(1) X = -106
Y = 112

$X = 11101010_{SM}$
$= 10010110_{C2}$

COUNT	A	Q	Q_{-1}	M
00	0 0000 0000	1001 0110	0	0111 0000
+	1 0010 0000	-2M		
	1 0010 0000			
	11100 1000	0010 0101	1	
01 +	01110 0000	+2M		
	01010 1000			
	00010 1010	0000 1001	0	
10 +	00111 0000			
	01001 1010			
	00010 0110	1000 0010	0	
		-2M		
11 +	10010 0000			
	10100 0110			
	11101 0001	1010 0000	1	

106 − 64 = 42; 42 − 32 = 10
112 − 64 = 48; 48 − 32 = 16

M = 01110000
M = 00111 0000
−M = 11001 0000
2M = 01110 0000
−2M = 10010 0000

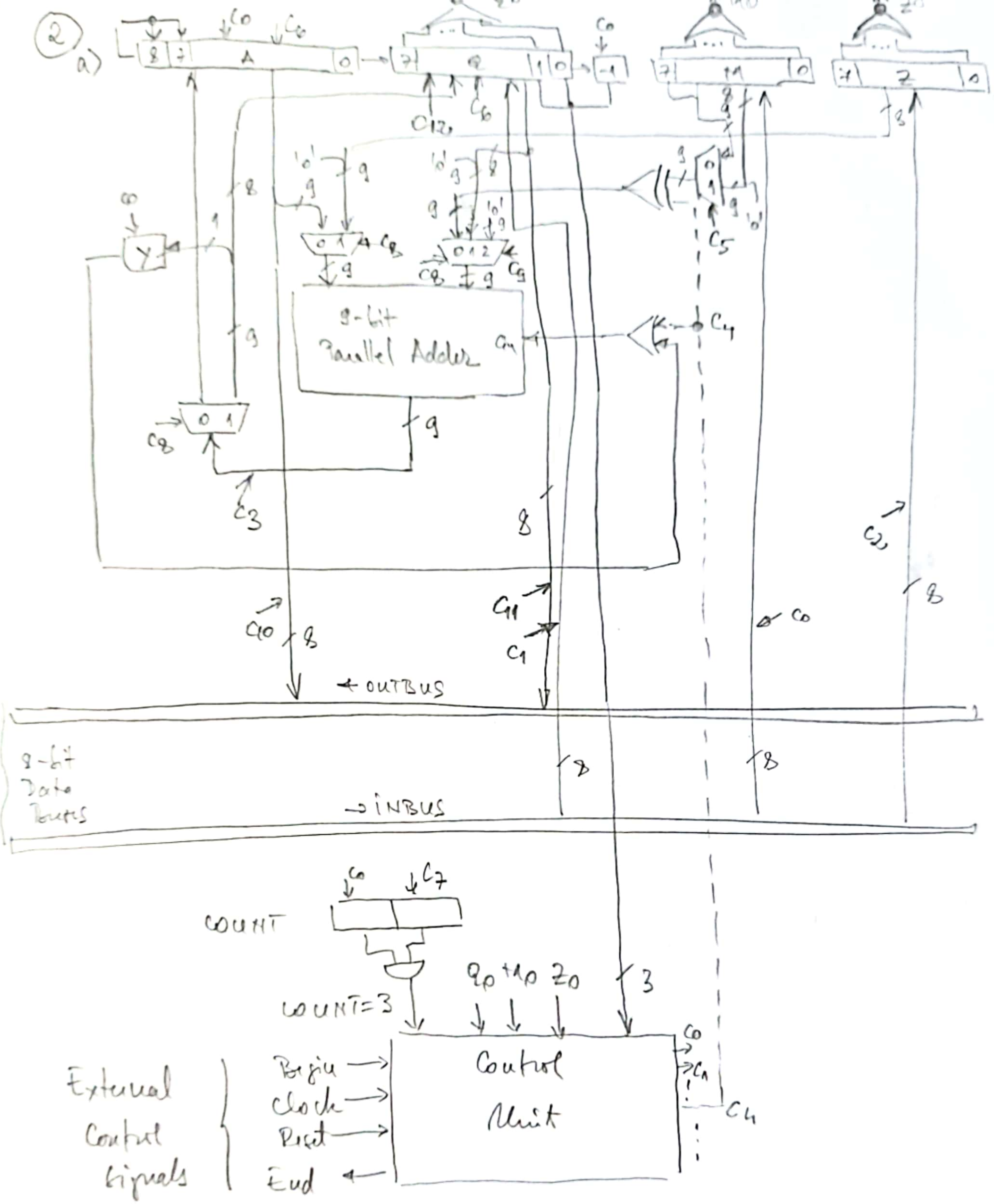
000 − 0
001, 010 } 1
011 − 2
100 − −2
101, 110 } −1
111 − 0

