Anthony Ranieri

Problem 1

a) We will use the Karnaugh's map for reduction by using the Product of Sums.

$$\begin{array}{ccccc} 0010 & 0011 & 0110 & 1001 & 1011 \end{array}$$

$$F = (A+B+\bar{C}+D)(A+B+\bar{C}+\bar{D})(A+\bar{B}+\bar{C}+D)(\bar{A}+B+C+\bar{D})(\bar{A}+B+\bar{C}+\bar{D})$$

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

$$F = (A+B+\bar{C})(A+\bar{C}+D)(\bar{A}+B+\bar{D})$$

b) Using the Quine-McCluskey table

$$F = \bar{A}\bar{B}\bar{C}\bar{D} + \bar{A}\bar{B}\bar{C}D + \bar{A}B\bar{C}\bar{D} + \bar{A}B\bar{C}D + \bar{A}BCD + A\bar{B}\bar{C}\bar{D} + A\bar{B}C\bar{D}$$
$$+ AB\bar{C}\bar{D} + AB\bar{C}D + ABC\bar{D} + ABCD$$

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Compliments	Term	Matched
4	$\bar{A}\bar{B}\bar{C}\bar{D}$	Yes
3	$\bar{A}\bar{B}\bar{C}D$	Yes
	$\bar{A}B\bar{C}\bar{D}$	yes
	$A\bar{B}\bar{C}\bar{D}$	Yes
2	$\bar{A}B\bar{C}D$	Yes
	$A\bar{B}C\bar{D}$	yes
	$AB\bar{C}\bar{D}$	yes
1	$\bar{A}BCD$	yes
	$AB\bar{C}D$	yes
	$ABC\bar{D}$	yes
0	$ABCD$	yes

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

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

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

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

$\bar{A}B\bar{C}\bar{D} + AB\bar{C}\bar{D} = B\bar{C}\bar{D}$

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

$A\bar{B}\bar{C}\bar{D} + AB\bar{C}\bar{D} = A\bar{C}\bar{D}$

$\bar{A}B\bar{C}D + \bar{A}BCD = \bar{A}BD$

$\bar{A}B\bar{C}D + AB\bar{C}D = B\bar{C}D$

$A\bar{B}C\bar{D} + ABC\bar{D} = AC\bar{D}$

$AB\bar{C}\bar{D} + ABC\bar{D} = AB\bar{D}$

$AB\bar{C}\bar{D} + AB\bar{C}D = AB\bar{C}$

$\bar{A}BCD + ABCD = BCD$

$AB\bar{C}D + ABCD = ABD$

$ABC\bar{D} + ABCD = ABC$

+
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Compliments	Term	Matched
	$\bar A\bar B\bar C$	No
3	$\bar A\bar C\bar D$	yes
	$\bar B\bar C\bar D$	yes
	$\bar A\bar C D$	yes
	$B\bar C\bar D$	yes
2	$A\bar B\bar D$	~~AB~~ yes
	$A\bar C\bar D$	yes
	$\bar A BD$	yes
	$B\bar C D$	yes
1	$AC\bar D$	no
	$AB\bar D$	yes
	$AB\bar C$	yes
	BCD	yes
0	ABD	yes
	ABC	yes

$\bar A\bar C\bar D + \bar A\bar C D = \bar A\bar C$

$\bar B\bar C\bar D + B\bar C\bar D = \bar C\bar D$

$\bar A\bar C\bar D + A\bar C\bar D = \bar C\bar D$

$B\bar C\bar D + B\bar C D = B\bar C$

$A\bar B\bar D + AB\bar D = A\bar D$

$\bar A BD + ABD = BD$

$B\bar C D + BCD = BD$

$AB\bar D + ABD = AB$

$AB\bar C + ABC = AB$

Compliments	Term	Matched
2	$\bar{A}\bar{C}$	no
	$\bar{C}\bar{D}$	no
	$\bar{C}\bar{D}$	no
1	$B\bar{C}$	no
	$A\bar{D}$	no
0	BD	no
	BD	no
	AB	no
	AB	no

Alright, so take the unmatched terms from last table $AC\bar{D}$ and $\bar{A}\bar{B}\bar{C}$ and originals and make table

	$\bar{A}\bar{B}\bar{C}\bar{D}$	$\bar{A}\bar{B}\bar{C}D$	$\bar{A}B\bar{C}\bar{D}$	$\bar{A}B\bar{C}D$	$\bar{A}BCD$	$A\bar{B}\bar{C}\bar{D}$	$A\bar{B}C\bar{D}$	$AB\bar{C}\bar{D}$	$AB\bar{C}D$	$ABC\bar{D}$	$ABCD$
$\bar{A}\bar{B}\bar{C}$	X	X									
$AC\bar{D}$							X			X	

