

# P3 - ORG

1) a)  $I(m_i + m_d L_S)$   

$$\frac{m_i + m_d L_S}{1 + L_S}$$

b) (I).  $m_i \cdot p$   
 $h + m_i \cdot p$

2)  $\begin{cases} 16\text{-way} \\ \text{bloco: } 64 \text{ bytes} \\ 1024 \cdot 2^{10} \text{ bytes} \end{cases}$

bloco  $\begin{cases} +1: \text{valido} \\ +1: \text{reference} \\ +1: \text{dirty} \end{cases}$  { endereço = 48 bits

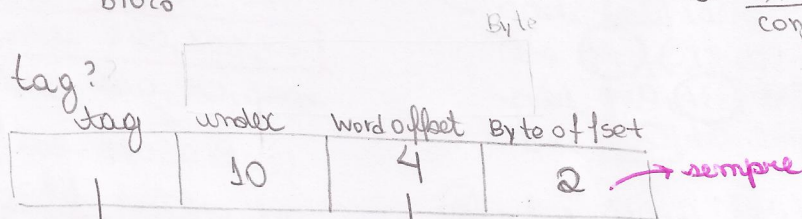
a) index?

$\rightarrow 16\text{-way} = \frac{16 \text{ blocos}}{\text{conjunto}} \rightarrow \frac{64 \text{ bytes}}{\text{bloco}} = \frac{2^{20} \text{ bytes}}{2^6 \text{ bytes}} = 2^{14} \text{ blocos}$

$\rightarrow \text{Size} = 2^{20} \text{ bytes}$

$\rightarrow \frac{64 \text{ bytes}}{\text{bloco}} \rightarrow \text{conjuntos} = \frac{2^{14} \text{ blocos}}{2^4 \text{ blocos}} = 2^{10} \text{ conjuntos}$   
 $\downarrow \log_2(2^{10})$   
 10 bits: índice

b) tag?



$= 48 - 10 - 4 - 2$

$= 32 \text{ bits}$

$\frac{64 \text{ bytes}}{\text{bloco}} = \frac{2^6 \text{ words}}{2^2 \text{ bloco}} = \frac{16 \text{ words}}{\text{bloco}}$   
 $\log_2 16 = 4$   
 $\rightarrow \text{word} = 4 \text{ bytes}$

c) tamanho em bits de um bloco?

	V	R	D	data
Bloco i:	1	1	1	64 bytes

$\text{Bloco} = 1 + 1 + 1 + 64 \cdot 8 = 547 \text{ bits}$

Cache? Conjunto de: 16 blocos

$\text{Conjuntos} = 2^4 \cdot 547 \text{ bits}$   
 $= 8752 \text{ bits}$

cache:  $2^{10} \text{ conjuntos}$

cache =  $2^{10} \cdot 8752 \text{ bits}$   
 $= 8752 \text{ K bits}$

d) penalidade main = 100 ciclos (leitura)

penalidade main = 80 ciclos (escrita) • I-C q I-D main

$I = 10^6$

$\% \text{ store} = 10\% = 10^{-1}$

write - through + write - buffer

4 palavras / bloco  $\rightarrow$  4 palavras / bloco

write allocate  $\rightarrow$  leitura de bloco da cache antes

miss rate I-C:  $10\% = 10^{-1}$

de substituir e escrever na MP

penalidade = 0 ciclos buffer

stalls escrita ??

total de escritas = programa

$I \cdot 10^{-1} = 10^6 \cdot 10^{-1} = 10^5$

$= 10^5 \cdot 10^{-1} \cdot 80 = 8 \cdot 10^3 = 8000 \text{ ciclos}$



$$\text{stalls} = 10^5 \cdot 10^{-1} (4 \cdot 80 + 100)$$

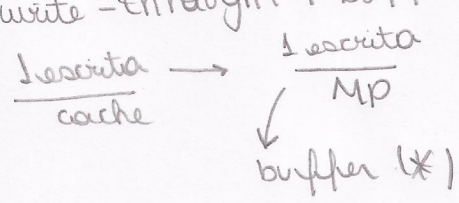
$$\downarrow$$

$$\text{str prog}$$

- write miss: tag #
- ↳ substituir e carregar os adjacentes no bloco
- ↳ buffer: evita a penalidade de escrita na MP (\*)
- ↳ allocate: evita a penalidade de leitura do bloco antes de substituir
- ↳ write-through + buffer

$$\text{stalls} = 10^5 \cdot 10^{-1} \cdot 9 \cdot 10^2$$

$$\text{stalls} = 9 \cdot 10^6 \text{ ciclos "escrita"}$$



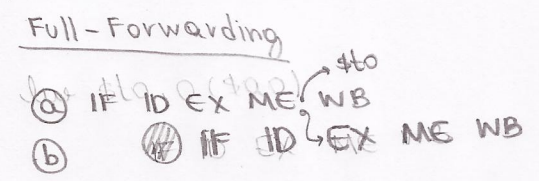
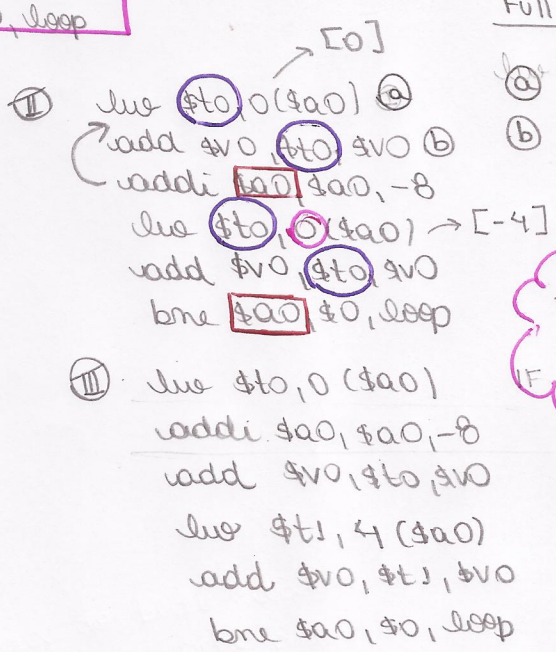
3) a)

```

Sum += add $v0, $0, $0
loop: lw $t0, 0($a0)
      add $v0, $t0, $v0
      addi $a0, $a0, -4
      bne $a0, $0, loop
      jr $ra
  