−106 × 112
212
106
106
P = −11872

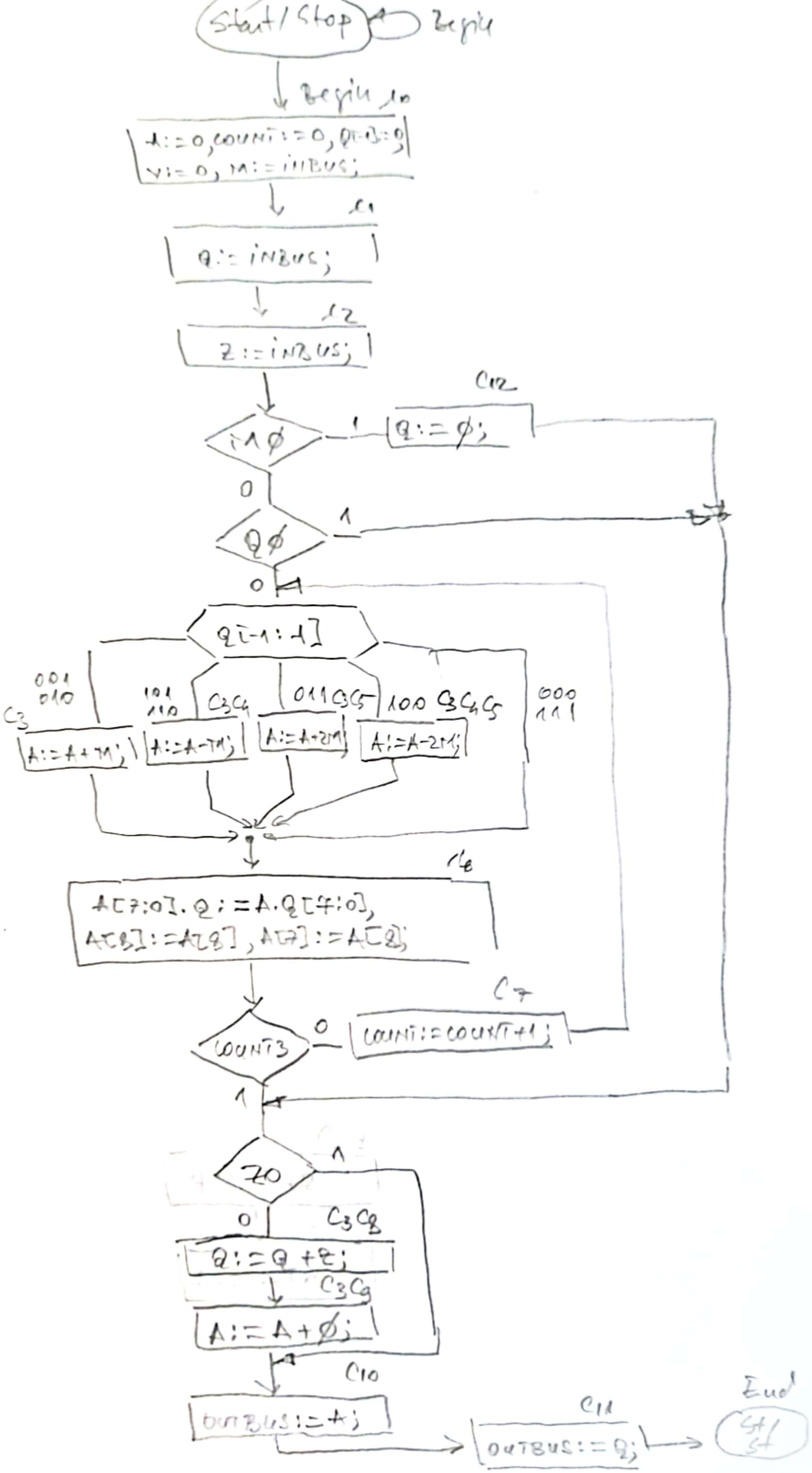
$2^{10} = 1024$
$2^{11} = 2048$
$2^{12} = 4096$
$2^{13} = 8192$