X means terms are compatible

X means the X is alone in column

X means the X is in a row with red X

$$\boxed{F = \bar{A}\bar{B}\bar{C} + AC\bar{D}}$$

If $Q_1 = 01$, add multiplicand
If $Q_1 = 10$, subtract multiplicand

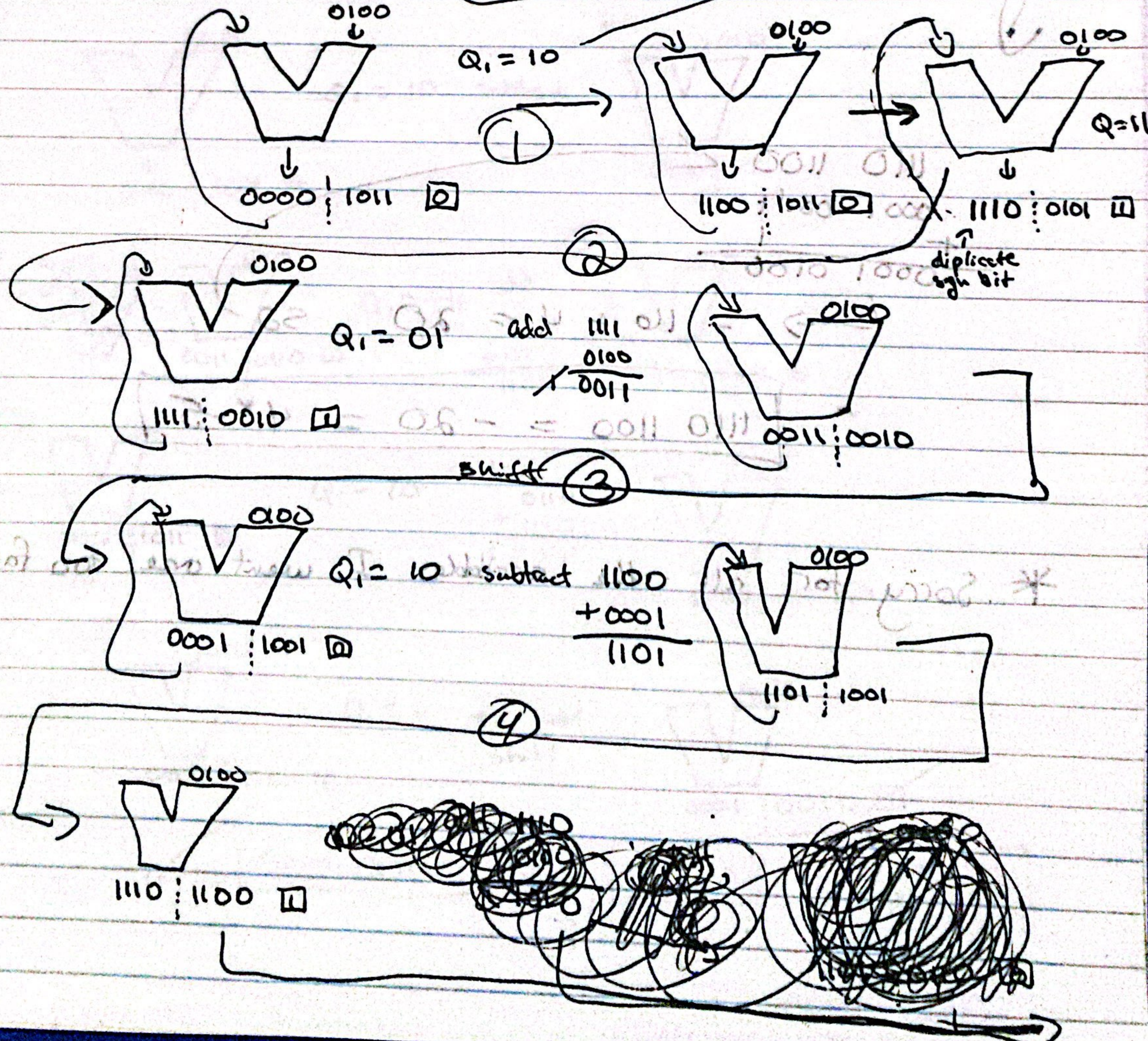
Anthony Ramier:

