Assignment 2

Q1 Perform Integer Arithmetic:

a] 75 + (-30)

$(75)_{10} = (01001011)_2$
$(30)_{10} = (00011110)_2$

ones complement $= (11100001)_2$
twos complement $= (11100001+1)_2$
$= (11100010)_2$

$\therefore (-30)_{10} = (11100010)_2$

$\therefore$ 75 + (-30) = 01001011 + 11100010

$$\begin{array}{r} 01001011 \\ +\ 11100010 \\ \hline 00101101 \end{array}$$

$\therefore (00101101)_2 = (45)_{10}$

Q2 Perform the unsigned Multiplication:
Multiplicand = 14
Multiplier = 12

$(14)_{10} = (1110)_2$ $\quad$ $(12)_{10} = (1100)_2$

$14 \times 12 = (168)_2$

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Multiplicand = $(1110)_2$
Multiplier = $(1100)_2$

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  1110      = Multiplicand
  1100      = Multiplier
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 00000000
 0000000 -
 000000 - -
 00000 - - -
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 10101000
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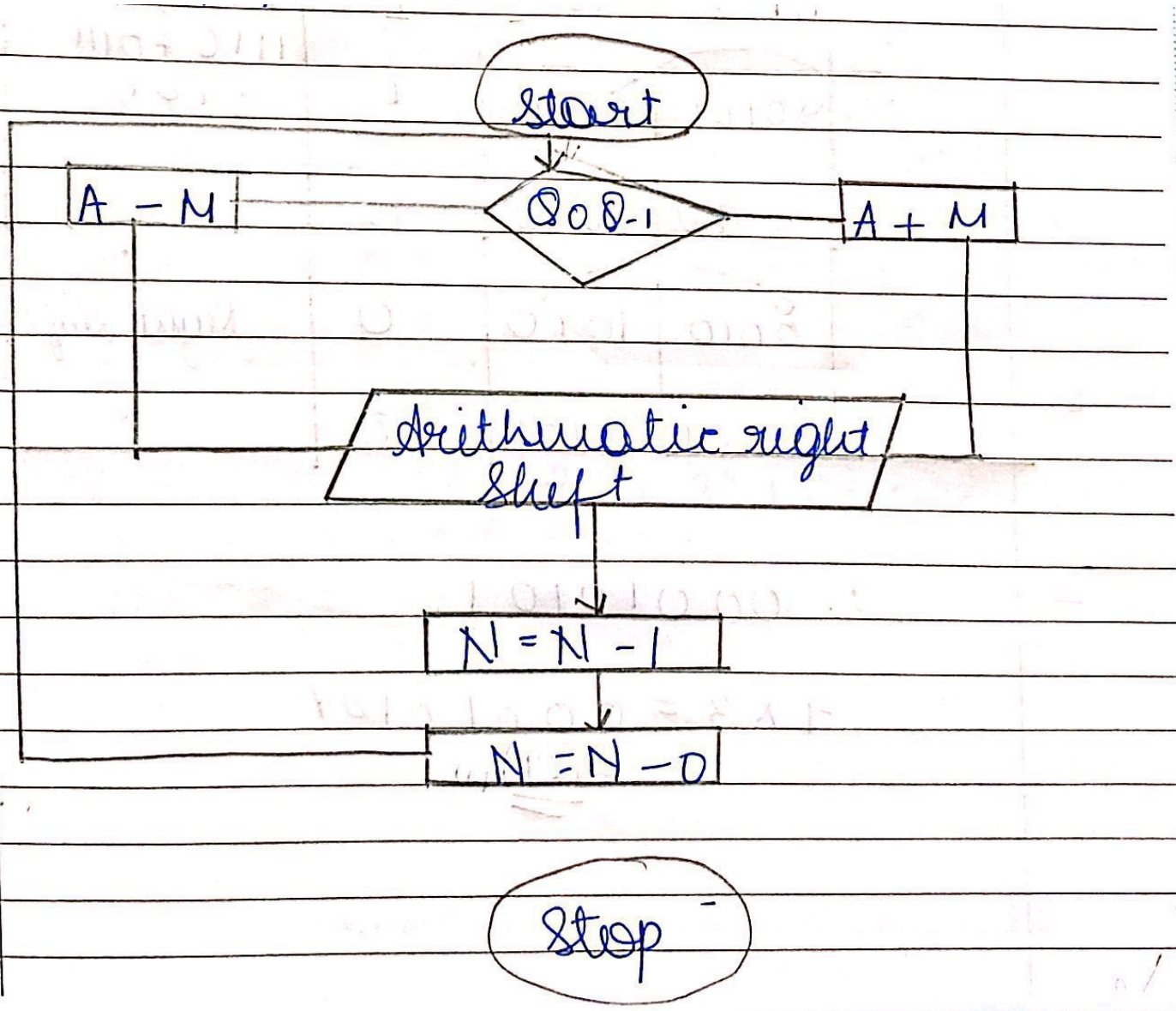
$\therefore (1110)_2 \times (1100)_2 = (10101000)_2$

