

Q. 1 soln:

Let bit pattern of the the -ve # be $-A$ be $a_{n-1} a_{n-2} \dots a_0$, where $a_{n-1} = 1$ as it is -ve. The value of this # is

$$-A = -2^n + \sum_{i=n-1}^0 a_i 2^i = -2^{n-1} + \sum_{i=n-2}^0 a_i 2^i \quad \text{-- (I)}$$

When we perform an ASR on register R storing this bit pattern, we get the bit pattern of another -ve number (say, $-Y$) as

$$\text{ASR}(-A) = 1 a_{n-1} a_{n-2} \dots a_1 = 1 1 a_{n-2} \dots a_1$$

whose value is

$$-Y = -2^n + 2^{n-1} + 2^{n-2} + \sum_{i=n-2}^0 a_i 2^{i+1}$$

(since position of each bit a_i in the summation corresponds to place value 2^{i+1}) Thus

$$-Y = -2^{n-2} + \sum_{i=n-2}^1 a_i 2^{i+1} \quad \text{-- (II)}$$

If we divide $-A$ in Eqn. (I) by 2, we get

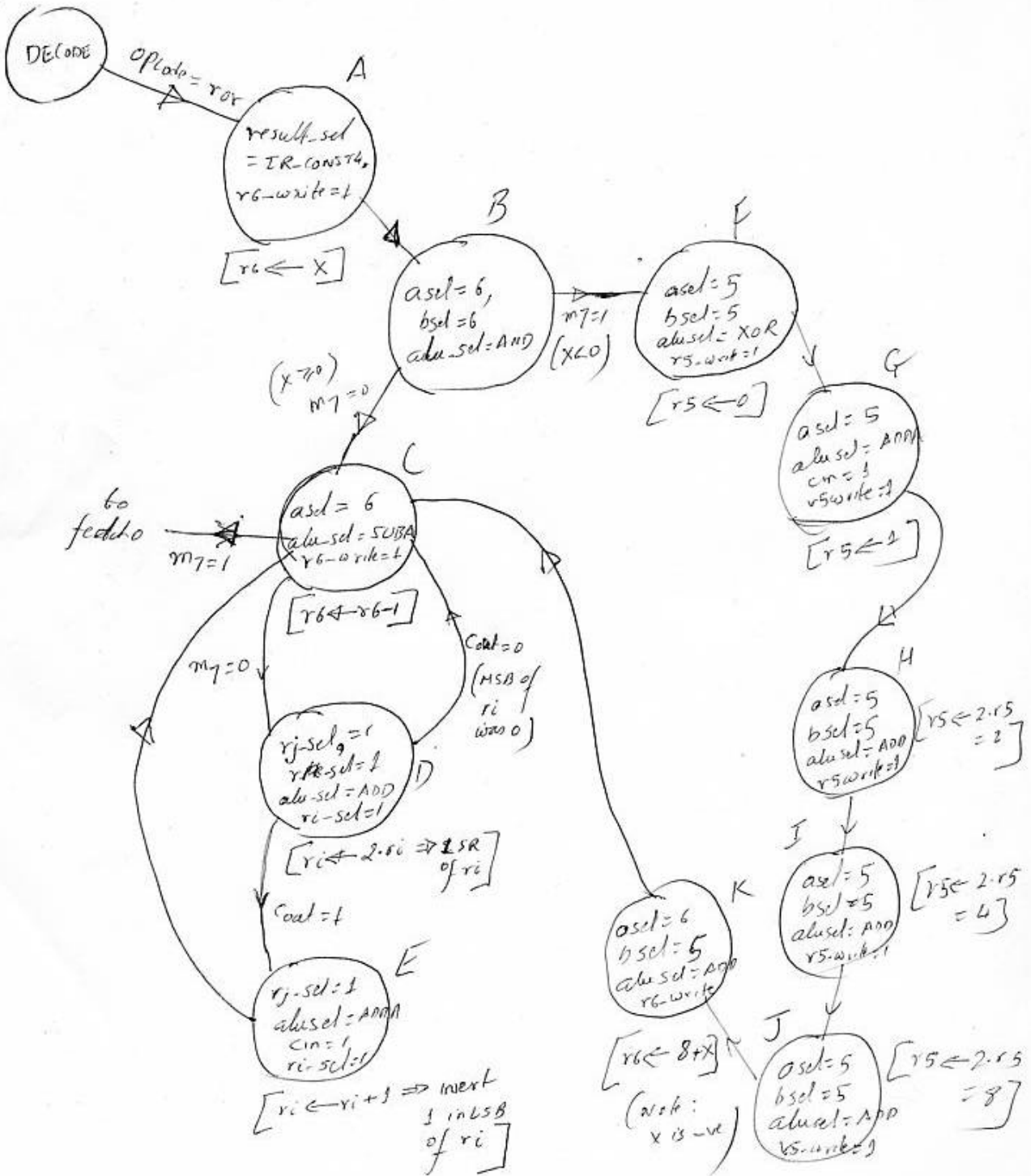
$$\begin{aligned} -A/2 &= -2^{n-2} + \sum_{i=n-2}^0 a_i 2^{i+1} \\ &= -2^{n-2} + \sum_{i=n-2}^1 a_i 2^{i+1} + (a_0/2) \quad \text{-- (III)}. \end{aligned}$$

