<u>EE2001 – Tutorial 1 Solutions</u>

Authors

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1)

i) A kilobyte is 1024 Bytes, a Megabyte is 1024 kilobytes, A Gigabyte is 1024 Megabytes

$$32\ KB = 32 \times 1024\ Bytes = 32768\ Bytes$$
$$64\ MB = 64 \times 1024^2\ Bytes = 67108864\ Bytes$$
$$6.4\ GB = 6.4 \times 1024^3\ Bytes = 6871947673.6\ Bytes$$

ii)

$$(4310)_5 = (4 \times 5^3) + (3 \times 5^2) + (1 \times 5^1) + (0 \times 5^0) = (580)_{10}$$
$$(198)_{12} = (1 \times 12^2) + (9 \times 12^1) + (8 \times 12^0) = (504)_{10}$$
$$(435)_8 = (4 \times 8^2) + (3 \times 8^1) + (5 \times 8^0) = (285)_{10}$$
$$(345)_6 = (137)_{10}$$

2)

i)

a)

$$\frac{(14)_b}{(2)_b} = (5)_b; clearly\ b \geq 6\ for\ 5\ to\ be\ a\ valid\ number\ in\ base\ b$$
$$\Rightarrow (14)_b = (5)_b(2)_b$$
$$\Rightarrow \left(1 \times b^1 + 4 \times b^0\right) = \left(5 \times b^0\right)_{10} \times \left(2 \times b^0\right)_{10} = (10)_{10};$$
$$\Rightarrow b + 4 = 10$$
$$\Rightarrow b = 6$$

b)

$$\frac{(54)_b}{(4)_b} = (13)_b; clearly\ b \geq 6\ for\ 5\ to\ be\ a\ valid\ number\ in\ base\ b$$
$$\Rightarrow (5 \times b^1 + 4 \times b^0) = (1 \times b^1 + 3 \times b^0) \times (4 \times b^0)$$
$$\Rightarrow 5b + 4 = (b + 3)4$$
$$\Rightarrow b = 8$$

c)

$(24)_b + (17)_b = (40)_b; clearly\ b \geq 8\ for\ 7\ to\ be\ a\ valid\ number\ in\ base\ b$
$\Rightarrow (2 \times b^1 + 4 \times b^0) + (1 \times b^1 + 7 \times b^0) = (4 \times b^1 + 0 \times b^0)$
$\Rightarrow 2b + 4 + b + 7 = 4b$
$\Rightarrow b = 11$

ii)

$\boxed{x^2 - (11)_b x + (22)_b = 0}$ $in\ base\ b\ has\ solutions\ x = (3)_b, (6)_b$
$solutions\ in\ base\ 10\ are\ therefore\ x = 3,6$
$equation\ in\ base\ 10\ is\ therefore\ (x-3)(x-6) = 0$
$expanding\ and\ reducing\ we\ get$ $\boxed{x^2 - 9x + 18 = 0}$
$comparing\ the\ two\ boxed\ equations\ we\ get\ -(11)_b = -9\ and\ (22)_b = 18$
$\Rightarrow (1 \times b^1 + 1 \times b^0) = 9$
$\Rightarrow b + 1 = 9$
$\Rightarrow b = 8$

3)

i)

$(64CD)_{16} = \left(0\ \underline{110}\ \underline{010}\ \underline{011}\ \underline{001}\ \underline{101}\right)_2 = (062315)_8$

ii)

a) $(10110.0101)_2 = (22.3125)_{10}$
b) $(16.5)_{16} = (1 \times 16^1 + 6 \times 16^0 + 5 \times 16^{-1})_{10} = (22.3125)_{10}$
c) $(26.24)_8 = (22.3125)_{10}$
d) $(DADA.B)_{16} = (56026.6875)_{10}$
e) $(1010.1101)_2 = (10.8125)_{10}$

4)

i)

a)

$$\begin{array}{r} 1^1 0^1 1^1\ 1 \\ +\quad 1\ 0\ 1 \\ \hline 1\ 0\ 0\ 0\ 0 \\ \hline \end{array}$$

$$\begin{array}{r} 1011 \\ \times\ \underline{101} \\ 1011 \\ 00000 \\ 101100 \\ \hline \underline{110111} \end{array}$$

b)

$$\begin{array}{r} (2E)_{16} \\ +(34)_{16} \\ \hline \underline{(62)}_{16} \end{array}$$

$$\begin{array}{r} 2E \\ \times\ \underline{34} \\ B8 \\ 8A0 \\ \hline \underline{958} \end{array}$$

ii)

With the help of subtraction by 2’s complement method we can easily subtract two binary numbers.

