2K22/CO/427

Sandesh Shrestha

Date ....

10-3 Perform the arithmetic operations below with binary numbers and with negative numbers in signed-2's complement representation. Use 7 bits to accomodate each number together with its sign. In each case, determine if there is an overflow by checking the carries into and out of the sign bit position.

(a) (+35) + (+40)

(b) (-35) + (-40)

(c) (-35) - (+40)

Solution,

(a)

+35	0	100011
+40	0	101000
+75	1	001011

F=0 E=1

F ⊕ E = 1 (overflow)

(b)

-35	1	011101
-40	1	011000
-70	0	110101

F=1 E=0

F ⊕ E = 1; overflow

(c)

-35	1	011101
+40	1	011000
	1 0	110101

F=0 E=1

F ⊕ E = 1 (overflow)

Spiral

Date ....

10.6)

a) Perform the operation $(-9)+(-6)=-15$ with binary numbers in signed-1's complement representation using only five bits to represent each number (including the sign). Show that the overflow detection procedure of checking the inequality of the last two carries fails in this case.

Sol^n,

$$\begin{array}{rr} -9 & 1\ 0110 \\ -6 & 1\ 1001 \\ \hline -15 & 0\ 1111 \end{array}$$

F=1   E=0 (carries)

$F \oplus E = 1$ but there should be no overflow since result is -15.

so adding the end around carry F as needed in signed-1's complement addition.

$$\begin{array}{r} 01111 \\ +\quad 1 \\ \hline 10000 \end{array} \longrightarrow (-15)$$

b) Suggest a modified procedure for detecting an overflow when signed 1's complement numbers are used.

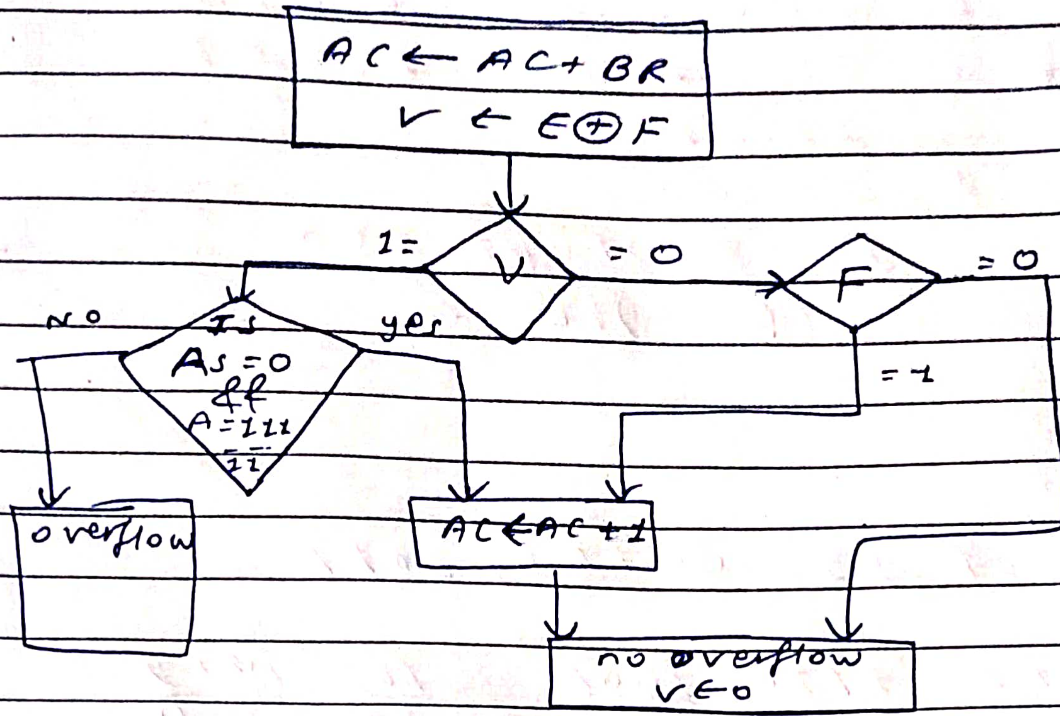
Sol^n,

The procedure $V \leftarrow E \oplus F$ is valid for 1's complement numbers provided we check the result $\underset{A_s}{0}\ \underbrace{1111\cdots11}_{A}$ when $V=1$

Spiral

2K21/CO/417

Date ....



10-9) Show the contents of registers E, A, Q, SC during the process of multiplication of 2 binary numbers, 11111 (multiplicand) and 10101 (multiplier). The signs are not included.

