EE-337 PROJECT-1 MULTI-CYCLE RISC

Project Team:

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1. ADD

$111 ightarrow ext{rf-a1}$ $ ext{rf-d1} ightarrow ext{Mem-a,alu}$ $ ext{Mem_d} ightarrow ext{IR}$ $ ext{+1} ightarrow ext{alu}$ $ ext{alu} ightarrow ext{PC}$	IR
	Х
	X-X
	HKT
	SB

	NONE
IR_(11-9) \rightarrow rf-a1 IR_(8-6) \rightarrow rf-a2 rf-d1 \rightarrow t1 rf-d2 \rightarrow t2	Х
	X-X
	GET_AB
	QB

t1 → alu t2 →alu alu → t3	NONE
	ADD
	C-Z
	ALU
	STORE_C

$t3 \rightarrow rf-d3$ IR_(5-3) $\rightarrow rf-a3$	NONE
	X
	X-X
	STORE_C
	SET_PC

111 → rf_a3 PC → rf_d3	NONE
	Х
	X-X
	SET_PC
	IB

2. & 3. ADC/Z

$111 ightarrow ext{rf-a1}$ $ ext{rf-d1} ightarrow ext{Mem-a,alu}$ $ ext{Mem_d} ightarrow ext{IR}$ $ ext{+1} ightarrow ext{alu}$ $ ext{alu} ightarrow ext{PC}$	IR
	X
	X-X
	HKT
	SB

If (C/Z==0)

111 → rf_a3 PC → rf_d3	NONE
	Х
	X-X
	SET_PC
	IB

If (C/Z==1)

	NONE
$IR_{-}(11-9) \rightarrow rf-a1$ $IR_{-}(8-6) \rightarrow rf-a2$ $rf-d1 \rightarrow t1$ $rf-d2 \rightarrow t2$	Х
	X-X
	GET_AB
	QB

t1 → alu t2 →alu alu → t3	NONE
	ADD
	C-Z
	ALU_ADD
	STORE_C

$t3 \rightarrow rf-d3$ IR_(5-3) $\rightarrow rf-a3$	NONE
	Х
	X-X
	STORE_C
	SET_PC

111 → rf_a3 PC → rf_d3	NONE
	Х
	X-X
	SET_PC
	IB

4. ADI

111 → rf-a1 rf-d1 → Mem-a,alu Mem_d → IR +1 → alu alu →PC	IR
	Х
	X-X
	HKT
	SB

	NONE
$IR_{-}(11-9) \rightarrow rf-a1$	Х
IR_(8-6) → rf-a2 rf-d1 → t1 rf-d2 → t2	X-X
	GET_AB
	QB

IR(5-0) → sgn-10 → alu t2 → alu alu → t3	NONE
	ADD
	C-Z
	ADDI
	РВ

$t3 \rightarrow rf -d3$ $IR_{-}(7-5) \rightarrow rf-a3$	NONE
	X
	X-X
	STORE_C
	SET_PC

111 → rf_a3 PC → rf_d3	NONE
	Х
	X-X
	SET_PC
	IB

5. NDU

111 → rf-a1 rf-d1 → Mem-a,alu Mem_d → IR +1 → alu alu →PC	IR
	X
	X-X
	HKT
	SB

	NONE
$IR_{-}(11-9) \rightarrow rf-a1$	X
IR_(8-6) → rf-a2 rf-d1 → t1 rf-d2 → t2	X-X
	GET_AB
	QB

t1 → alu t2 →alu alu → t3	NONE
	NAND
	X-Z
	ALU
	STORE_C

$t3 \rightarrow rf -d3$ $IR_{(5-3)} \rightarrow rf -a3$	NONE
	X
	X-X
	STORE_C
	SET_PC

111 → rf_a3 PC → rf_d3	NONE
	Х
	X-X
	SET_PC
	IB

6. & 7. NDC/Z

111	IR
111 → rf-a1 rf-d1 → Mem-a,alu	Х
Mem_d → IR +1 → alu alu →PC	X-X
	HKT
	SB

If (C/Z==0)

111 → rf_a3 PC → rf_d3	NONE
	Х
	X-X
	SET_PC
	IB

If (C/Z==1)