11872 − 8192 = 3680
3680 − 2048 = 1632
1632 − 1024 = 608
608 − 512 = 96
96 − 64 = 32

$101011100110 0000_{SM} = P$
$11010001101 0 0000_{C2}$


2
a)
A
Q
M
Z
9-bit Parallel Adder
OUTBUS
INBUS
8-bit Data Buses
COUNT
COUNT=3
Control Unit
External Control Signals
Begin
Clock
Reset
End

(2) b



Start / Stop
Begin
Begin
A := 0, COUNT := 0, Q[-1] := 0
Z := 0, M := INBUS;
Q := INBUS;
Z := INBUS;
Q := Ø;
Q Ø
Q[-1 : 1]
001
010
101
110
011
100
000
111
A := A + M;
A := A - M;
A := A + 2M;
A := A - 2M;
A[7:0].Q := A.Q[7:0],
A[8] := A[8], A[7] := A[8];
COUNT3
COUNT := COUNT + 1;
Z0
Q := Q + Z;
A := A + Ø;
OUTBUS := A;
OUTBUS := Q;
End
St/St

(3) $CCT = 0.25us \Rightarrow$ Clock frequency $= \frac{1}{0.25us} = 4\,GHz$

$$CPU\ time_X = IC \times \overbrace{(0.4\times5 + 0.3\times4 + 0.1\times2 + 0.2\times3)}^{CPI_X = 4} \times 0.25us$$

$$= IC \times 4 \times 0.25us = IC \times 1us$$

$$CPU\ time_Y \overset{0.25us}{=} IC \times (1 - 0.3\times0.5)\ \frac{0.4\times5 + 0.3\times0.5\times4 + 0.1\times2 + 0.2\times}{1 - 0.3\times0.5}$$

$$= IC \times \cancel{(1-0.3\times0.5)}\ \frac{3.4}{\cancel{(1-0.3\times0.5)}} \cdot 0.25us$$

$$= IC \times 3.4 \times 0.25us$$

$$CPI_Y = \frac{3.4}{0.85} = 4$$

a) $CPU\ time_X = CPU\ time_Y \Rightarrow \cancel{IC}\times4\times CCT_X = \cancel{IC}\times3.4\times0.25us$

$$CCT_X = \frac{3.4}{4}\times0.25us = \boxed{0.2125us}$$

b) $MIPS_X = MIPS_Y \Rightarrow \frac{Clock\ frequency_X}{CPI_X\times10^6} = \frac{Clock\ frequency_Y}{CPI_Y\times10^6}$

$$\Rightarrow \frac{CF_X}{\cancel{4\cdot10^6}} = \frac{CF_Y}{\cancel{4\cdot10^6}} \Rightarrow Clock\ frequency_X = Clock\ frequency_Y$$

$$\Rightarrow CCT_X = CCT_Y = \boxed{0.25us}$$

(4)

