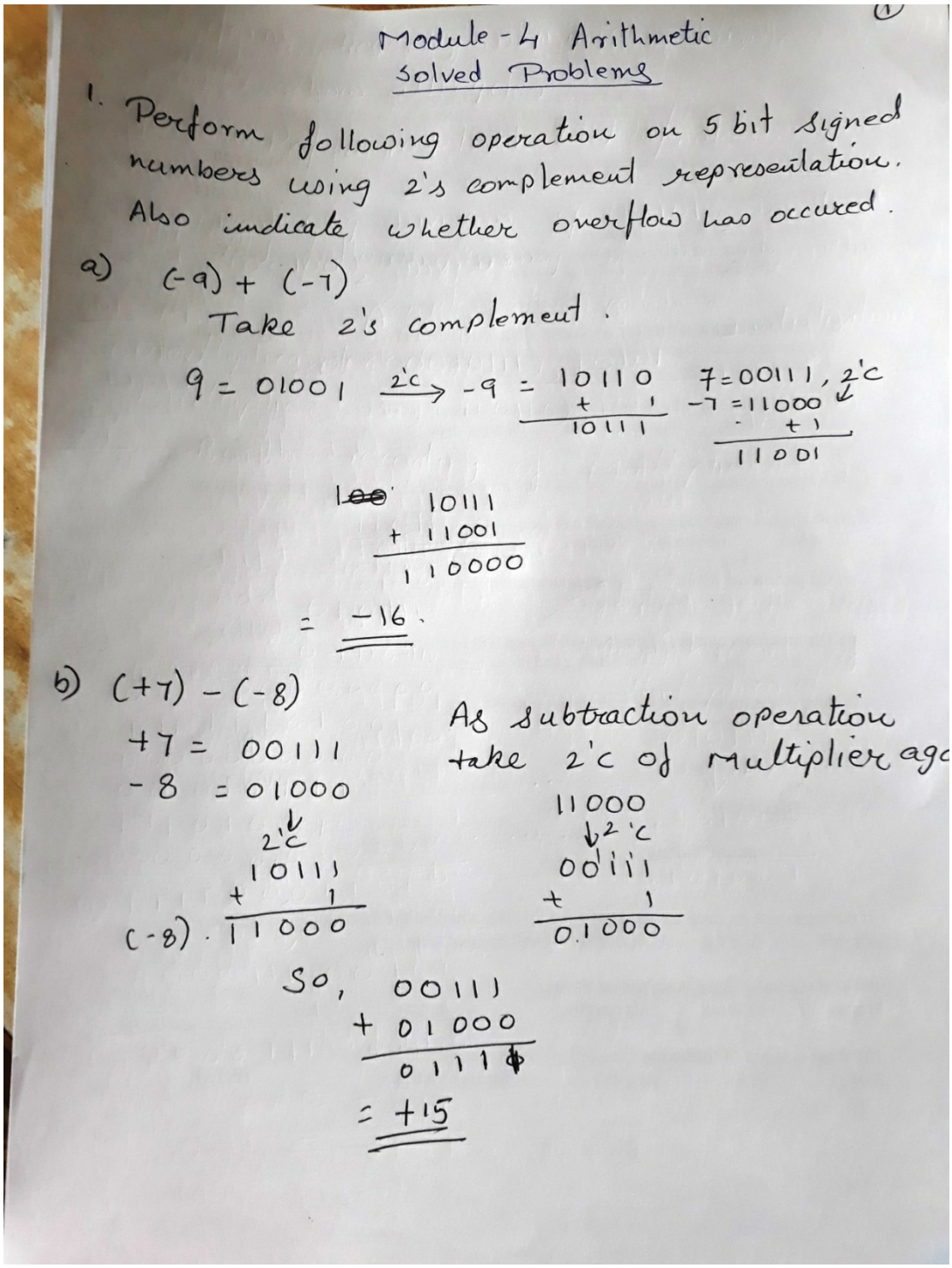
Solve all Multiplication problems using Bit Pair recoding Method while preparing for final exam.



Module - 4 Arithmetic

Solved Problems

1. Perform following operation on 5 bit signed numbers using 2's complement representation. Also indicate whether overflow has occured.

a) (-9) + (-7)

Take 2's complement.

9 = 01001 $\xrightarrow{2'c}$ -9 = 10110 + 1 = 10111

7 = 00111, 2'c, -7 = 11000 + 1 = 11001

10111
+ 11001
110000

= -16.

b) (+7) - (-8)

+7 = 00111

-8 = 01000 $\xrightarrow{2'c}$ 10111 + 1 = 11000 (-8)

As subtraction operation take 2'c of multiplier ag

11000 $\xrightarrow{2'c}$ 00111 + 1 = 01000

So, 00111
+ 01000
01111

= +15

Problems

1. Perform Multiplication of −13 and +09 using Booth's Algorithm.

Sol^n (−13) = Multiplicand

2'C = 10011

+09 = Multiplier.

Booth recoding of Multiplier

+9 = 01001 0 ← Add zero to LSB.