$IR_{-}(11-9) \rightarrow rf-a1$ $IR_{-}(8-6) \rightarrow rf-a2$ $rf-d1 \rightarrow t1$ $rf-d2 \rightarrow t2$	NONE
	X
	X-X
	GET_AB
	QB

t1 → alu t2 →alu alu → t3	NONE
	NAND
	X-Z
	ALU
	STORE_C

$t3 \rightarrow rf -d3$ $IR_{(5-3)} \rightarrow rf -a3$	NONE
	Х
	X-X
	STORE_C
	SET_PC

111 → rf_a3 PC → rf_d3	NONE
	Х
	X-X
	SET_PC
	IB

8. LHI

$111 \rightarrow \text{rf-a1}$ $\text{rf-d1} \rightarrow \text{Mem-a,alu}$ $\text{Mem_d} \rightarrow \text{IR}$ $+1 \rightarrow \text{alu}$ $\text{alu} \rightarrow \text{PC}$	IR
	Х
	X-X
	HKT
	SB

IR(8-0) → trail_zero_7 → rf-d3 IR(9-11) → rf-a3	NONE
	Х
	X-X
	LHI
	SET_PC

111 → rf_a3 PC → rf_d3	NONE
	Х
	X-X
	SET_PC
	IB

	IR	
111 → rf-a1 rf-d1 → Mem-a,alu	Х	
$Mem_d \to IR$	X-X	
+1 → alu alu →PC	HKT	
alu →PC	SB	
	1	
	NONE	
IR_(11-9) → rf-a1	Х	
IR_(8-6) → rf-a2 rf-d1 → t1	X-X	
$rf-d2 \rightarrow t2$	GET_AB	
	QB	
	NONE	
IR(5-0) → sgn-10 → alu	ADD	
t2 → alu	C-Z	
alu → t3	ADDI	
	PB	
	NONE	
	Х	
t3 \rightarrow mem_a mem_d \rightarrow t3	X-X	
	GET_MEM	
	ST_MEM	
	NONE	
	Х	
$t3 \rightarrow rf_d3$ IR_(8-6) $\rightarrow t3$	X-X	
	ST_MEM	
	SET_PC	
	NONE	
111 → rf_a3 PC → rf_d3	X	
	X-X	
	SET_PC	
	1	

ΙB

111	IR
111 → rf-a1 rf-d1 → Mem-a,alu	Х
Mem_d → IR +1 → alu alu →PC	X-X
	HKT
	SB

IR_(11-9) \rightarrow rf-a1 IR_(8-6) \rightarrow rf-a2 rf-d1 \rightarrow t1 rf-d2 \rightarrow t2	NONE
	X
	X-X
	GET_AB
	QB

$IR_{-}(5-0) \rightarrow sgn-10 \rightarrow alu$ $t2 \rightarrow alu$ $alu \rightarrow t3$ $IR_{-}(9-11) \rightarrow rf_{-}a1$ $rf_{-}d1 \rightarrow t1$	NONE
	ADD
	C-Z
	SW1
11_d1 → t1	SW2

t3 → mem_a t1 → mem_d	DW
	Х
	X-X
	SW2
	SET_PC

111 → rf_a3 PC → rf_d3	NONE
	Х
	X-X
	SET_PC
	IB

11. LM

$111 \rightarrow \text{rf-a1}$ $\text{rf-d1} \rightarrow \text{Mem-a,alu}$ $\text{Mem_d} \rightarrow \text{IR}$ $+1 \rightarrow \text{alu}$ $\text{alu} \rightarrow \text{PC}$	IR
	ADD
	X-X
	HKT
	SB

	NONE
IR (9-11) → rf a1	Х
$ \begin{array}{c} \text{rf_d1} \to \text{t1} \\ \text{IR_(0-7)} \to \text{SE(8)} \to \text{t4} \end{array} $	X-X
	LM1
	LM2

$t1 ightarrow \text{mem_a}$, alu $ \begin{array}{c} \text{mem_d} \rightarrow t2 \\ +1 \rightarrow \text{alu} \\ \text{alu} \rightarrow t3 \end{array} $ $t4 \rightarrow \text{pr.enc} \rightarrow \text{decoder(3 to 8)}$	DR
	ADD
	X-X
	LM2
decoder → t5	SB