The operation is carried out by means of the following steps:

-Represent all numbers in signed 2’s complement form (ie sign bit as MSB, negative numbers are just the 2’s complement of their positive representation). Any subtraction will reduce to an addition of 2’s complement numbers.

- The result of the addition is positive if the carry out is 1 and negative if the carry out is 0. Negative numbers are in their 2’s Complement representation.

a)

$$10011 - 10010 = 010011 + 2's\ Complement(010010) = 010011 + 101110$$

$$\begin{array}{r} 010011 \\ +101110 \\ \hline 1\underline{000001} \end{array}$$

$Result\ is\ positive, discard\ carry\ out$

$Answer\colon\ +1$

b)

$$0100010 - 0100110 = 0100010 + 1011010$$
$$\begin{array}{r} 0100010 \\ \underline{1011010} \\ 0\underline{1111100} \end{array}$$
$Result\ is\ negative, discard\ carry\ out$
$Answer:\ -100$

c)

$$0001001 - 0110101 = 0001001 + 1001011$$
$$\begin{array}{r} 0001001 \\ +\underline{1001011} \\ 0\underline{1010100} \end{array}$$
$Result\ is\ negative, discard\ carry\ out$
$Answer:\ -101100$

d)

$$0101000 - 0010101 = 0101000 + 1101011$$
$$\begin{array}{r} 0101000 \\ +\underline{1101011} \\ 1\underline{0010011} \end{array}$$
$Result\ is\ positive, discard\ carry\ out$
$Answer:\ +010011$

5)

$(49)_{10} = (0110001)_2 \Rightarrow (-49)_{10} = (1001111)_2$
$(29)_{10} = (0011101)_2 \Rightarrow (-29)_{10} = (1100011)_2$

a)$(29) + (-49) = (0011101)_2 + (1001111)_2$
$$\begin{array}{r} 0011101 \\ +\ \underline{1001111} \\ 0\underline{1101100} \end{array}$$
$\Rightarrow Result = -(010100)_2 = -(20)_{10}$

b)$(-29) + (+49) = (1100011)_2 + (0110001)_2$
$$\begin{array}{r} 1100011 \\ +\ \underline{0110001} \\ 1\underline{0010100} \end{array}$$
$\Rightarrow Result = +(010100)_2 = +(20)_{10}$

c) $(-29) + (-49) = (1100011)_2 + (1001111)_2$

$$\begin{array}{r} 1100011 \\ +\underline{1001111} \\ 1\underline{0110010} \end{array}$$

$\Rightarrow$ *Result is not the same sign as the two 2's complement numbers added, overflow has occured(incidentally, with a carryout). So, sign extending the summands, we get:*

$$\begin{array}{r} 11100011 \\ +\underline{11001111} \\ 1\underline{10110010} \end{array}$$

$\Rightarrow$ *Result is negative, discard carry out*

$\Rightarrow Result = -(01001110)_2 = -(78)_{10}$

(6)

12 bit register 1000 1001 0111

(a) Three decimal digits in BCD

$$\underbrace{1000}_{8}\ \underbrace{1001}_{9}\ \underbrace{0111}_{7} = 897.$$

(b) excess-3-code.

564

(c) 8-4-2-1 Code is same as BCD.

871

(d) Binary.

2199

(7)

(i) Simplify to minimum no. of literals

(a) $ABC + A'B + ABC'$

$= AB(C+C') + A'B$

$= AB + A'B$

$= B(A+A')$

$= B$

(b) $x'yz + xz$

$= z(x + x'y)$

$= z(x+x')\cdot(x+y).$

$= (x+y)\cdot z$

(c) $\overline{(x+y)}\ (\bar{x}+\bar{y})$

$= (\bar{x}\cdot\bar{y})(\bar{x}+\bar{y})$

$=$ [illegible]

$=$ [illegible]