$\therefore (10101000)_2 = (168)_2$



Q3 Perform the signed Multiplication using booths algorithm of
multiplicand = 14
multiplier = -12

$M = (14)_{10} = (01110)_2$
$Q_0 = (-12)_{10} = (10100)_2$
$-M = (-14)_{10}$ = 1's complement $= (10001)_2$
2's $= (10010)_2$

$Q_0 Q_{-1}$	Action
00	A·S·R
11	A·S R
01	AC+M
10	AC+(-M)

n	AC	Q_0	Q_{-1}	M	Action
(5)	00000	10100	0	01110	i] $Q_0Q_{-1} = 00$ ∴ A·S·R
	00000	01010	0	01110	
(4)	00000	00101	0	01110	i] $Q_0Q_{-1} = 00$ ∴ A·S·R
(3)	10010	00101	0	01110	i] $Q_0Q_{-1} = 10$ Ac = Ac+(-M) 00000 + 10010 = 10010
	11001	00010	1	01110	ii] A·S R

n	Ac	Q_0	Q_{-1}	M	Action
②	00111	00010	1	01110	$Q_0 \cdot Q_{-1} = 01$ Ac = Ac + M 11001 +01110 100111
	00011	10001	0	01110	ii] A·S·R
①	10101	10001	0	01110	$Q_0 \cdot Q_{-1} = 10$ Ac ← Ac + (-M) 00011 +10010 10101
	11010	11000	1	01110	ii] A·S·R

$AcQ_0 = (1101011000)_2$

As M·S·B is 1
hence product is (-ve)
so we take 2's complement

1's complement = 0010100111
2's complement = 0010100111
+ 1
0010101000

$\therefore (+14)_{10} \times (-12)_{10} = (-168)_{10}$

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Q4 Perform division of the following no. using Restoring algorithm

