Derek Barbosa, Peter Wallace Professor Herbordt: EC 413 Oct 30th 2020

Lab 5: Pipeline Datapath

Datapath and Timing Diagrams

Description

We built our own datapath from the ground up. We initialized the three stage registers and "piped" each output according to the diagram given (see Lab 5 Manual).

To test our datapath, we utilized the I-type and R-type instructions provided to us from the Lab Manual and other sample test benches (see the .tb file).

```
InstrIn= 32'b011010_00000_00000_00000000000000101;
                                                              // I, add r0 with 00000005 => r0 = 00000005
                                                              // I, add r1 with 0000000A \Rightarrow r1 = 0000000A
InstrIn= 32'b011010_00001_00001_0000000000001010;
InstrIn= 32'b011010_00010_00010_11111111111111000;
                                                              // I, add r2 with 0000FFF8 => r2 = 0000FFF8
                                                              // I, not r3
                                                                                                              => r3 = FFFFFFFAM
InstrIn= 32'b011001_00011_00011_111111111111111000;
InstrIn= 32'b011100_00100_00100_1010101010101010;
                                                              // I, or r4 with 0000AAAA => r4 = 00000AAAA^M
InstrIn= 32'b011101_00101_00101_1111111111111111;
                                                              // I, and r5 with 0000FFFF => r5 = 00000000^M
InstrIn= 32'b011110_00110_00110_111111111111111000;
                                                              // I, slt r6 with 0000FFFF8 => r6 = 00000001^M
InstrIn= 32'b010001_00111_00001_00000_00000000000;
                                                              // R, not r1(0000000A)
                                                                                                     => r7 = FFFFFFF5
InstrIn= 32'b010010_01000_00001_00010_00000000000;
                                                              // R, add r1(0000000A) with r2(0000FFF8) => r8 = 00010002^M
                                                              // R, add r1(0000000A) with r3(FFFFFFF) \Rightarrow r9 = 00000009^M
InstrIn= 32'b010010_01001_00001_00011_00000000000;
InstrIn= 32'b010010_01010_00001_00100_00000000000;
                                                              // R, add r1(0000000A) with r4(0000AAAA) => r10 = 0000AAB4^M
InstrIn= 32'b010010_01011_00001_00101_00000000000;
                                                              // R, add r1(0000000A) with r5(00000000) => r11 = 0000000A ^{\text{AM}}
InstrIn= 32'b010010_01100_00001_00110_00000000000;
                                                              // R, add r1(0000000A) wtih r6(00000001) \Rightarrow r12 = 0000000B ^{\text{AM}}
```

Some sample instructions

Waveforms

				165.000 ns								
Name	Value											
Name	Value	لسسس	164.000 ns		166.000 n	s 	168.000 n	: 	170.000 n		172.000 n	<u> </u>
> MInstrin[31:0] Wireset	0110010001		- 01	1001000110			,		11110		0101010101	0101010
₩ clk	1											
> ® ALUOut[31:0]	0000000a	0000	0005					0000000)a			
				175.000 ns								
Name	Value		174.000 ns		176.000 ns		178.000 ns		180.000 ns	بينطيني	182.000 ns	
> W InstrIn[31:0]	0111000010		01	100001000	0100101010	1010101010			01110	1001010010	11111111111	111111
₩ reset	0											
 clk MALUOut[31:0]	0000fff8	00000	000a					0000fff	8			
« ALGOUR[51.0]	00001110											
							<u></u>					
				185.000 ns								
Name	Value	i i	184.000 ns		186.000 ns		188.000 ns		190.000 ns		192.000 ns	194
> W InstrIn[31:0]	0111010010		01	101001010	0101111111	1111111111			011110	0011000110	1111111111	194 111000
₩ reset	0											
₩ clk	1							fffffff				
> [®] ALUOut[31:0]	ffffffff	00001	CITS						-			