$= \bar{x}\bullet\bar{y}.$

$= \bar{x}\cdot\bar{y}$

(d) $xy + x(wz + wz')$

$= xy + xw$

$= x(y+w).$

(e) $(Bc' + A'D)(AB' + CD')$

$= 0.$

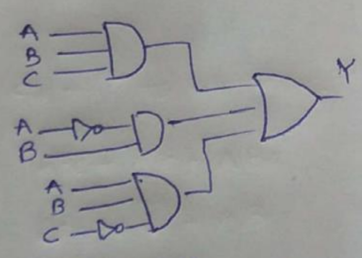
(f) $(a'+c')(a+b'+c')$

$= a'b' + a'c' + ac' + b'c' + c'$

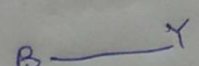
$= a'b' + c'$

(ii)

(a)

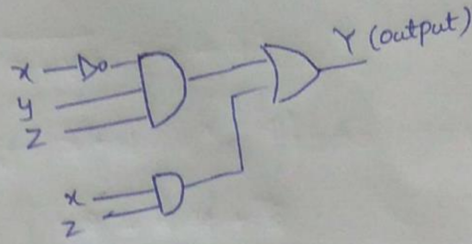


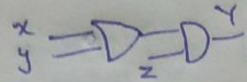
original



simplified.

(b)





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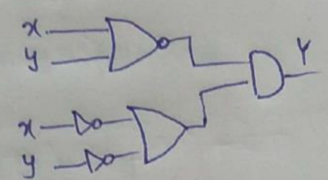
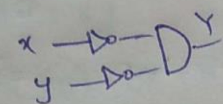
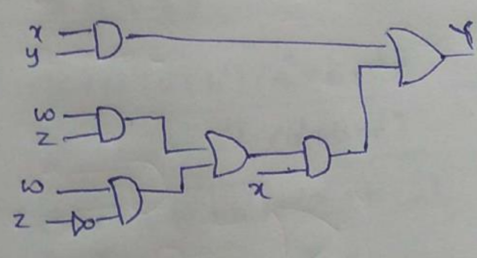
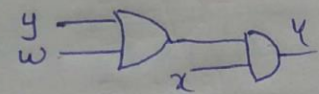


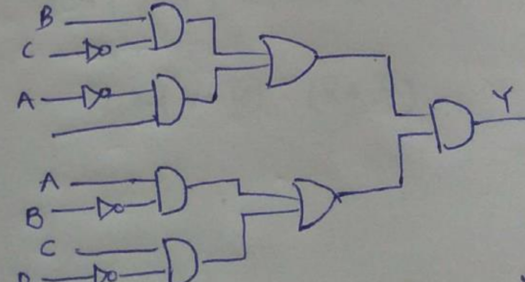


(d)



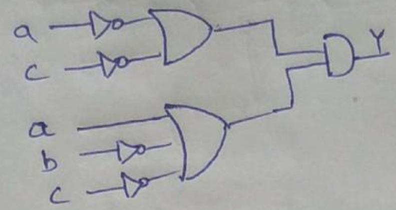


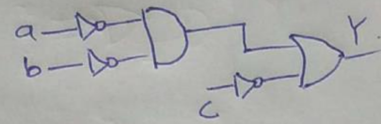
(e)



0 — Y

(f)





(8) compliment following.

(a) $xy' + x'y$

$\overline{xy' + x'y}$

$(\overline{x}+y)\cdot(x+\overline{y})$.

$\overline{x}\,\overline{y} + xy$.

(b) $(a+c)(a+b')(a'+b+c')$

$\overline{(a+c)\;(a+b')\;(a'+b+c')}$

$\overline{(a+c)} + \overline{(a+b')} + \overline{(a'+b+c')}$

$\bar{a}\bar{c} + \bar{a}b + a\bar{b}c$

(c) $\overline{z + z'(v'w + xy)}$

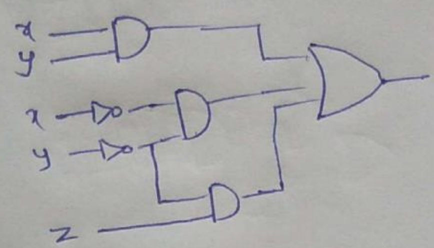
$\overline{z}\cdot\overline{\overline{z}(\overline{v}w+xy)}$

$\overline{z}\cdot(z + (v+\overline{w})\cdot(\overline{x}+\overline{y}))$

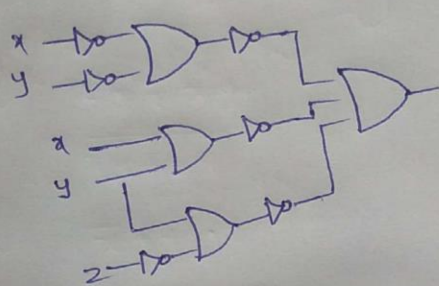
$= \overline{z}\cdot(v+\overline{w})\cdot(\overline{x}+\overline{y})$.