Problem 2 — * 8 bits for product

a) Multiplicand = 4 = 0100 → 1011 + 1 = 1100 = −4

Multiplier = −5 = 0101 → 1010 + 1 = 1011

* use an ALU



~~010~~

1010 ; 1100 ☐

now shift

1101 0110

0010 1001

+ 1

0010 1010

1110 1100

0001 0011 0011

+ 1

0001 0100

= 16 + 4 = 20 so

$\boxed{1110\ 1100 = -20 = 4 * -5}$

* Sorry for all the scribbles I went one too far

+
3ms

Problem 2

b) Multiplicand = −6 = 0110

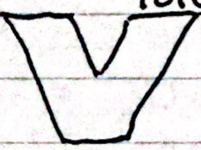
Multiplier = −3

$$\begin{array}{r} 1001 \\ +\ \ \ \ 1 \\ \hline 1010 \end{array}$$

$$\begin{array}{r} 0011 \\ 1100 \\ +\ \ \ \ 1 \\ \hline 1101 \end{array}$$

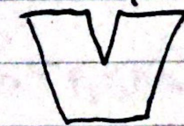
−6 = 1010
6 = 0110
−3 = 1101
3 = 0011

①

1010

0000 ¦ 1101 ⓪

Q_1 = 10 subtract

②

1010

0110 ¦ 1101

③

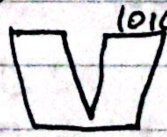
1010

0011 | 0110 ①

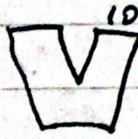
Q_1 = 01 add

$$\begin{array}{r} 1010 \\ +\,0011 \\ \hline 1101 \end{array}$$

④

1010

1101 ¦ 0110 ⓪

⑤

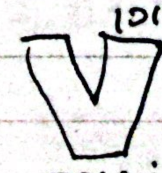
1010

1110 ¦ 1011 ⓪

Q_1 = 10 subtract

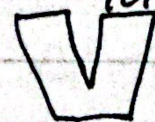
$$\begin{array}{r} 0110 \\ +\,1110 \\ \hline \cancel{1}0100 \end{array}$$

1010

0100 ¦ 1011 ⓪

1010

0010 ¦ 0101 ①

Q_1 = 11 so, just shift

1010

0001 ¦ 0010 ①

$\boxed{00010010 = 16 + 2 = 18 = -6 * -3}$

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Problem 3

* Please add 61 and 25

61 = 0011 1101 = a

25 = 0001 1001 = b

g (and) = $a_i b_i$

p (or) = $a_i + b_i$

$C_{i+1} = a_i b_i + (a_i + b_i) c_i$

$C_{i+1} = g_i + (p_i) c_i$

61	=	0011	1101
25	=	0001	1001
g	=	0001	1001
p	=	0011	1101

$P_0 = p_3 p_2 p_1 p_0 = 1*1*0*1 = 0$

$G_0 = g_3 + p_3 g_2 + p_3 p_2 g_1 + p_3 p_2 p_1 g_0$
$= 1 + 1*0 + 1*1*0 + 1*1*0*1 = 1$

$C_1 = G_0 + P_0 c_0 = 1 + 0*0 = 1$

ALU 0

$C_0 = 0$

$c_1 = g_0 + p_0 c_0$
$= 1 + 1*0 = 1$

$c_2 = g_1 + p_1 g_0 + p_1 p_0 c_0$
$= 0 + 0*1 + 0*1*0 = 0$

$c_3 = g_2 + p_2 g_1 + p_2 p_1 g_0 + p_2 p_1 p_0 c_0$
$= 0 + 1*0 + 1*0*1 + 1*0*1*0 = 0$

C = 0010

ALU 1

$C_4 = 1 = C_1$

$c_5 = g_4 + p_4 c_4$
$= 1 + 1*1 = 1$

$c_6 = g_5 + p_5 g_4 + p_5 p_4 c_4$
$= 0 + 1*1 + 1*1*1 = 1$

$c_7 = g_6 + p_6 g_5 + p_6 p_5 g_4 + p_6 p_5 p_4 c_4$
$= 0 + 0*0 + 0*1*1 + 0*1*1*1 = 0$

C = 0111

ALU 0

carry = 0010

c = 0010
(61) a = 1101
(25) b = 1001
0110

ALU 1

carry = 0111

c = 0111
(61) a = 0011
(25) b = 0001
0101

Sum is 0101 0110 = 64 + 16 + 4 + 2 = 86

61 + 25 = 86 ✓

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