+1 −1 0 +1 −1

10011

× +1 −1 0 +1 −1

00000010 1 0 1

11111001 1

00000000

00011010

10011

1 1 10001011

↓2'C

000111 0100 1

+

1 0001110101 = −117.

for −1 Multiplier take 2's complement of Multiplicand.

(−13) = 10011

↓2'C

01100

+ 1

01101

2. Perform Signed Multiplication of numbers (−12) and (−11) using Booth recoding.

Sol^n. −12 $\xrightarrow{2'C}$ 01100 $\xrightarrow{2'C}$ 10011 + 1 = 10100

−11 → 01011 $\xrightarrow{2'C}$ 10100 + 1 = 11011

(-11) Multiplier

Booth recoding

1 0 1 0 1 0 ← add 0.

-1 +1 -1 +1 -1

for -1, take 2's complement of Multiplicand.

(-12) = 10100

↓2'c

01011

+ 1

01100

10100

× -1 +1 -1 +1 -1

0 0 0 0 0 0 0 1 1 0 0

1 1 1 1. 1 0 1 0 0

0 0 0 0 1 1 0 0

1 1 1 0 1 0 0

0 0 1 1 0 0

(10) 0 0 1 0 0 0 0 1 0 0

Ignore

= +132.

(5) Perform 14 * -8 using Booth's Algorithm

14 → 01110 (Multiplicand)

-8 → 01000 —2'c→ 10111 + 1 = 11000 → Booth recoding

1 1 0 0 0 0.

0 -1 0 0 0

2's complement of Multiplicand

01110

↓2'c

10001

+ 1

10010

01110

× 0 -1 0 0 0

0 0 0 0 0 0 0 0 0 0

0 0 0 0 0 0 0 0 0

0 0 0 0 0 0 0 0

1 1 1 0 0 1 0

0 0 0 0 0 0

(1) 1 1 0 0 1 0 0 0 0

Sign ↓2'c

0 0 1 1 0 1 1 1 1

+ 1

0 0 1 1 1 0 0 0 0 = -112.

⑥ Apply Booth's Algorithm to multiply signed numbers +13 and −6. (4)

Soln − Refer to text book / Notes.

⑦ Multiply following using booth's algorithm of signed 2's complement Numbers.

Multiplicand = $(010111)_2$ = +23

Multiplier = $(110110)_2$ = −10.

Soln Booth recoding of Multiplier

1 1 0 1 1 0 0

0 −1 +1 0 −1 0

0 1 0 1 1 1

× 0 −1 +1 0 −1 0

0 0 0 0 0 0 0 0 0 0 0 0

1 1 1 1 1 0 1 0 0 1

0 0 0 0 0 0 0 0 0 0 0 0

0 0 0 0 1 0 1 1 1

1 1 1 0 1 0 0 1

0 0 0 0 0 0 0 0

① 1 1 1 1 0 0 0 1 1 0 1 0

↓ 2's C

0 0 0 0 1 1 1 0 0 1 0 1

+ 1

0 0 0 0 1 1 1 0 0 1 1 0

= −230

for −1 take 2's complement of Multiplicand.

0 1 0 1 1 1

↓ 2's C

1 0 1 0 0 0

+ 1

1 0 1 0 0 1

③ Given A = 10101, B = 00100, perform A/B using restoring division method. (5)

Sol^n:

$\frac{A}{B} = \frac{10101}{00100}$ — Dividend (Q).
Divisor (M)

M	Step.	A	Q.	
00100		00000	10101	Initialization
↓2's C				
11011	Shift	00001	0101□	
+ 1	Sub.	11100		
11100	Set q_0	11101		Ist cycle.
	Restore	+00100	0101[0]	
		00001		
	Shift	00010	101[0]□	
	Sub	+11100		
	Set q_0	11110		II cycle.
	Restore	00100	101[0][0]	
		00010		
	Shift	00101	01[0][0]□	
	Sub	+11100		
	Set q_0 Dis card	00001		III cycle
	Don't Restore		01[0][0][1]	
		00001		
	Shift	00010	1[0][0][1]□	
	Sub	+11100		
	Set q_0	11110		IV cycle.
	Restore	00100	1[0][0][1][0]	
		00010		
	Shift	00101	[0][0][1][0]□	
	Sub	+11100		
	Set q_0	00001		V cycle.
	Don't Restore	[00001]	[0][0][1][0][1]	
		Remainder	quotient	

Non Restoring Division of (10101) Dividend (6)
and (00100) Divisor

Sol^n

M	steps	A	Q	
00100		00000	10101	Initialization
11011	Shift	00001	0101 □	
+ 1	Sub	+ 11100		I cycle
11100	Set q_0	① 11101		
			0101 0	
	Shift	11010	101 0 □	
	Add	00100		
	Set q_0	① 11110		II cycle
			1010 0	
	Shift	11101	010 0 □	
	Add	00100		
	Set q_0	⓪ 00001		III cycle
			0100 1	
	Shift	00010	100 1 □	
	Sub	11100		
	Set q_0	① 11110		IV cycle
			1001 0	
	Shift	11101	001 0 □	
	Add	00100		
	Set q_0	⓪ 00001		
		00001	0010 1	
		Remainder	quotient	

4. Perform following division $1000/11$

Sol^n Refer to text book / Notes.