(ii) $F = xy + x'y' + y'z$

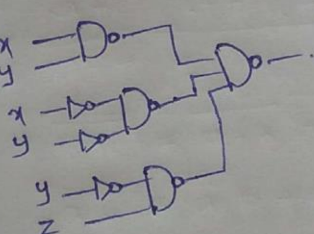
(a) AND OR INVERTER



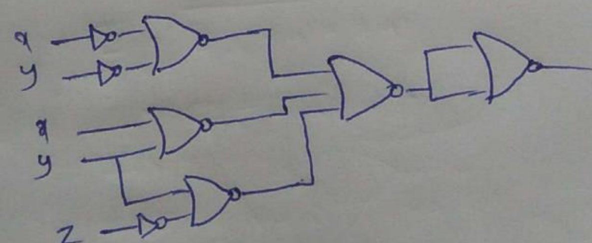
(b) OR INVERTER.



(c) NAND INVERTER.



(d) NOR INVERTER.



9

a) $(b+cd)(c+bd)$

$bc+bd+cd+bcd$

$bc+bd+cd.$

b	c	d	Y
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

min terms.

$\bar{b}cd+b\bar{c}d+bc\bar{d}+bcd.$

max terms

$(b+c+d)(b+c+\bar{d})(b+\bar{c}+d)(\bar{b}+c+d).$

b) $(b+d)(cd+\bar{b}c+b\bar{d}).$

$bcd+b\bar{d}+cd+\bar{b}cd$

$cd+b\bar{d}$

min terms

$bcd+\bar{b}cd+bc\bar{d}+b\bar{c}\bar{d}$

max terms.

$(c+b\bar{d})(d+b\bar{d})$

$(b+c)(c+\bar{d})(b+d)$

$(b+c+d)\cdot(b+c+\bar{d})\cdot(b+\bar{c}+d)\cdot(\bar{b}+c+\bar{d})$

b	c	d	Y
0	0	0	0
0	0	1	0
0	1	0	0
0	1	1	1
1	0	0	1
1	0	1	0
1	1	0	1
1	1	1	1

ⓒ $(c'+d)\,(b+c') = \bar{c} + bd.$

Pos

$(c'+d+b)(c'+d+b').(b+c'+d)\ (b+c'+d')$

$(b+c'+d)\,(b'+c'+d)\,(b+c'+d').$

Sop

$\bar{b}\bar{c}\bar{d} + \bar{b}\bar{c}d + b\bar{c}\bar{d} + b\bar{c}d + bcd.$

b	c	d	Y
0	0	0	1
0	0	1	1
0	1	0	0
0	1	1	0
1	0	0	1
1	0	1	1
1	1	0	0
1	1	1	1

(d) $b\bar{d} + ac\bar{d} + a\bar{b}c + \bar{a}\bar{c}$

$(a+\bar{a})\,b(c+\bar{c})\bar{d} + a(b+\bar{b})\,c\,\bar{d} + a\bar{b}c(d+\bar{d}) + \bar{a}\,(b+\bar{b})\bar{c}\,(d+\bar{d})$

$= abc\bar{d} + \bar{a}bc\bar{d} + ab\bar{c}\bar{d} + \bar{a}b\bar{c}\bar{d} + a\bar{b}c\bar{d} +$

$a\bar{b}cd +$ [illegible] $+ \bar{a}b\bar{c}d + \bar{a}\bar{b}\bar{c}d + \bar{a}\bar{b}\bar{c}\bar{d}$

Pos

$(a+b+\bar{c}+d)\cdot(a+b+\bar{c}+\bar{d})\cdot(a+\bar{b}+\bar{c}+\bar{d})\cdot(\bar{a}+b+c+d)\cdot$
$(\bar{a}+b+c+\bar{d})\cdot(\bar{a}+\bar{b}+c+\bar{d})\cdot(\bar{a}+\bar{b}+\bar{c}+\bar{d})$

a	b	c	d	Y
0	0	0	0	→ 1
0	0	0	1	→ 1
0	0	1	0	0
0	0	1	1	0
0	1	0	0	→ 1
0	1	0	1	→ 1
0	1	1	0	→ 1
0	1	1	1	0
1	0	0	0	0
1	0	0	1	0
1	0	1	0	→ 1
1	0	1	1	→ 1
1	1	0	0	→ 1
1	1	0	1	0
1	1	1	0	→ [illegible]
1	1	1	1	0

(ii)

(a)

$F(A,B,C,D) = \Sigma(2,4,7,10,12,14)$.

