DLD Homework 1 Solutions
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## Problem 1

(a) Convert $54_{10}$ to:

(a) base 2: $\boxed{110110_2}$

| | Remainder | |
|---|---|---|
| $54 \div 2 = 27$ | 0 | LSB |
| $27 \div 2 = 13$ | 1 | |
| $13 \div 2 = 6$ | 1 | |
| $6 \div 2 = 3$ | 0 | |
| $3 \div 2 = 1$ | 1 | |
| | 1 | MSB |

Check

1 1 0 1 1 0

$2^6\ 2^5\ 2^4\ 2^3\ 2^2\ 2^1\ 2^0$

$32+16+0+4+2+0 = 54$ ✓

(b) base 6: $\boxed{130_6}$

| | Remainder | |
|---|---|---|
| $54 \div 6 = 9$ | 0 | LSB |
| $9 \div 6 = 1$ | 3 | |
| | 1 | MSB |

Check

$1\cdot 6^2 + 3\cdot 6^1 + 0\cdot 6^0 = 54$ ✓

(c) base 16: $\boxed{36_{16}}$

| | Remainder | |
|---|---|---|
| $54 \div 16 = 3$ | 6 | LSB |
| | 3 | MSB |

Check

$3\cdot 16^1 + 6\cdot 16^0 = 54$ ✓

(b) convert to base 10

(a) $1001\ 0100\ 1100_2$: $\boxed{2380_{10}}$

$2^{11}\quad 2^8\quad 2^6\quad 2^3\ 2^2$

$2048+256+64+8+4 = 2380$

(b) $733_8$: $\boxed{475_{10}}$

$7\cdot 8^2 + 3\cdot 8^1 + 3\cdot 8^0 = 475$

(c) $DA4_{16}$: $\boxed{3492_{10}}$

$13\cdot 16^2 + 10\cdot 16^1 + 4\cdot 16^0 = 3492$

## Problem 2

(a) $932_{16} \to$ binary: $\boxed{100100110010_2}$

9 3 2

1001 0011 0010

$932_{16} \to$ octal: $\boxed{4462_8}$

$100100110010_2$

4 4 6 2

(b) $54_{10}+22_{10}$ in binary: $\boxed{1001100_2}$

from 1a we have $54_{10} = 110110_2$

$22_{10} = 10110_2 \quad (22 = 2^4+2^2+2^1)$

$$
\begin{array}{r}
1\ \ 11\ \ \\
110110 \\
+\ 010110 \\
\hline
1001100
\end{array}
$$

Check

$54_{10}+22_{10} = 76_{10}$

$1001100_2 = 76_{10}$ ✓

(c) $15_{10}-22_{10}$ in binary:

$15_{10} = 1111_2$

$22_{10} = 10110_2$ (from 2b)

$$
\begin{array}{r}
111\ \ \\
01111 \\
+\ 01010 \\
\hline
11001
\end{array}
$$

flip bits and add 1

(d)

(a) $FFFF_{16} = 65535_{10}$

(b) $B^N$ (for example above, $16^4 = 65535$)

## Problem 3

(a) $X = \bar{A}\bar{B}C + A\bar{B} + A\bar{B}C$

$X = \bar{A}\bar{B}C + A\bar{B}(\underbrace{1+C}_{1})$

$X = \bar{A}\bar{B}C + A\bar{B}$

$X = \bar{B}(\underbrace{\bar{A}C+A}_{C+A \text{ by absorption}})$

$\boxed{X = \bar{B}(C+A)}$

(b) $Y = \bar{A}\;\overline{BCA + C}$

$Y = \bar{A}\;\overline{C(\underbrace{BA+1}_{1})}$

$\boxed{Y = \bar{A}\bar{C}}$

(c) $Z = \overline{\overline{AB}C} + \overline{A+B+\bar{C}}$

$Z = \overline{\overline{AB}} + \bar{C} + \bar{A}\bar{B}\bar{\bar{C}}$ by DeMorgan's Thm

$Z = AB + \underbrace{\bar{C} + \bar{A}\bar{B}C}_{\bar{C} + \bar{A}\bar{B} \text{ by absorption}}$

$\boxed{Z = AB + \bar{C} + \bar{A}\bar{B}}$

## Problem 4

(a) boolean expression:

$\overline{((A+B) \oplus CD) + \overline{CD}}$

(b)

| d | c | b | a | z |
|---|---|---|---|---|
| 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 1 | 0 |
| 0 | 0 | 1 | 0 | 0 |
| 0 | 0 | 1 | 1 | 0 |
| 0 | 1 | 0 | 0 | 0 |
| 0 | 1 | 0 | 1 | 0 |
| 0 | 1 | 1 | 0 | 0 |
| 0 | 1 | 1 | 1 | 0 |
| 1 | 0 | 0 | 0 | 0 |
| 1 | 0 | 0 | 1 | 0 |
| 1 | 0 | 1 | 0 | 0 |
| 1 | 0 | 1 | 1 | 0 |
| 1 | 1 | 0 | 0 | 0 |
| 1 | 1 | 0 | 1 | 1 |
| 1 | 1 | 1 | 0 | 1 |
| 1 | 1 | 1 | 1 | 1 |

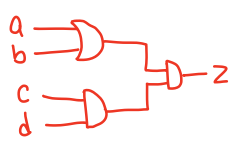
(c)

| d, c \ b, a | 00 | 01 | 11 | 10 |
|---|---|---|---|---|
| 00 | 0 | 0 | 0 | 0 |
| 01 | 0 | 0 | 0 | 0 |
| 11 | 0 | 1 | 1 | 1 |
| 10 | 0 | 0 | 0 | 0 |