			185.000 ns				
Name	Value	184.000 ns	186.000 ns	,188.000 ns	190.000 n	s 192.000 ns	194
> V Instrin[31:0]	0111010010	184.000 ns	11010010100101111111			000110001101111111111	
₩ reset	0						
₩ clk	1						
> ® ALUOut[31:0]	ffffffff	0000fff8			ffffffff		
			195.000 ns				
Name	Value	194.000 r	as 196.000 i			ns 202.000	ns á
> W Instrin[31:0]	011110001		1110001100011011111			00100111000010000000	00000000
¹ reset	0						
U clk	1	ffffffff			0000aaaa		
> ® ALUOut[31:0]	0000aaaa				OUOUAAAA		
			205.000 ns				
Name	Value	204.000 ns	206.000 ns	208.000 ns	210.000 r	ns 212.000 ns	s 21
> M Instrin[31:0]	0100010011	01	00010011100001000000	000000000	0100	100100000001000100000	0000000
¼ reset ¼ clk	0						
> ® ALUOut[31:0]	00000000	0000aaaa			0000000		

			215.000 ns			MARKET
Name	Value	014 000	016 000	018 000		
> W InstrIn[31:0]	0100100100	214.000 ns	216.000 ns			Derek Deoliveira Barbosa
reset	0				010010	010010001000110000000000
[™] clk	1					
> 8 ALUOut[31:0]	00000001	0000000			00000001	
					You are usin	g the computer audio
Name	Value	224.000 ns	226.000 ns	228.000 ns	230.000 ns	232.000 ns
▼ InstrIn[31:0] ▼ reset	0100100100	01	001001001000010001100	0000000000	01001	001010000010010000000000000000000000000
₩ clk	1					
® ALUOut[31:0]	fffffff5	00000001			fffffff5	
Name	Value	234.000 ns	236.000 ns	238.000 ns	240.000 ns	242.000 ns
₩ InstrIn[31:0]	0100100101		00100101000001001000	000000000		001011000010010100000000000
₩ reset	0					
¹ clk	1					
	00010002	fffffff5			00010002	

Name	Value	244.000 ns	, ,2	46.000 ns		248.000 ns	;	250.000 n	s	252.000 ns	. 2	
> W Instrin[31:0]	0100100101	01	00100101100001001010000000000					01001001100000010011000000000000				
₩ reset	0											
₩ clk	1						130					
	00000009	00010002 00000009										
-												
Name	Value	254.000 ns	25	6.000 ns	25	8 000 ns	26	0.000 ns	262	.000 ns	264.	
> Instrin [31:0]	0100100110			01	0010011000	0001001100	000000000					
₩ reset	0											
[™] clk	1											
> [®] ALUOut[31:0]	0000aab4	00000009	00009 0000aab4									
Name	Value	264.000	ns	266.000 n	s +	268.000 r	ns 	270.000	ns l	272.000 n	s +	
> MInstrln[31:0]	0100100110)			010010011	0000001001	.1000000000	000				
₩ reset	0											
¹ dk	1											
> MALUOut[31:0]	0000000a	0000aab4 0000000a								1		

Name	Value	274.000 r	s 276.00	0 ns	278.000 ns	s	280.000 n	s	282.000	ns			
> M InstrIn[31:0]	0100100110				10000001001								
₩ reset	0												
₩ clk	1												
> [®] ALUOut[31:0]	0000000b	0000000a		00000					000Ъ				
			155.000 ns										
Name	Value	154 000 ns	156 000	ne	158 000 ns	16	0 000 ne		62 000 ns		164		
> 🦊 InstrIn[31:0]	0110100001	154.000 ns	156.000 .01000010000101111	1111111111000		·····	0110010	001100011	1111111111	11000			
₩ reset	0												
[™] clk	1												
> M ALUOut[31:0]	00000005	00000000				00000005	-						
- / 120 0 0 (5 110)	0000000												