If we ignore $a_0/2$ (which is either 0 or 0.5 if $a_0 = 0$ or 1, resp.) in Eqn. (III) then the rest of the value is $\text{floor}(-A/2)$ (e.g., if $-A = -9$, then $-A/2 = -4.5$, in which case $a_0/2 = 0.5$, then ignoring $a_0/2$ in Eqn. III, the rest of the expression is $-5 = \text{floor}(-9/2)$).

$$\text{Thus } \text{floor}(-A/2) = -2^{n-2} + \sum_{i=n-2}^1 a_i 2^{i+1} \quad \text{-- (IV)}.$$

Since the right hand sides (RHS's) of both Eqn. (II) and (IV) are the same, we have $-Y = \text{floor}(-A/2)$.

2 a)



b) # cc's for

i) ROT of 3 bits : States A-B once each = 2 cc's

States C-D ~~3~~ 2 times each = 6 cc's
(1 for each bit ROT)

State E (used say 50% of the # of iterations when MSB of $x_i = 1$)

\Rightarrow used 1.5 times = $\lceil 1.5 \rceil = 2$ cc's

State C = one more time = 1 cc when $x = 0$

\Rightarrow Total of 11 cc's

ii) ROT of 4 bits : States A-B once each = 2 cc's

States F-K once each = 6 cc's

States C-D 4 times each = 8 cc's

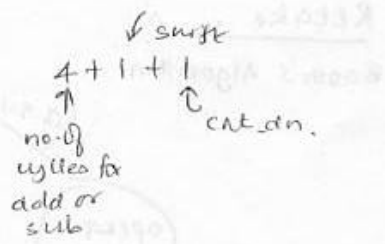
State E (50% of the # of iterations) = 2 times = 2 cc's

State C used one more time when $x = 0$ = 1 cc

\Rightarrow Total = 19 cc's

Cycles:

cnt_r_val	Operation	Cycles:	
	Load counter	1	1
	sub	4 + 1	5
(15)	no addition/sub	0 + 1 + 1	2
(14)	add	4 + 1 + 1	6
(13)	no add/sub	0 + 1 + 1	2
(12)	no add/sub	0 + 1 + 1	2
(11)	sub	4 + 1 + 1	6
(10)	no add/sub	0 + 1 + 1	2
(9)	no add/sub	0 + 1 + 1	2
(8)	add	4 + 1 + 1	6
(7)	no add/sub	0 + 1 + 1	2
(6)	no add/sub	0 + 1 + 1	2
(5)	sub	4 + 1 + 1	6
(4)	no add/sub	0 + 1 + 1	2
(3)	no add/sub	0 + 1 + 1	2
(2)	no add/sub	0 + 1 + 1	2
(1)	add	4 + 1 + 1	6



Total cycles \Rightarrow

56

Note: 1. counter value given is before the start of cycle.

cycle is \Rightarrow cnt_dn \rightarrow add/sub/wop \rightarrow shift