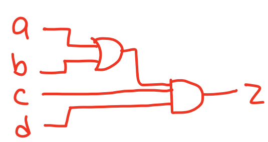
(d)

$Z = dca + dcb$

$Z = dc(a+b)$




or



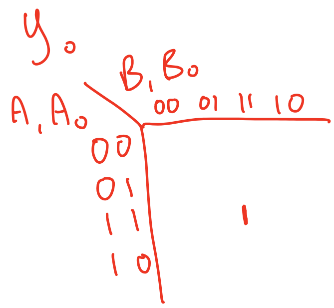
5. (a) the largest $A_1A_0$ and $B_1B_0$ can be is $11 = 3_{10}$

$3_{10} \times 3_{10} = 9_{10} = \underbrace{1001_2}_{\boxed{\text{4-bits}}}$

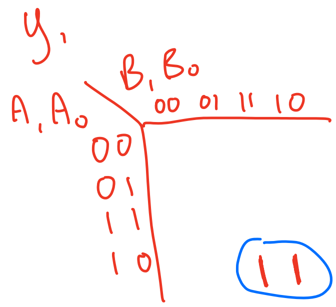
(b)

| $A_1$ | $A_0$ | $B_1$ | $B_0$ | $y_0$ | $y_1$ | $y_2$ | $y_3$ |
|---|---|---|---|---|---|---|---|
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 |
| 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 |
| 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 1 | 0 | 1 | 0 | 0 | 0 | 1 |
| 0 | 1 | 1 | 0 | 0 | 0 | 1 | 0 |
| 0 | 1 | 1 | 1 | 0 | 0 | 1 | 1 |
| 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1 | 0 | 0 | 1 | 0 | 0 | 1 | 0 |
| 1 | 0 | 1 | 0 | 0 | 1 | 0 | 0 |
| 1 | 0 | 1 | 1 | 0 | 1 | 1 | 0 |
| 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1 | 1 | 0 | 1 | 0 | 0 | 1 | 1 |
| 1 | 1 | 1 | 0 | 0 | 0 | 1 | 0 |
| 1 | 1 | 1 | 1 | 1 | 0 | 0 | 1 |

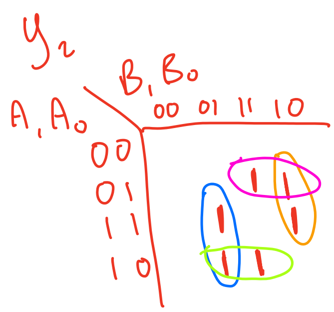
(c)

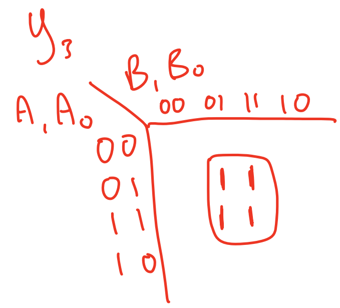



$y_0 = A_1A_0B_1B_0$




$y_1 = A_1\bar{A_0}B_1$

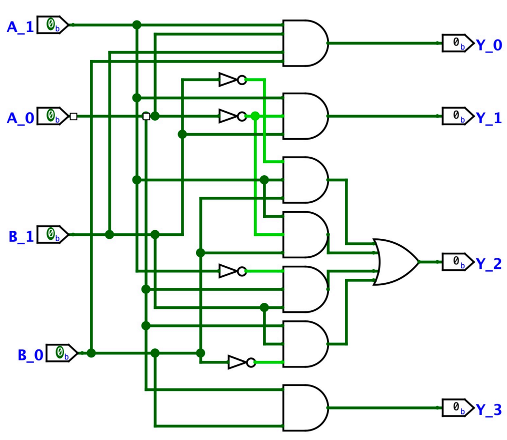


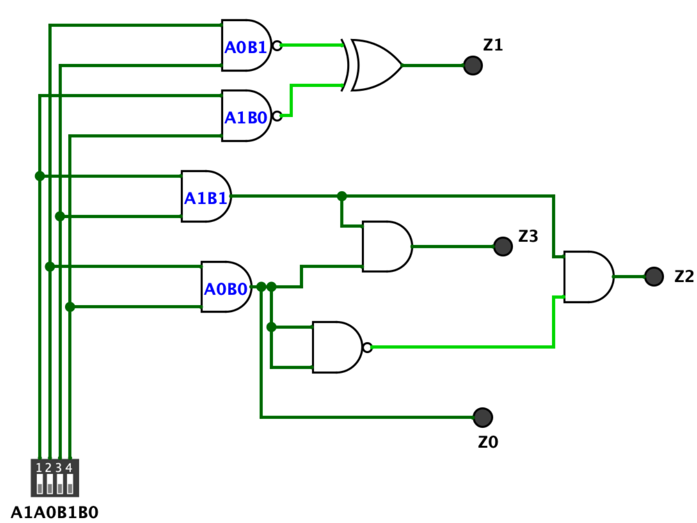

$y_2 = A_1\bar{B_1}B_0 + A_1\bar{A_0}B_0 + \bar{A_1}A_0B_1 + A_0B_1\bar{B_0}$

$y_3 = A_0B_0$

(d)




following the logic expressions explicitly




Simplified