$\bar{F}(A,B,C,D) = \Sigma(0,1,3,5,6,8,9,11,13,15)$.

SOP

$\bar{a}\bar{b}\bar{c}\bar{d} + \bar{a}\bar{b}\bar{c}d + \bar{a}\bar{b}cd + \bar{a}b\bar{c}d + \bar{a}bc\bar{d}$

$+ a\bar{b}\bar{c}\bar{d} + a\bar{b}\bar{c}d + a\bar{b}cd + ab\bar{c}d + abcd$

(b) $F(x,y,z) = \pi(3,5,7)$

$\pi(3,5,7) = \Sigma(0,1,2,4,6)$.

$\bar{F}(x,y,z) = \Sigma(3,5,7)$

Sop $\bar{a}bc + a\bar{b}c + abc$.

(10)

(a) $F(x,y,z) = \Sigma(1,3,5)$.

$\Sigma(1,3,5) = \pi(0,2,4,6,7)$.

(b) $F(A,B,C,D) = \pi(3,5,8,11)$

$\Sigma(0,1,2,4,6,7,9,10,12,13,14,15)$.

(ii)

(a) $(u + xw)(x + u'v)$.

POS

$(u+x)(u+w)(u'+x)(v+x)$.

$$(u+v\cdot\bar{v}+w\cdot\bar{w}+x)(u+v\cdot\bar{v}+w+x\cdot\bar{x})(\bar{u}+v\cdot\bar{v}+w\cdot\bar{w}+x)$$

$$=(u\cdot\bar{u}+v+w\cdot\bar{w}+x)$$

$$=(u+v+w+x)\cdot(u+v+\bar{w}+x)\cdot(u+\bar{v}+w+x)\cdot(u+\bar{v}+\bar{w}+x)$$

$$(u+v+w+x)\cdot(u+v+w+\bar{x})\cdot(u+\bar{v}+w+x)\cdot(u+\bar{v}+w+\bar{x})$$

$$(\bar{u}+v+w+x)\cdot(\bar{u}+v+\bar{w}+x)\cdot(\bar{u}+\bar{v}+w+x)(\bar{u}+\bar{v}+\bar{w}+x)$$

$$(u+v+w+x)(u+v+\bar{w}+x)(\bar{u}+v+w+x)(\bar{u}+v+\bar{w}+x)$$

$$=(u+v+w+x)(u+v+\bar{w}+x)\cdot(u+\bar{v}+w+x)(u+\bar{v}+\bar{w}+x)$$

$$(u+v+w+\bar{x})(u+\bar{v}+w+\bar{x})(\bar{u}+v+w+x)(\bar{u}+v+\bar{w}+x)$$

$$(\bar{u}+\bar{v}+w+x)(\bar{u}+\bar{v}+\bar{w}+x).$$

SOP

$ux + wx + \bar{u}vwx$.

$ux + wx$.

$$uvwx + uv\bar{w}x + u\bar{v}wx + u\bar{v}\bar{w}x$$

$$+\ \bar{u}vwx + \bar{u}\bar{v}wx$$

(b) $\bar{x} + x(x+\bar{y})(y+\bar{z})$

Pos

$(\bar{x} + x(x+\bar{y}))\cdot(\bar{x}+y+\bar{z})$

$(\bar{x}+x)\cdot(x+\bar{x}+\bar{y})\cdot(\bar{x}+y+\bar{z})$

$= (\bar{x}+y+\bar{z})$.

Sop

$\bar{x} + xy + x\bar{z}$

$\bar{x}\bar{y}\bar{z} + \bar{x}\bar{y}z + \bar{x}y\bar{z} + \bar{x}yz + x\bar{y}\bar{z} + xy\bar{z} + xyz$