TEMA 5

1) R = C - (A - B) / (C - D)

a) Tipo pila

```
add /sub /mul /div   # (top) [+ - / *] (top+1) → (top+1) ;  top = top+1
push @               # top = top - 1 ;  pila[top] = M[@]
pop @                # M[@] = top ;  top = top+1
```

CODE

```
push D
push C
sub
push B
push A
sub
div
push C
sub
pop R
```

---

b) Tipo Acumulador

```
add /sub /mul /div   # ACC = ACC (op) M[@]
load @
store @
```

```
load C
sub D
store R      # (C-D)
load A
sub B
div R        # (A-B)/(C-D)
store R
load C
sub R
store R
```

2)

CISC

a) $10^9 \cdot (0'3 \cdot 1 + 0'1 \cdot 2) = 0'5 \cdot 10^9 = 500 \cdot 10^6$ accesos

b) $2'5 = 10^9 \cdot 2'5 \cdot T_c \rightarrow T_c = \frac{1}{10^9} \rightarrow f = 10^9 = \boxed{1\,GHz}$

RISC

c) $m = 10^9 \cdot [0'9 \cdot 1 + 0'1 \cdot 2]$ traducción a RISC

$+ 500 \cdot 10^6 \cdot [1 + (1 - 0'7 - 0'2) \cdot 1 + 0'2 \cdot 1]$ accesos a memoria

$+ 10^9 \cdot [0'2 \cdot 0'15] = \boxed{1'78 \cdot 10^9 \text{ instrucciones}}$

d) $2'5 = 1'78 \cdot 10^9 \cdot 1'2 \cdot \frac{1}{f} \rightarrow f = 0'8544 \cdot 10^9 \approx \boxed{0'85\,GHz}$

e)

$Ec_{CISC} = t \cdot P = 2'5 \cdot 60 = \boxed{150\,J}$

$P_{cons} = Pot_{comm} + Pot_{fuga}$

$Pot_{comm} = C \cdot V^2 \cdot frec. = 50 \cdot 10^{-9} \cdot 1^2 \cdot 1 \cdot 10^9 = 50\,w$

$Pot_{fuga} = V \cdot I_{fuga} = 1 \cdot 10 = 10\,w$

$\Big\} 60\,w$

$Ec_{RISC} = t \cdot P = 2'5 \cdot 42 = \boxed{105\,J}$

$P_{cons} = Pot_{comm} + Pot_{fuga}$

$Pot_{comm} = C \cdot V^2 \cdot frec. = 40 \cdot 10^{-9} \cdot 1^2 \cdot 0'85 \cdot 10^9 = 34\,w$

$Pot_{fuga} = V \cdot I_{fuga} = 1 \cdot 8 = 8\,w$

$\Big\} 42\,w$

f) $\frac{42}{60} = 0'7 \rightarrow$ RISC ahorra 30% batería respecto CISC

$\frac{1}{0'7} \approx 1'43 \rightarrow$ CISC consume un 43% más de batería que RISC.

g) $2'5 = 1'5 \cdot 10^9 \cdot 1'3 \cdot \frac{1}{f} \rightarrow f = \boxed{0'78\ GHz}$

h) $Ec_{RISC} = t \cdot P = 2'5 \cdot 39'2 = \boxed{98\ J}$

$P_{cons} = Pot_{com} + Pot_{fuga}$ $\begin{cases} Pot_{com} = C \cdot V^2 \cdot frec. = 40 \cdot 10^{-9} \cdot 1^2 \cdot 0'78 \cdot 10^9 = 31'2\ w \\ Pot_{fuga} = V \cdot I_{fuga} = 1 \cdot 8 = 8\ w \end{cases}$ $39'2\ w$

$\frac{39'2}{60} = 0'65 \rightarrow$ $RISC_{V2}$ ahorra 35% bateria respecto CISC

$\frac{39'2}{42} \approx 0'93 \rightarrow$ $RISC_{V2}$ ahorra 7% bateria respecto $RISC_{V1}$

3) a)

```
1   movl   %ecx ← $0
loop: cmpl   %ecx , $1.000.000   ecx ≥ 10
      jge    fim
      load   %r1 ← x
5     movl   %eax ← %r1
      load   %r1 ← V(, %ecx, 4)
      imull  %eax ← %eax * %r1
      load   %r1 ← suma
      addl   %eax ← %eax + %r1
10    addl   %eax ← %eax + $1
      jmp    loop
fim:
```

b) $\approx 7 \cdot 10^6$ inst dim. $\approx 10 \cdot 10^6$ uops dim.

c) $\frac{1'3 \text{ uops}}{1 \text{ c}} \cdot \frac{7 \cdot 10^6 \text{ i}}{10 \cdot 10^6 \text{ uops}} = 0'91 \text{ i/c} \rightarrow \approx$ **1'1 cpi** (IPC)

d) $T_{exe} = 7 \cdot 10^6 \cdot 1'1 \cdot \frac{1}{3 \cdot 10^9} \approx$ **2'57 ms**

e)

uops

11 líneas

⇓

11 · 6 = 66 bytes

× 86

1+1+4 = 6 → +6 bytes first it.

1+1+4 = 6
1+4 = 5
1+1+1+4 = 7
1+1+1+4 = 7
1+1+1+4 = 7
1 = 1
+ 1+4 = 5

} +11 bytes last iteration

38 bytes en el bucle. (× 10^6 iteraciones)

44 bytes

f) • sin uop cache: $6 + 38 \cdot 10^6 + 11 = 38\,000\,017 \approx 38$ MB (−44) ↑ miss

$A.B. = \frac{38 \cdot 10^6}{2'57 \cdot 10^{-3}} =$ **14'79 GB/s**

g) • con uop cache: $6 + 60 \cdot 10^6 + 12 = 60\,000\,018 \approx 60$MB (−66) ↑ miss

$A.B. = \frac{60 \cdot 10^6}{2'57 \cdot 10^{-3}} =$ **23'35 GB/s**

h)

mès consum xD

$$10 \cdot 10^{-9} \cdot 44 + 1 \cdot 10^{9} \cdot 37\,999\,973 + 7 \cdot 10^{6} \cdot 10 \cdot 10^{-9} = \boxed{108\ mJ}$$

$$10 \cdot 10^{-9} \cdot 66 + 1 \cdot 10^{9} \cdot 59\,999\,952 = \boxed{60\ mJ}$$