

1.

(a)

Execution time:

$$\frac{500 \times 4 + 50 \times 4 + 100 \times 5 + 250 \times 3}{2 \times 10^9} = 1.725 \times 10^{-6} \text{ sec}$$

CPI =

$$\frac{500 \times 4 + 50 \times 4 + 100 \times 5 + 250 \times 3}{500 + 50 + 100 + 250} = 3.83\bar{3}$$

(b)

Execution time:

$$\frac{500 \times 4 + 50 \times 4 + 100 \times \frac{1}{2} \times 5 + 250 \times 3}{2 \times 10^9} = 1.6 \times 10^{-6} \text{ sec}$$

$$\text{Speed up} = \frac{\text{Execution time old}}{\text{Execution time new}} = \frac{1.725}{1.6} \\ = 1.078$$

$$\text{CPI} = \frac{3200}{850} = 3.765$$

(C)

total cycle =

$$\begin{array}{cccc} \text{Arith} & \text{store} & \text{load} & \text{branch} \\ 500 \times 4 & + 50 \times 4 & + 100 \times 5 & + 250 \times 1 = 2950 \end{array}$$

$$\text{speed up} = \frac{3450 \times 1.8 \times 10^9}{2950 \times 2 \times 10^9} = 1.053$$

CPI =

$$\frac{2950}{900} = 3.27\bar{7}$$

2.

(a)

$$5000 \times 0.2 = 1000 \text{ ms}$$

$$\frac{1000}{7300} = 0.137$$

reduce 13.7%

(b)

Maximum \Rightarrow branch = 0 ms

$$5000 + 800 + 1000 = 6800 \text{ ms}$$

$$\frac{6800}{7300} = 93.15\%, \text{ IMPOSSIBLE}$$

(c)

Instruction Ratio:

$$\text{FP} : \text{INT} : \text{LW} : \text{Branch}$$

$$= 100 : 100 : 100 : 250$$

with new Algorithms

$$\text{FP} : \text{INT} : \text{LW} : \text{Branch}$$

$$= 0 : 300 : 300 : 250$$

$$(300 \times 8) + (300 \times 10) + (250 \times 2) = 5900 \text{ ms}$$

3.

Leaf_example:

```
addi $SP, $SP, -8
sw   $t0, 0($SP)
sw   $t1, 4($SP)
sll  $t0, $S1, 2
add  $t0, $S7, $t0
lw   $t0, 0($t0)
sll  $t0, $t0, 2
add  $t0, $S6, $t0
lw   $t0, 4($t0)
add  $t0, $t0, $S2
add  $t1, $S3, $S4
sub  $S0, $t0, $t1
add  $V0, $S0, $zero
lw   $t0, 0($SP)
lw   $t1, 4($SP)
addi $SP, $SP, 8
jr   $ra
```

(a) case .a

or)	0101	0101	0101	0101	0101	0101	0101	0000
	0001	0010	0011	0100	0101	0110	0111	1000
	0101	0111	0111	0101	0101	0111	0111	1000
	5	7	7	5	5	7	7	8

$$\$t2 = 0x5775_5778$$

case .b

or)	1110	1010	1101	1111	1110	1110	1101	0000
	1101	1110	1010	1101	1111	1010	1101	1110
	1111	1110	1111	1111	1111	1110	1101	1110
	F	E	F	F	F	E	D	E

$$\$t2 = 0xFEFF_FEDE$$

1b) case .a

and)	0101	0101	0101	0101	0101	0101	0101	0000
	1111	1111	1111	1111	1111	1111	1111	1111
	0101	0101	0101	0101	0101	0101	0101	0000

$$\$t2 = 0x5555_5550$$

case .b

$$\$t2 = EADF_EEDO$$

and)	1110	1010	1101	1111	1110	1110	1101	0000
	1111	1111	1111	1111	1111	1111	1111	1111
	1110	1010	1101	1111	1110	1110	1101	0000
	E	A	D	F	E	E	D	0

(c)

CASE . a

and)	0000	1010	1010	1010	1010	1010	1010	1010
	1111	1111	1111	1111	1111	1111	1110	1111
<hr/>								
	0	A	A	A	A	A	A	A

$$\$t2 = 0x0AAA_AAAA$$

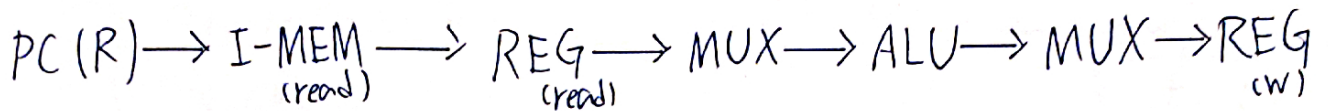
case . b

and)	0001	0111	1101	0101	1011	1111	1101	1101
	1111	1111	1111	1111	1111	1111	1110	1111
<hr/>								
	1	7	D	5	B	F	C	D

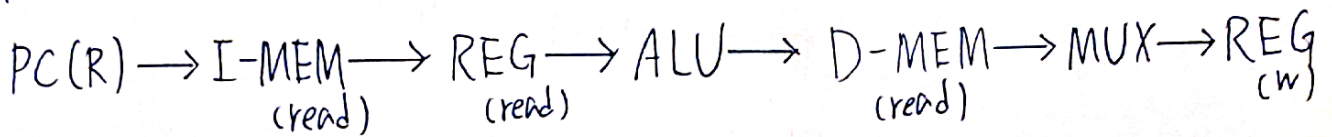
$$\$t2 = 0x17D5_BFCD$$

5. (a)

