David Wang

CSE 140

Collab w/ Jan Tanja

Homework 2

C. 1)

a.)

R1 LD DADDI

R1 DADDI SD

R2 LD DADDI

R2 SD DADDI

R2 DSUB DADDI

R4 BNEZ DSUB

b.)

1. LD R1, 0(R2)
2. DADDI R1, R1, #1
3. SD 0(R2), R1
4. DADDI R2, R2, #4
5. DSUB R4, R3, R2
6. BNEZ R4, LOOP

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Inst. # | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 |
| 1 | F | D | X | M | W |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 2 |  | F | S | S | D | X | M | W |  |  |  |  |  |  |  |  |  |  |
| 3 |  |  |  |  | F | S | S | D | X | M | W |  |  |  |  |  |  |  |
| 4 |  |  |  |  |  |  |  | F | D | X | M | W |  |  |  |  |  |  |
| 5 |  |  |  |  |  |  |  |  | F | S | S | D | X | M | W |  |  |  |
| 6 |  |  |  |  |  |  |  |  |  |  |  | F | S | S | D | X | M | W |
| 7 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | F | D |

Two cycles were lost, and the last takes 2 additional cycles, so

96 \* 16 + 18 = 1586

c.

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Inst. # | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 |
| 1 | F | D | X | M | W |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 2 |  | F | D | s | X | M | W |  |  |  |  |  |  |  |  |  |  |  |
| 3 |  |  | F | s | D | X | M | W |  |  |  |  |  |  |  |  |  |  |
| 4 |  |  |  |  | F | D | X | M | W |  |  |  |  |  |  |  |  |  |
| 5 |  |  |  |  |  | F | D | X | M | W |  |  |  |  |  |  |  |  |
| 6 |  |  |  |  |  |  | F | s | D | X | M | W |  |  |  |  |  |  |
| 7(inc) |  |  |  |  |  |  |  |  | F | S | S | S | S |  |  |  |  |  |
| 8 |  |  |  |  |  |  |  |  |  | F | D | X | M | W |  |  |  |  |

9 \* 98 + 12 = 894

d.

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Inst. # | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 |
| 1 | F1 | F2 | D1 | D2 | X1 | X2 | M1 | M2 | W1 | W2 |  |  |  |  |  |  |  |  |  |  |
| 2 |  | F1 | F2 | D1 | D2 | S | S | S | X1 | X2 | M1 | M2 | W1 | W2 |  |  |  |  |  |  |
| 3 |  |  | F1 | F2 | D1 | S | S | S | D2 | X1 | X2 | M1 | M2 | W1 | W2 |  |  |  |  |  |
| 4 |  |  |  | F1 | F2 | S | S | S | D1 | D2 | X1 | X2 | M1 | M2 | W1 | W2 |  |  |  |  |
| 5 |  |  |  |  | F1 | S | S | S | F2 | D1 | D2 | X1 | X2 | M1 | M2 | W1 | W2 |  |  |  |
| 6 |  |  |  |  |  |  |  |  | F1 | F2 | D1 | S | D2 | X1 | X2 | M1 | M2 | W1 | W2 |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 8 |  |  |  |  |  |  |  |  |  | F1 | F2 | s | D1 | D2 | X1 | X2 | M1 | M2 | W1 | W2 |

10 \* 98 + 19 = 999

f.

0.8 + 0.1 = 0.9ns for 5-stage pipeline

0.5ns for the 10-stage pipeline

g.

CPI of 5-stage pipeline: 796 / (99 \* 6) = 1.34

CPI of 10-stage pipeline: 999 / (99 \* 6) = 1.68

Average Instruction Execution Time for 5-stage pipeline: 1.34 \* 0.9 = 1.12

Average Instruction Execution Time for 10-stage pipeline: 1.68 \* 0.5 = 0.84

C.2

a.

15% \* 60% = 9%

15% \* 40% = 6%

b.

C.3

a.

2ns + 0.1ns = 2.1ns

b.

5 cycles/4 instructions = 1.25

c.

execution time = I \* CPI \* Cycle Time

Speedup = (I \* 1 \* 7)(I \* 1.25 \* 2.1) = 2.67

d.

Ignoring extra stall cycles:

I \* 1 \* (7/I) \* 1 \* 0.1 = 70

C.4

LOOP: LW R1, 4(R2) # R1 = r1->value

SUB R3, R3, R1 # x = x – R1

LW R2, 0(R2) # R2 = R2->next

BNE R2, R0, LOOP while (R2 != NULL) loop;