Soln,

~~multiplicand B = 11111 = (31)10 31×21=651~~

~~multiplier in Q E A Q SC Q = (21)10~~

~~0 00000 10101 101~~

multiplicand B = 1 1 1 1 1 = (31)10 31 × 21 = 651

	E	A	Q	SC
multiplier in Q	0	00000	10101	101
$Q_n = 1$, add B		11111		
	0	11111		
shr EAQ		01111	11010	100
$Q_n = 0$, shr EAQ		00111	11101	011
$Q_n = 1$, add B		11111		
	1	00110		

Q = (21)10

Spiral

Date ....

shr EAQ	0	10011	01110	010
$Q_n=0$, shr EAQ		010011	10111	001
$Q_n=1$, add B		11111		
	1	01000		
shr EAQ		1010001011		000

$(651)_{10}$

10.1@) soln,

@ division of 10100011 by 1011

$\frac{10100011}{1011} = 1110 + \frac{1001}{1011}$ $\frac{163}{11} = 14 + \frac{9}{11}$

B = 1011 $\bar{B}+1 = 0101$ DVF = 0

	E	A	Q	SC
dividend in AQ	0	1010	0011	100
shl EAQ	1	0100	0110	
add $\bar{B}+1$, suppress carry		0101		
	1	1001	0111	011
shl EAQ	1	0010	1110	
add $\bar{B}+1$, suppress carry		0101		
	1	0111	1111	010
shl EAQ	0	1111	1110	
add $\bar{B}+1$, carry to E		0101		
		0100	1111	001
shl EAQ	0	~~1~~111	1110	
add $\bar{B}+1$, carry to E		0101		
E=1, set Q_n to 1	1	0100	1111	001
shl EAQ	0	1001	1110	
add $\bar{B}+1$, carry to E		0101		
E=0, leave $Q_n=0$	0	1110	1110	

2K22/CO/417

Date ....

add B		1011	
restore remainder	1	1001	1110	000

$\underbrace{1001}_{\text{remainder}}$ $\underbrace{1110}_{\text{quotient}}$

10-20) (b) $\frac{1111}{0011} = 01101$, $B = 0011$, $\bar{B}+1 = 1101$

	E	A	Q	SC
dividend in Q, A = 0		0000	1111	100
Sh L EAQ	0	0001	1110	
add $\bar{B}+1$		1101		
E=0, leave $Q_n=0$	0	1110	1110	
add B		0011		
restore partial remainder	1	0001		011
sh L EAQ	0	0011	1100	
add $\bar{B}+1$		1101		
E=1, set Q_n to 1	1	0000	1101	010
Sh L EAQ	0	0001	1010	
add $\bar{B}+1$		1101		
E=0, leave $Q_n=0$	0	1110	1010	
add B		0011		
restore partial remainder	1	0001		001
Sh L EAQ	0	0011	0100	
add $\bar{B}+1$		1101		
E=1, set Q_n to 1	1	$\underbrace{0000}_{\text{remainder}}$	$\underbrace{0101}_{\text{quotient}}$	000

Date ....

10-11) Show that adding B after the operation $A+\bar{B}+1$ restores the original value of A. What should be done with the end carry?

Sol^n,

$A+\bar{B}+1$ performs: $A+2^n-B = 2^n+A-B$

adding B : $(2^k+A-B)+B = 2^n+A$

remove end carry 2^n to obtain A.

10-12) Sol^n,

To correspond with correct result, In general:

$$\frac{A}{B} = Q + \frac{R}{B}$$

where, A is dividend, Q is quotient and R is the remainder.

Four possible signs for A and B:

$$\frac{+52}{+5} = +10 + \frac{+2}{+5} = +10.4$$

$$\frac{-52}{+5} = -10 + \frac{-2}{+5} = -10.4$$

$$\frac{+52}{-5} = -10 + \frac{+2}{-5} = -10.4$$

$$\frac{-52}{-5} = +10 + \frac{-2}{-5} = +10.4$$

The sign of the remainder (2) must be same as sign of dividend (52).

Date ....

10-1?) soln,

(a) $(+15) \times (+13) = +195 = (0011000011)_2$

$BR = 01111 (+15)$; $\overline{BR}+1 = 10001 (-15)$

$QR = 01101 (+13)$

Q_n	Q_{n+1}		AC	QR	Q_{n+1}	SC
1	0	Initial	00000	01101	0	101
		subtract BR	10001			
			10001			
0	1	ashr	11000	10110	1	100
		add BR	01111			
			00111			
		ashr	00011	11011	0	011
1	0	substract BR	10001			
			10100			
		ashr	11010	01101	1	010
1	1	ashr	11101	00110	1	001
0	1	add BR	01111			
			01100			
		ashr	00110	00011	0	000