a) $VM = 256\,TiB = 2^8 \times 2^{40}\,B = 2^{48}\,B$

64 entries

$PM = 128\,GiB = 2^7 \times 2^{30}\,B = 2^{37}\,B$

$37 - 14 = 23$

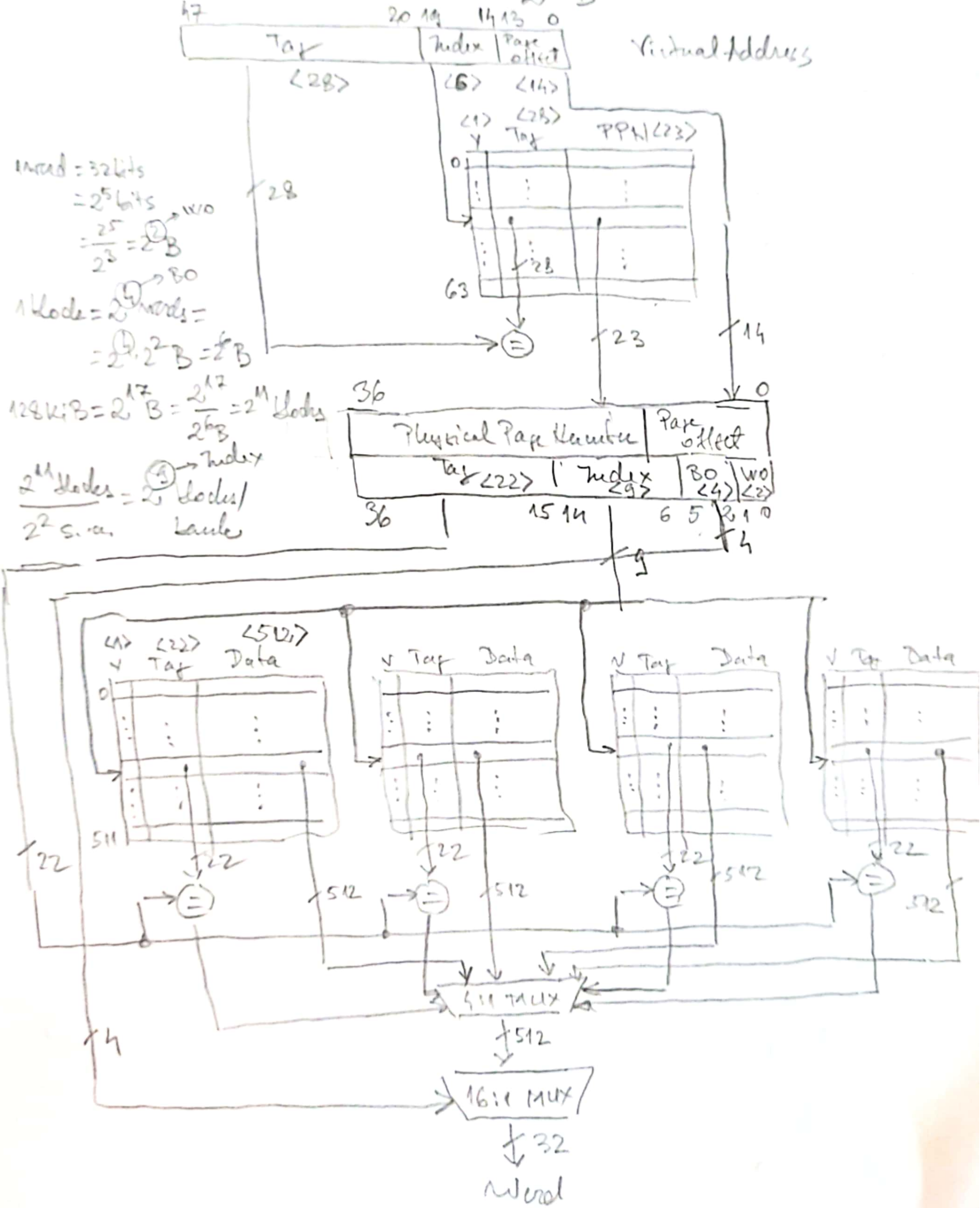
$\text{Page size} = 16\,KiB = 2^4 \times 2^{10} = 2^{14}\,B$

word $= 32$ bits $= 2^5$ bits $= \frac{2^5}{2^3} = 2^{2}\,B \to$ WO

1 block $= 2^{4}$ words $= 2^{4} \cdot 2^2\,B = 2^6\,B$ ($4 \to$ BO)