dividend $= (1000)_2 = Q$

divisor $= (0011)_2 = M$

to handle borrow

$M \leftarrow (00011)_2$

$-M$ = 1's complement = 11100

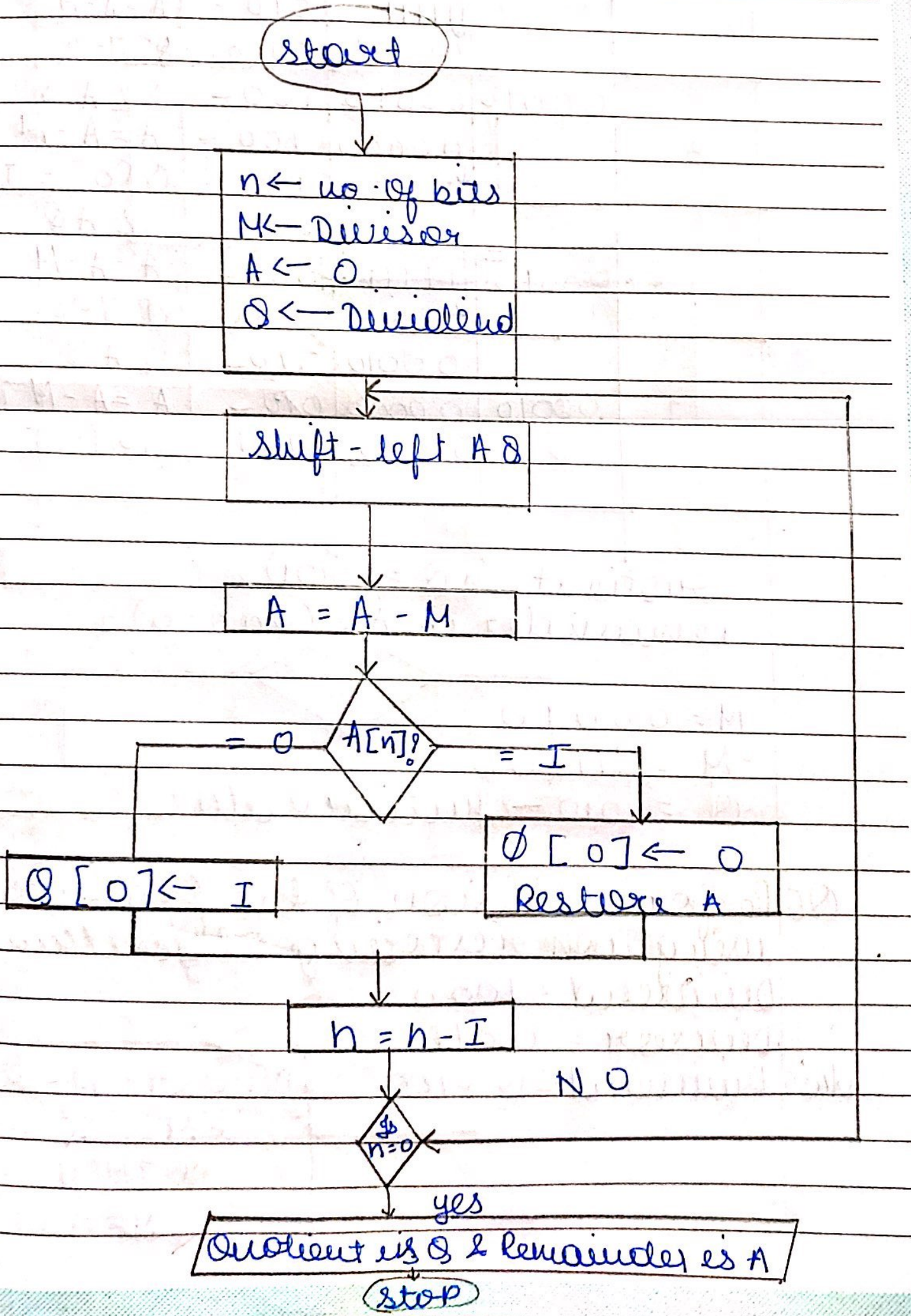
2's complement = 11100 + 1 = 11101

n	C	Ac	Q	M	Action
4	0	00000	1000	00011	i Initialization
	0	0001	000	00011	ii Left shift
	1	1110	0000	00011	iii C, Ac + (-M) 00001 + 11101 = 11110
					iv Restoring C, AC + M 11110 + 00011 = 00001
	0	0001	0000	00011	
2	0	0010	0000	00011	i] Left shift
	1	1111	0000	00011	ii] C, AC + (-M) 00010 + 11101 = 11111
	0	0010	0000		iii] Restoring 11111 + 00011 = 00010

n	C	Ac	Q	M	Actions
②	0	0100	0010	00011	i] Shift left
	0	0001	0010	00011	ii] C, A = C+(-M)
					00100
					+11101
					00001
①	0	0010	0010	00011	i] Shift Left
	1	1111	0010	00011	ii] C, A = C+(-M)
					00010
					+11101
					11111
	0	0010	0010	00011	iii] Restoring
					11111
					+00011
					00010

Q ← Quotient = $(0010)_2 = (2)_{10}$

R ← Remainder = $(0010)_2 = (2)_{10}$



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Q5 - Perform division of the following no. using non restoring algorithm:

dividend = 1010 → Q

Divisor = 00011 → M

-M = 11101

R = $(0001)_2 = (1)_{10}$, Q = $(0011)_2 = (3)_{10}$

n	C	Ac	Q	M	Action
(1)	0	0000	1010	00011	i] Initialization
	0	0001	010□	00011	ii] Shift left
					iii] C,Ac+(-M)
	1	1110	0100	00011	00001
					+11101
					11110
(2)	1	1100	100□	00011	i] Shift left
	1	1111	1000	00011	ii] C,Ac+M
					11100
					+00011
					11111
(3)	1	1111	000□	00011	i] Shift left
	0	0010	0001	00011	ii] C,Ac+M
					11111
					+00011
					000100
(4)	0	0100	001□	00011	i] Shift left
	0	0001	0011	00011	ii] C,Ac-M
					00100
					+11101
					00001

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Flowchart :-