$\underbrace{00110\ 00011}_{+195}$

(b) soln,

$(+15) \times (-13) = -195 = (1100111101)$ 2's comp

$BR = 01111 (+15)$; $\overline{BR}+1 = 10001 (-15)$;

$QR = 10011 (-13)$

Q_n	Q_{n+1}		AC	QR	Q_{n+1}	SC
1	0	Initial	00000	10011	0	101
		Subtract BR	10001			
			10001			

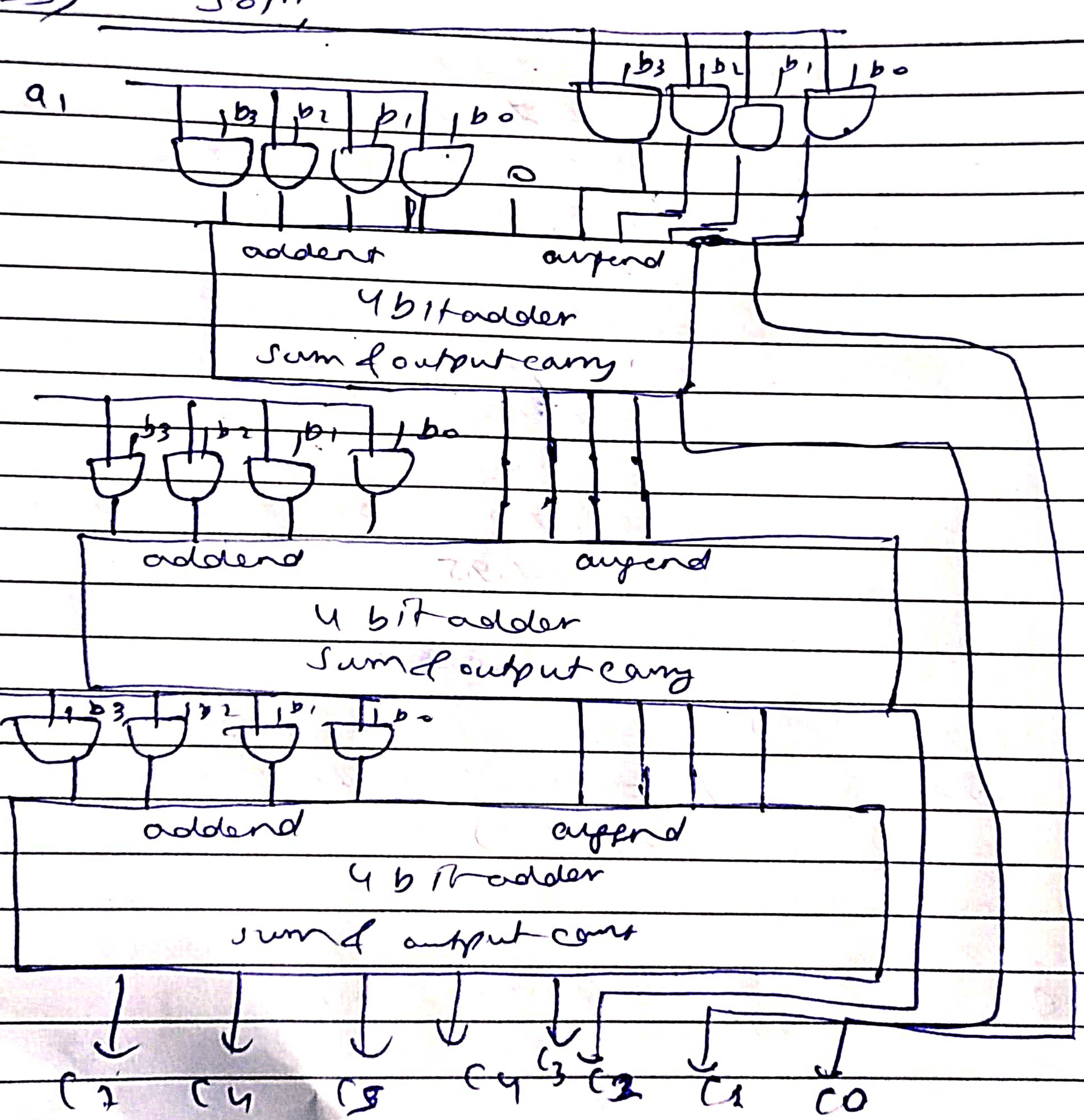
Spiral

Date ....

	asha	00101	10110	0	010
00	asha	00010	11011	0	001
10	subtract BR	10001			
		10011			
	asha -	11001	11101	1	000

$\underbrace{11001\ 11101}_{-195}$

10-13)



array multiplier (4x4)

Spiral