$128\,KiB = 2^{17}\,B = \frac{2^{17}}{2^6\,B} = 2^{11}$ blocks

$\frac{2^{11}\text{ blocks}}{2^2\text{ s.a.}} = 2^{9}$ blocks/bank ($9 \to$ Index)



b) TLB Total Size = $2^6 \times$ (1 bit V + 28 bits tag + 23 bits PPN) $\cong 2^6 \times 64$ bits

$$= 2^6 \times 2^3 B = 2^9 B$$

$$\cong \boxed{0.5 KiB}$$

Cache Total Size $= \underbrace{2^2}_{s.a} \times \underbrace{2^9}_{index} \times \left[(23 \text{ bits}) + 2^6 B\right] \cong \underbrace{2^5 \times 2^{11}}_{ctrl\ bits} + 128 KiB$

$$= 2^{13} B + 128 KiB$$

$$= 8 KiB + 128 KiB$$

$$= \boxed{136 KiB}$$

(5)

a) $\text{Clock cycle time}_x = \frac{1}{3.5 \times 10^9 s^{-1}} = \frac{1}{3.5} us = 0.2857 us$

$\text{Miss Penalty}_x = \left\lceil \frac{300 us}{0.2857 us} \right\rceil = 1051 \text{ c.c.}$

$\text{Misses per instruction}_x = 1 \times 0.1 + 0.25 \times 0.08 = 0.12$

$\text{Miss rate}_x = \frac{0.12}{\text{Mem acc per inst}_x} = \frac{0.12}{1.25} = 0.096$

$\text{CPU time}_x = IC \times (4 + 0.12 \times 1051) \times 0.2857 us = \boxed{IC \times 37.175284 \; us}$

$\text{CPU time}_y = IC \times (\text{CPI ideal}_y + 1.25 \times 0.09 \times 1051) \times 0.2857 us$

$\text{Perf}_y > \text{Perf}_x \Rightarrow \text{CPU time}_y < \text{CPU time}_x$

$\cancel{IC} \times (\text{CPI ideal}_y + 1.25 \times 0.09 \times 1051) < \cancel{IC} (4 + 0.12 \times 1051)$

$\text{CPI ideal}_y < \underbrace{4 + 0.12 \times 1051}_{130.12} - \underbrace{1.25 \times 0.09 \times 1051}_{118.2375}$

$\Rightarrow \boxed{\text{CPI ideal}_y < 11.8825}$

b) $\text{AMAT}_x = 2 \times 0.2857 us + 0.096 \times 1051 \times 0.2857 us =$

$= (2 + 0.096 \times 1051) \times 0.2857 us = \boxed{29.3973872 \; us}$

$\text{AMAT}_y = (a + 0.09 \times 1051) \times 0.2857 us$

$\text{AMAT}_y < \text{AMAT} \Rightarrow (a + 0.09 \times 1051) < (2 + 0.096 \times 1051)$

$a < 2 + 0.096 \times 1051 - 0.09 \times 1051$

$a < 2 + 1051 (0.096 - 0.09)$

$a < 2 + 1051 \times 0.006$

$\boxed{a < 8.306}$ a - access in c.c to the cache.

$\Rightarrow a < 9$ deoarece a - nr întreg.

Scanat cu CamScanner

(6)

```
      MOV  r0, #0        ; initialize i
      MOV  r1, #0        ; initialize m
      ADR  r2, max       ; bring the address of max
      LDR  r3, [r2]      ; bring the value of max
      ADR  r5, q
      ADR  r6, r
loop: MUL  r4, r0, #2    ; put 2*i in r4
      ADD  r1, r1, r4    ; m := m + 2i
      CMP  r1, r3        ; compare m with max
      BNE  next
      MOV  r7, r3, ASR #2     ; divide max by 4
      STR  r7, [r5]           ; store q
      SUB  r8, r3, r7         ; calculate r = max - max/4
      STR  r8, [r6]           ; store r
next: ADD  r0, r0, #1         ; update index i
      CMP  r0, r3             ; compare i with max
      BLT  loop               ; if i < max continue loop
loopend: ...
```