EE2026
Tutorial 4 - Solutions

1.

Truth Table

A	B	C	D	F
0	0	0	0	1
0	0	0	1	1
0	0	1	0	1
0	0	1	1	1
0	1	0	0	1
0	1	0	1	1
0	1	1	0	1
0	1	1	1	0
1	0	0	0	1
1	0	0	1	1
1	0	1	0	0
1	0	1	1	0
1	1	0	0	1
1	1	0	1	0
1	1	1	0	0
1	1	1	1	0

$$Z_{SOP} = \bar{A}\bar{B}\bar{C}\bar{D} + \bar{A}\bar{B}\bar{C}D + \bar{A}\bar{B}C\bar{D} + \bar{A}\bar{B}CD + \bar{A}B\bar{C}\bar{D} + \bar{A}B\bar{C}D + \bar{A}BC\bar{D} + A\bar{B}\bar{C}\bar{D} + A\bar{B}\bar{C}D$$
$$+ AB\bar{C}\bar{D}$$

$$Z_{POS} = (A + \bar{B} + \bar{C} + \bar{D}).(\bar{A} + B + \bar{C} + D).(\bar{A} + B + \bar{C} + \bar{D}).(\bar{A} + B + C + \bar{D}).(\bar{A} + \bar{B} + \bar{C}$$
$$+ D).(\bar{A} + \bar{B} + \bar{C} + \bar{D})$$

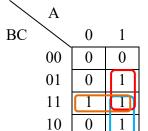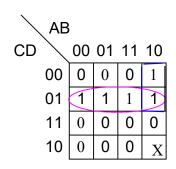$$Z_{MSOP} = \bar{A}\bar{B} + \bar{C}\bar{D} + \bar{A}\bar{C} + \bar{A}\bar{D} + \bar{B}\bar{C}$$

2.

Truth Table

A	B	C	F
0	0	0	0
0	0	1	0
0	1	0	0
0	1	1	1
1	0	0	0
1	0	1	1
1	1	0	1
1	1	1	1

$$Z_{SOP} = \bar{A}BC + A\bar{B}C + AB\bar{C} + ABC$$
$$Z_{POS} = (A + B + C).(A + B + \bar{C}).(A + \bar{B} + C).(\bar{A} + B + C)$$

A

BC	0	1
00	0	0
01	0	1
11	1	1
10	0	1

$$Z_{MSOP} = AC + BC + AB$$

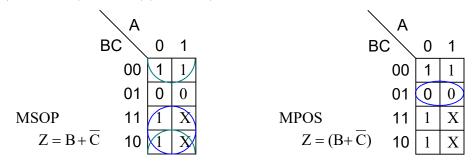3.   (a) $Z = \overline{A}\,\overline{B}\overline{C}D + \overline{A}B\overline{C}D + AB\overline{C}D + A\overline{B}\,\overline{C}D + A\overline{B}\,\overline{C}\,\overline{D}$ with 'X' for $ABCD = 1010$

AB

CD	00	01	11	10
00	0	0	0	1
01	1	1	1	1
11	0	0	0	0
10	0	0	0	X

AB

CD	00	01	11	10
00	0	0	0	1
01	1	1	1	1
11	0	0	0	0
10	0	0	0	X

MSOP
$$Z = \overline{C}D + A\overline{B}\,\overline{C}$$

MPOS
$$Z = \overline{C}(A + D) \cdot (\overline{B} + D)$$

(b) $Z = (\overline{A} + B + \overline{C})(A + B + \overline{C})$ with don't cares for $ABC = 111$ and 110

A

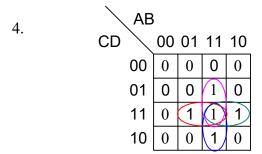| BC	0	1
00	1	1
01	0	0
11	1	X
10	1	X

MSOP
$$Z = B + \overline{C}$$

A

BC	0	1
00	1	1
01	0	0
11	1	X
10	1	X

MPOS
$$Z = (B + \overline{C})$$

2

(c) $f(x_1, \ldots, x_4) = \sum m(0,4,5,6,7) + D(1,12,13,14,15)$, where D is the set of don't

cares and m is the set for which $f = 1$ (this alternate shorthand notation is also used to express min terms).

X₃X₄ \ X₁X₂	00	01	11	10
00	1	1	X	0
01	X	1	X	0
11	0	1	X	0
10	0	1	X	0

MSOP

$Z = (x_2 + \bar{x}_1\bar{x}_3)$

X₃X₄ \ X₁X₂	00	01	11	10
00	1	1	X	0
01	X	1	X	0
11	0	1	X	0
10	0	1	X	0

MPOS

$Z = (x_2 + \bar{x}_3) \cdot (\bar{x}_1)$

4.

CD \ AB	00	01	11	10
00	0	0	0	0
01	0	0	1	0
11	0	1	1	1
10	0	0	1	0

MSOP

$Z = ACD + BCD + ABC + ABD$

A.H   B.H $\bar{C} \cdot H$ $\bar{D} \cdot H$

$C \cdot H$ $D \cdot H$

$\overline{ACD}$

$\overline{BCD}$

$\overline{ABC}$

$\overline{ABD}$

$ACD + BCD + ABC.H$

Z.H

$Z.H = (ACD + BCD + ABC + ABD).H$

Critical Path Delay
= 0.3 (NOT) + 0.8 (NAND3) + 0.8 (NAND3) + 0.3 (NOT) + 0.5 (NAND2)
= 2.7ns

3