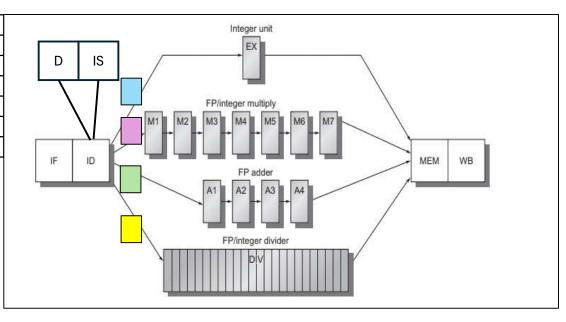# CS613 Homework 8

	Instructions	1	2	3	4	5	6	7	8	9	10	11
1	add x1, x0, x0	IF	D	IS	EX | R1	MEM | R1	WB | R1					
2	addi x5, x0, 2000		IF	D	IS	EX | R2	MEM | R2	WB | R2				
3	fld f1, -8(x5)			IF	D	IS	EX | R6	MEM | R6	WB | R6			
4	addi x2, x2, 10				IF	D	IS	EX | R1	MEM | R1	WB | R1		
Strt: 5	fld f1, -8(x5)					IF	D	IS/s	s/IS	EX | R6	MEM | R6	WB | R6
6	addi x5, x5, 8						IF	D/s	s/D	IS	EX | R1	MEM | R1
7	fadd.d f7, f7, f1							IF/s	s/IF	D	IS	EX1 | R3
7A	fmul.d f7, f10, f1									IF	D	IS
8	fld f1, -8(x5)										IF	D
9	addi x5, x5, 8											IF
10	fadd.d f7, f7, f1											
11	fmul.d f7, f10, f1											
12	fsd f7, -8(x5)											
13	subi x2, x1, 2											
14	bne x2, x2, Strt											
End 15	xor x4, x1											
16	fld f1, -8(x5)											
17	addi x5, x5, 8											
18	fadd.d f7, f7, f1											
19	fmul.d f7, f10, f1											
8	fld f1, -8(x5)											
20	addi x5, x5, 8											
21	fadd.d f7, f7, f1											

Reservation Stations	Shorthand
ALU-1	R1
ALU-2	R2
FPA-1	R3
FPA-2	R4
Mul	R5
L/S	R6

Diagram (pipeline with reservation stations):

- D | IS
- Integer unit: EX
- FP/integer multiply: M1 M2 M3 M4 M5 M6 M7
- IF | ID
- FP adder: A1 A2 A3 A4
- MEM | WB
- FP/integer divider: DIV

CS613 Homework 8	Instructions	12	13	14	15	16	17	18	19	20	21	22
1	add x1, x0, x0											
2	addi x5, x0, 2000											
3	fld f1, -8(x5)											
4	addi x2, x2, 10											
Strt: 5	fld f1, -8(x5)											
6	addi x5, x5, 8	WB | R1										
7	fadd.d f7, f7, f1	EX2| R3	EX3 | R3	EX4 | R3	MEM | R3	WB | R3						
7A	fmul.d f7, f10, f1	EX1 | R5	EX2| R5	EX3 | R5	EX4 | R5	EX5 | R5	EX6 | R5	EX7 | R5	MEM | R5	WB | R5		
8	fld f1, -8(x5)	IS	EX | R6	MEM | R6	B	B	B	B	B	B	WB | R6	
9	addi x5, x5, 8	D	IS	EX | R1	MEM | R1	B	WB | R1					
10	fadd.d f7, f7, f1	IF/s	D	IS	EX1 | R4	EX2| R4	EX3 | R4	EX4 | R4	MEM | R4	WB | R4		
11	fmul.d f7, f10, f1		IF	D	IS/s	IS/s	IS/s	IS/s	IS/s	s/IS	EX1 | R5	EX2| R5
12	fsd f7, -8(x5)			IF	D/s	D/s	D/s	D/s	D/s	D/s	s/D	s/IS
13	subi x2, x1, 2						IF/s	IF/s	IF/s	IF/s	s/IF	s/D
14	bne x2, x2, Strt											IF
End 15	xor x4, x1											
16	fld f1, -8(x5)											
17	addi x5, x5, 8											
18	fadd.d f7, f7, f1											
19	fmul.d f7, f10, f1											
8	fld f1, -8(x5)											
20	addi x5, x5, 8											
21	fadd.d f7, f7, f1											