If V = 0

111 → rf_a3 PC → rf_d3	NONE
	Х
	X-X
	SET_PC
	IB

If V = 1

$t2 \rightarrow rf_d3$ $t4 \rightarrow rf_a3$,alu $t3 \rightarrow t1$ $t5 \rightarrow alu$ $alu \rightarrow t4$	NONE
	Х
	X-X
	LM3
	LM2

12. SM

$111 ightarrow ext{rf-a1}$ $ ext{rf-d1} ightarrow ext{Mem-a,alu}$ $ ext{Mem_d} ightarrow ext{IR}$ $ ext{+1} ightarrow ext{alu}$ $ ext{alu} ightarrow ext{PC}$	IR
	ADD
	X-X
	HKT
	SB

	NONE
IR (9-11) → rf a1	Х
$ \begin{array}{c} \text{rf_d1} \to \text{t1} \\ \text{IR_(0-7)} \to \text{SE(8)} \to \text{t4} \end{array} $	X-X
	LM1
	LM2

#1	DR
t1 → alu +1 → alu	ADD
alu → t3	X-X
$t4 \rightarrow pr.enc \rightarrow decoder(3 to 8)$ $decoder \rightarrow t5$	LM2
decodel → to	SB

if V = 0

111 → rf_a3 PC → rf_d3	NONE
	Х
	X-X
	SET_PC
	IB

if V = 1

$t4 \rightarrow pr.enc \rightarrow rf_a1$ $rf_d1 \rightarrow t4$ $t3 \rightarrow t1$	NONE
	Х
	X-X
	LM3
	LM4

t4 → mem_d3 t1 → mem_a3	DW
	Х
	X-X
	LM5
	LM6

t4 → alu t5 → alu alu → t4	NONE
	XOR
	X-Z
	LM6
	LM2

13. BEQ

111 → rf-a1 rf-d1 → Mem-a,alu Mem_d → IR +1 → alu alu →PC	IR
	ADD
	X-X
	HKT
	SB

	NONE
$IR_{-}(11-9) \rightarrow rf_{-}a1$	Х
IR_(8-6) → rf_a2 rf_d1 → t1 rf-d2 →t2	Х
	GET_AB
	QB

$T1 \rightarrow ALU$ $T2 \rightarrow ALU$ $ALU \rightarrow T3$	NONE
	SUB
	C-Z
	ALU
	SB

IF (Z = 0)

111 → rf_a3 PC → rf_d3	NONE
	Х
	X-X
	SET_PC
	IB

IF (Z = 1)

PC → ALU $IR_{-}(5-0) \rightarrow SE10 \rightarrow ALU$ $ALU \rightarrow PC$	NONE
	ADD
	X-X
	SE10-PC
	SET_PC

111 → rf_a3 PC → rf_d3	NONE
	Х
	X-X
	SET_PC
	IB

14. JAL

$111 ightarrow ext{rf-a1}$ $ ext{rf-d1} ightarrow ext{Mem-a,alu}$ $ ext{Mem_d} ightarrow ext{IR}$ $ ext{+1} ightarrow ext{alu}$ $ ext{alu} ightarrow ext{PC}$	IR
	Х
	X-X
	HKT
	SB

$IR_{-}(9_{-}11) \rightarrow RF_{-}A3$ $PC \rightarrow RF_{-}D3$, ALU $IR_{-}(0_{-}8) \rightarrow SE7 \rightarrow ALU$ $ALU \rightarrow T3$	NONE
	ADD
	X-X
	SE7-PC
	T3-PC

111 → RF_A3 T3 → RF_D3	NONE
	Х
	X-X
	T3-PC
	IB

15. JLR

111 → rf-a1 rf-d1 → Mem-a,alu Mem_d → IR +1 → alu alu →PC	IR
	X
	X-X
	HKT
	SB

	NONE
$IR_{-}(11-9) \rightarrow rf_{-}a1$	Х
IR_(8-6) → rf_a2 rf_d1 → t1 rf-d2 →t2	Х
	GET_AB
	QB

PC→ RF_D3 IR_(9_11) → RF_A3	NONE
	X
	X-X
	PC-REG
	T2-PC

T2 → RF_D3 111 → RF_A3	NONE
	Х
	X-X
	T2-PC
	IB