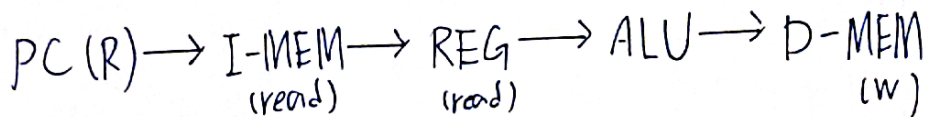
R-type :



LOAD:



store:



b)

$$R\text{-type} : 1 + 15 + 7 + 2 + 10 + 2 + 5 = 42 \text{ ns}$$

$$\text{Load} : 1 + 15 + 7 + 10 + 15 + 2 + 5 = 55 \text{ ns}$$

$$\text{store} : 1 + 15 + 7 + 10 + 15 = 48 \text{ ns}$$

$$\therefore \text{To } 55 \text{ ns} \Rightarrow \text{freq} = \frac{1}{55 \times 10^{-9}} = 1.818 \times 10^7 \text{ Hz}$$

6.
(c)

case. a

0 0100100 | 0100110 0000 0000 0000 0100

0100100
↓

$$73 - 127 = -54$$

$$\Rightarrow + (1.010011000000000000000100)_2 \times 2^{-54}$$

$$\Rightarrow + (1.29687)_{10} \times 2^{-54}$$

$$\Rightarrow 7.199105 \times 10^{-17}$$

case. b

1 0101111 | 011111 0000 0000 0000 0000

0101111
 $95 - 127 = -32$

$$\Rightarrow - (1.0111111)_2 \times 2^{-32}$$

$$\Rightarrow - (1.492)_{10} \times 2^{-32}$$

$$\Rightarrow -3.473 \times 10^{-10}$$

(b)

$$-938.8125 = 15021 \times 2^{-4}$$

$$= 1110101010110_2 \times 2^{-4}$$

$$= 1.110101010110_2 \times 2^9$$

$$9 + 129 = 136$$

$$\Rightarrow 1 \quad 1000/000 \quad 110/0/0/0/1/0/000 \quad 0000 \quad 000$$

(c)

$$1609.5 = 3219 \times 2^{-1}$$

$$= 110010010011 \times 2^{-1}$$

$$= 1.10010010011 \times 2^{10}$$

10+123

$$\Rightarrow 1 \quad \underbrace{10000001001}_{11 \text{ bit}} \quad \underbrace{10010010011000\dots0}_{52 \text{ bit}}$$

7. (A)

case .a

$$\begin{array}{r} 11001000 \quad -56 \\ + 01100111 \quad 103 \\ \hline 10010111 \quad 47 \end{array}$$

\Rightarrow nither

$$A-B = A + (-B)$$

$$\begin{array}{r} 11001000 \quad -56 \\ + 10011001 \quad -103 \\ \hline 01100001 \quad 97 \end{array}$$

\Rightarrow underflow

$\Rightarrow \because$ saturation arithmetic

$$-56 - 103 = -128 \quad (-159)$$

case .b

$$\begin{array}{r} 11110111 \quad -9 \\ + 11101101 \quad -19 \\ \hline 11100100 \quad -28 \end{array}$$

\Rightarrow nither

$$\begin{array}{r} 11110111 \quad -9 \\ + 00010011 \quad 19 \\ \hline 00001010 \quad 10 \end{array}$$

\Rightarrow nither

(b)

case .a

$$200 + 103 = 255 \quad (303)$$

\Rightarrow overflow

$$200 - 103 = 97$$

\Rightarrow nither

case .b

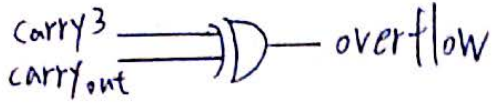
$$247 + 237 = 255 \quad (484)$$

\Rightarrow overflow

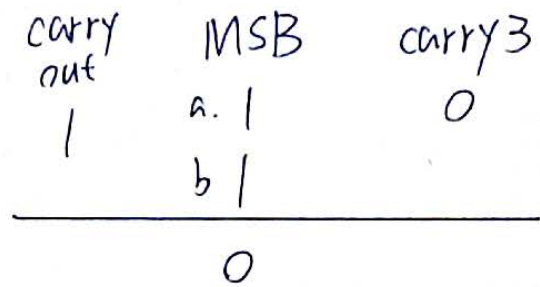
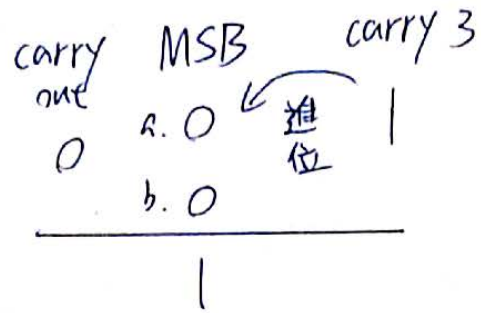
$$247 - 237 = 10$$

\Rightarrow nither

8.



發生 overflow



若 $carry_3 \neq carry_{out}$

則 發生 overflow