```

loop unrolling

I lw \$t0, 0(\$a0)  
 add \$v0, \$t0, \$v0  
 addi \$a0, \$a0, -4  
 bne \$a0, \$0, loop  
 jr \$ra  
 II lw \$t0, 0(\$a0)  
 add \$v0, \$t0, \$v0  
 addi \$a0, \$a0, -4  
 bne \$a0, \$0, loop  
 jr \$ra



→ dar arquivo 3-a. ods!

b) 8 instruções  
 $8 \times 4 = 32 \text{ bytes}$

c) Emissão dinâmica: as npos desaparecem, pois o HW vai emitir quando puder e vai parar quando necessário.

Logo: 6 instruções  $6 \times 4 = 24 \text{ bytes}$

d)  $\frac{2 \cdot 10^8 \text{ iterações}}{2} = 10^8 \text{ iterações c/loop unrolling}$   
 ↳  $\frac{6 \text{ instruções iterações}}{\text{iterações}} \Rightarrow 6 \cdot 10^8 \text{ instruções}$

e) 6 instruções e 4 ciclos  
 $\text{CPI}_{\text{ideal}} = \frac{4}{6} = \frac{2}{3}$   
 $\text{CPI} = \frac{\text{ciclos}}{\text{instruções}}$   
 $\rightarrow 0,6 < \text{CPI} = 0,5$   
 ↳ flag sentido



3)  $mru = 0,01 = 10^{-2}$      $\%LS = \frac{1}{4} = 0,25$

$p = 100 \text{ cycles}$

$CPI_{total} = CPI_{ideal} + CPI_{stall} \cdot \frac{cycles_{stall}}{I}$

$CPI_{total} = \frac{2}{3} + \frac{1}{4} = \frac{24+13}{12}$

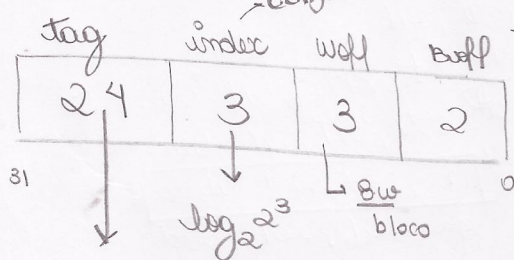
$CPI_{total} = \frac{11}{12}$

$cycles_{stall} = (I \cdot \frac{1}{4}) \cdot 10^{-2} \cdot 10^2 = \frac{I}{4}$

4) • 2-way • 128 palabras • 8 palabras bloco • LRU

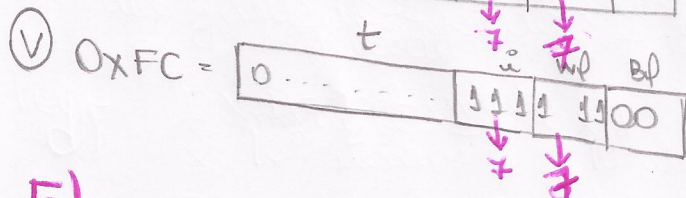
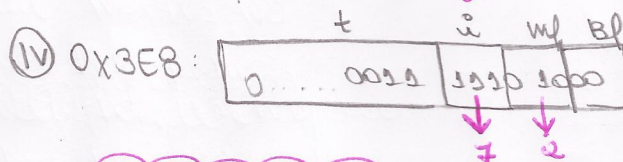
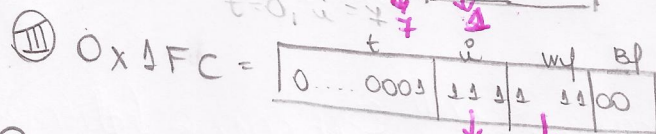
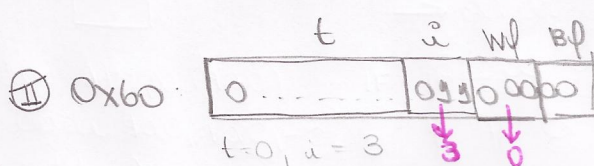
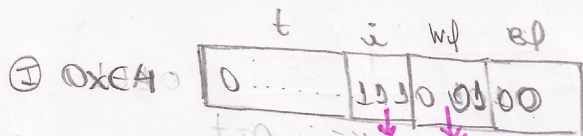
$\rightarrow \frac{2 \text{ bloco}}{\text{conjunto}} \rightarrow \frac{128}{8} = \frac{2^4}{2^3} = 2^1 \text{ bloco}$

$\rightarrow \frac{2^4 \text{ bloco}}{2^1} = 2^3 \text{ conjuntos}$



$32 - 3 - 3 - 2 = 24$

Endereços = ① 0xEA, ② 0x60, ③ 0x1FC, ④ 0x3E8, ⑤ 0xFC  
6 byte address!



• there is archive  
 4. ads!

5) `addi $s0, $0, 0`  
`addi $s1, $0, 8` (?)

loop: ...  
`addi $s0, $s0, 1 # $s0++`  
`bne $s1, $0, loop # se $s1 != 0 -> loop`  
`addi $s1, -4 #`