Homework 2

CDA 4102/ CDA 5155: Fall 2024

Due: October 16, 2024 at **11:30 pm** **Total Points:** 20 points

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I have neither given nor received any unauthorized aid on this assignment.

1.

```
Loop:  fld     f0, 32(x1)
       fld     f2, 64(x1)
       fmul.d  f4, f0, f2
       fadd.d  f4, f2, f0
       fsd     f4, 64(x1)
       addi    x1, x1, #-8
       bne     x1, x0, Loop
```

Function Unit	Related Instruction	Latency Cycles	Number of Units
ALU1	addi, bne	1	1
ALU2	fld, fsd (Address Calculation)	2	1
Memory Unit	fld, fsd	3	1
FP Adder	fadd.d	4	1
FP Multiplier	fmul.d	5	1

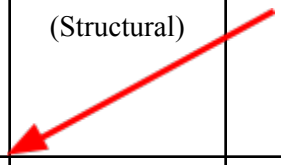
a)

Iter.	Instruction		Issue	Execute	Memory	Write-CDB
1	fld	f0, 32(x1)	1	2-3	4-6	7
1	fld	f2, 64(x1)	1	4-5 (Structural)	7-9 (Structural)	10
1	fmul.d	f4, f0, f2	2	11-15 (RAW)		16
1	fadd.d	f4, f2, f0	2	11-14		17

						(in-order)
1	fsd	f4, 64(x1)	3	6-7	18-20 (RAW)	
1	addi	x1, x1, #-8	3	4		8 (in-order)
1	bne	x1, x0, Loop	4	9 (RAW)		
2	fld	f0, 32(x1)	4	10-11 (Control)	12-14	15
2	fld	f2, 64(x1)	5	12-13 (Structural)	15-17 (Structural)	18
2	fmul.d	f4, f0, f2	5	19-23 (RAW)		24
2	fadd.d	f4, f2, f0	6	19-22		25 (in-order)
2	fsd	f4, 64(x1)	6	14-15	26-28 (RAW)	
2	addi	x1, x1, #-8	7	10 (Control)		29 (in-order)
2	bne	x1, x0, Loop	7	30 (RAW)		

b)

Iter	Instruction		Issue	Execute	Memory Read	Write-CDB	Commit
1	fld	f0, 32(x1)	1	2-3	4-6	7	8
1	fld	f2, 64(x1)	1	4-5 (Structural)	7-9 (Structural)	10	11
1	fmul.d	f4, f0, f2	2	11-15 (RAW)		16	17



1	fadd.d	f4, f2, f0	2	11-14 (RAW)		17 (in-order)	18
1	fsd	f4, 64(x1)	3	6-7	18-20 (RAW)		24
1	addi	x1, x1, #-8	3	4		8 (in-order)	9
1	bne	x1, x0, Loop	4	9 (RAW)			10
2	fld	f0, 32(x1)	4	9-10 (RAW)	15-17	18	19
2	fld	f2, 64(x1)	5	11-12 (Structural)	18-20 (Structural)	21	22
2	fmul.d	f4, f0, f2	5	22-26 (RAW)		27	28
2	fadd.d	f4, f2, f0	6	22-25 (RAW)		28 (in-order)	29
2	fsd	f4, 64(x1)	6	13-14 (Structural)	29-31 (RAW)		35
2	addi	x1, x1, #-8	7	10 (Structural)		15 (in-order)	16
2	bne	x1, x0, Loop	7	16 (RAW)			18

2.

a)

b1 prediction	b1 action	New b1 prediction	b2 prediction	b2 action	New b2 prediction
T	T	T	T	T	T
T	NT	NT	T	NT	NT
NT	T	T	NT	T	T
T	NT	NT	T	NT	NT

Prediction Accuracy: 2 / 8 = 0.25 = 25%

b)

b1 prediction	b1 action	New b1 prediction	b2 prediction	b2 action	New b2 prediction

T	T	T	T/T	T	T/T
T	NT	NT	T/T	NT	NT/T
NT	T	T	NT/T	T	NT/T
T	NT	NT	NT/T	NT	NT/T

Prediction Accuracy: 4 / 8 = 0.5 = 50%

c)

b1 prediction	b1 action	New b1 prediction	b2 prediction	b2 action	New b2 prediction
T/T	T	T/T	T/T	T	T/T
T/T	NT	T/NT	T/T	NT	NT/T
T/NT	T	T/NT	NT/T	T	NT/T
T/NT	NT	T/NT	NT/T	NT	NT/T

Prediction Accuracy: 6 / 8 = 0.75 = 75%

d) Because there's a repeating pattern, it makes sense to me that the correlated predictors do better. They're using/storing more information than the local predictors, which means they can easily pick up on a repeating pattern like the one given in the problem.

3.

beq x1, x0, #16

andi x3, x1, #1

add x2, x2, x3

sra x1, x1, #1

bne x1, x0, #-12

4.

Clock Period = ι = Max { time delay of a stage } + other delay (e.g., skew, latch delay) = 5ns

Speedup = $s_k = \frac{nk}{k+(n-1)} = \frac{(100)(14*10^{-9})}{[5+(100-1)](5*10^{-9})} = 2.69$

efficiency = η $= \frac{s_k}{k} = 0.53$

throughput = $w = \frac{\eta}{\iota}$ = 100 instructions / 520 ns = 190,000,000 instructions/second