $f(A, B, C, D) = m(1, 3, 4, 9, 10, 12) + D(0, 2, 5, 11)$
 // Ans = $B'D + B'C + BC'D'$
 module l1q2a(a, b, c, d, f);
 input a, b, c, d;
 output f;
 assign f = ($\sim b \& d$) | ($\sim b \& c$) | ($b \& \sim c \& \sim d$);
 endmodule
 Part 1

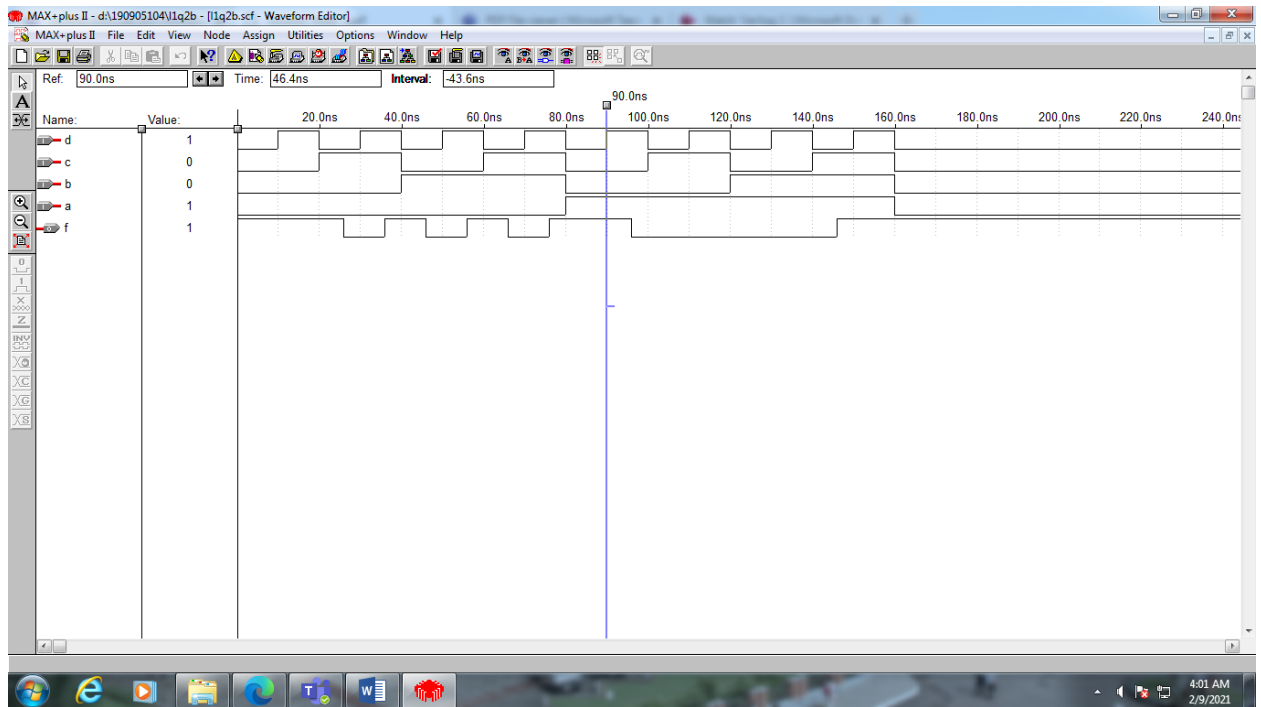


Part 2

```
// f(A,B,C,D) = ?M(6,9,10,11,12) + D(2,4,7,13)
```

```
// Ans = B'C'D' + ABC + A'D
```

```
module l1q2b(a, b, c, d, f);
input a, b, c, d;
output f;
assign f = (~a & d) | (~b & ~c & ~d) | (a & b & c);
endmodule
```



3)

Minimize the following expression using K-map and simulate using only NAND gates.

// $f(A,B,C,D)=\sum m(2,6,8,9,10,11,14)$

// Ans = $A'C' + A'D + BC' + BD$

```
module l1q3(a, b, c, d, f);
```

```
input a, b, c, d;
```

```
output f;
```

```
nand(x1, ~a, ~c);
```

```
nand(x2, ~a, d);
```

```
nand(x3, b, ~c);
```

```
nand(x4, b, d);
```

```
nand(f, x1, x2, x3, x4);
```

```
endmodule
```