Reservation Stations	Shorthand
ALU-1	R1
ALU-2	R2
FPA-1	R3
FPA-2	R4
Mul	R5
L/S	R6

2. b

Loop unrolling actually had a negative effect on this specific code section. The reason being that the loop unrolling removed instructions that excecuted between the fld and fsd instructions as well as the mul instructions. This caused the shortage of Reservation Stations to be hightened which can be seen in CC15-20 as well as CC26-29

CS613 Homework 8	Instructions	23	24	25	26	27	28	29	30	31	32	33
1	add x1, x0, x0											
2	addi x5, x0, 2000											
3	fld f1, -8(x5)											
4	addi x2, x2, 10											
Strt: 5	fld f1, -8(x5)											
6	addi x5, x5, 8											
7	fadd.d f7, f7, f1											
7A	fmul.d f7, f10, f1											
8	fld f1, -8(x5)											
9	addi x5, x5, 8											
10	fadd.d f7, f7, f1											
11	fmul.d f7, f10, f1	EX3 | R5	EX4 | R5	EX5 | R5	EX6 | R5	EX7 | R5	MEM | R5	WB | R5				
12	fsd f7, -8(x5)	EX | R6	MEM | R6	B	B	B	B	B	WB | R6			
13	subi x2, x1, 2	IS	EX | R1	MEM | R1	WB | R1							
14	bne x2, x2, Strt	D	IS	EX | R2	MEM | R2	WB | R2						
End 15	xor x4, x1	IF	D	IS	NOP	NOP	NOP					
16	fld f1, -8(x5)		IF	D	IS/s	IS/s	IS/s	IS/s	s/IS	EX | R6	MEM | R6	WB | R6
17	addi x5, x5, 8			IF	D/s	D/s	s/D	IS	EX | R1	MEM | R1	B	B
18	fadd.d f7, f7, f1				IF/s	IF/s	s/IF	D	IS	EX1 | R3	EX2| R3	EX3 | R3
19	fmul.d f7, f10, f1							IF	D	IS	EX1 | R5	EX2| R5
8	fld f1, -8(x5)								IF	D	IS/s	s/IS
20	addi x5, x5, 8									IF	D/s	D/s
21	fadd.d f7, f7, f1										IF/s	s/IF

Reservation Stations	Shorthand
ALU-1	R1
ALU-2	R2
FPA-1	R3
FPA-2	R4
Mul	R5
L/S	R6

CS613 Homework 8	Instructions	34	35	36	37	38	39	40	41	42	43
1	add x1, x0, x0										
2	addi x5, x0, 2000										
3	fld f1, -8(x5)										
4	addi x2, x2, 10										
Strt: 5	fld f1, -8(x5)										
6	addi x5, x5, 8										
7	fadd.d f7, f7, f1										
7A	fmul.d f7, f10, f1										
8	fld f1, -8(x5)										
9	addi x5, x5, 8										
10	fadd.d f7, f7, f1										
11	fmul.d f7, f10, f1										
12	fsd f7, -8(x5)										
13	subi x2, x1, 2										
14	bne x2, x2, Strt										
End 15	xor x4, x1										
16	fld f1, -8(x5)										
17	addi x5, x5, 8	WB | R1									
18	fadd.d f7, f7, f1	EX4 | R3	MEM | R3	WB | R3							
19	fmul.d f7, f10, f1	EX3 | R5	EX4 | R5	EX5 | R5	EX6 | R5	EX7 | R5	MEM | R5	WB | R5			
8	fld f1, -8(x5)	EX | R6	MEM | R6	B	B	B	B	B	WB | R6		
20	addi x5, x5, 8	IS	EX | R1	MEM | R1	WB | R1						
21	fadd.d f7, f7, f1	D	IS	EX1 | R3	EX2 | R3	EX3 | R3	EX4 | R3	MEM | R3	B	B	WB | R3

Reservation Stations	Shorthand
ALU-1	R1
ALU-2	R2
FPA-1	R3
FPA-2	R4
Mul	R5
L/S	R6