به نام خدا

دانشگاه تهران

دانشکده مهندسی برق و کامپیوتر

معماری کامپیوتر

تمرین کامپیوتری شماره 4

نیما زمان پور 810198407

سید علیرضا جاوید 810198375

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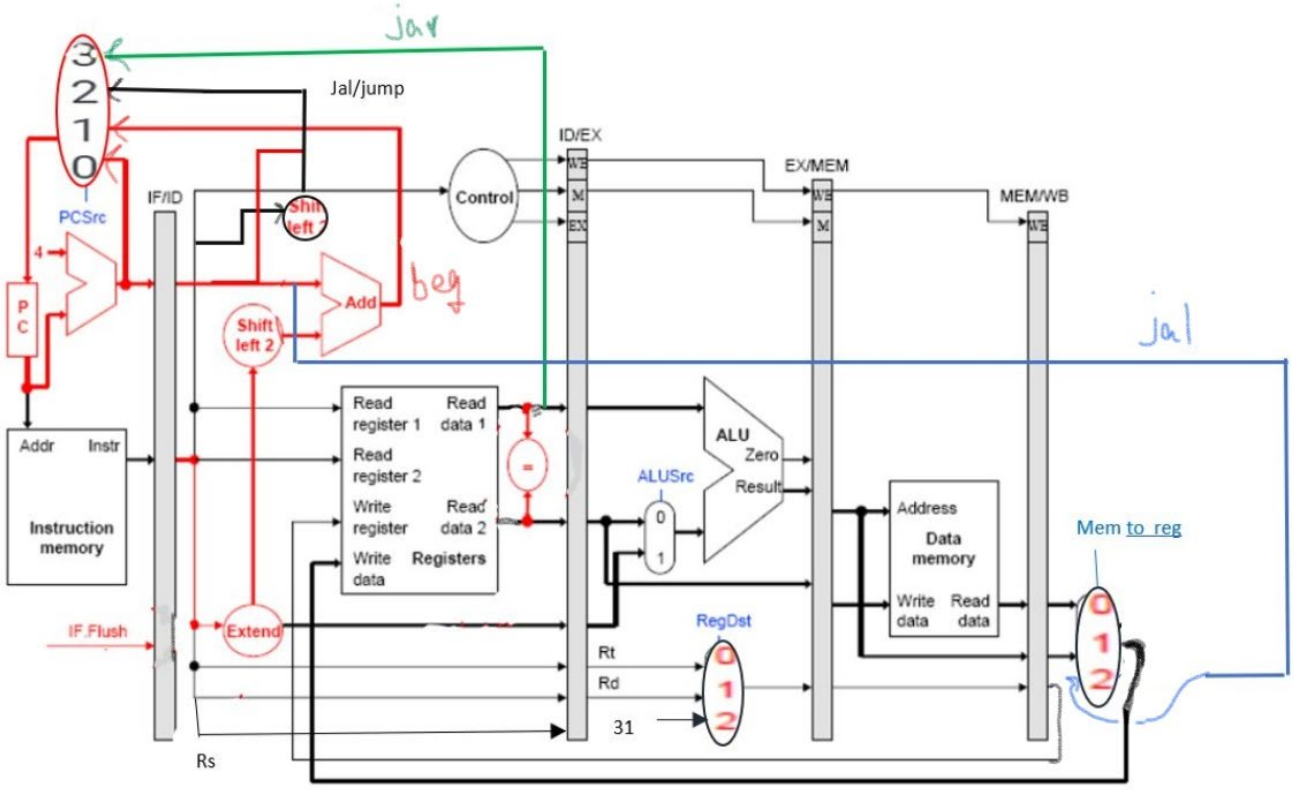
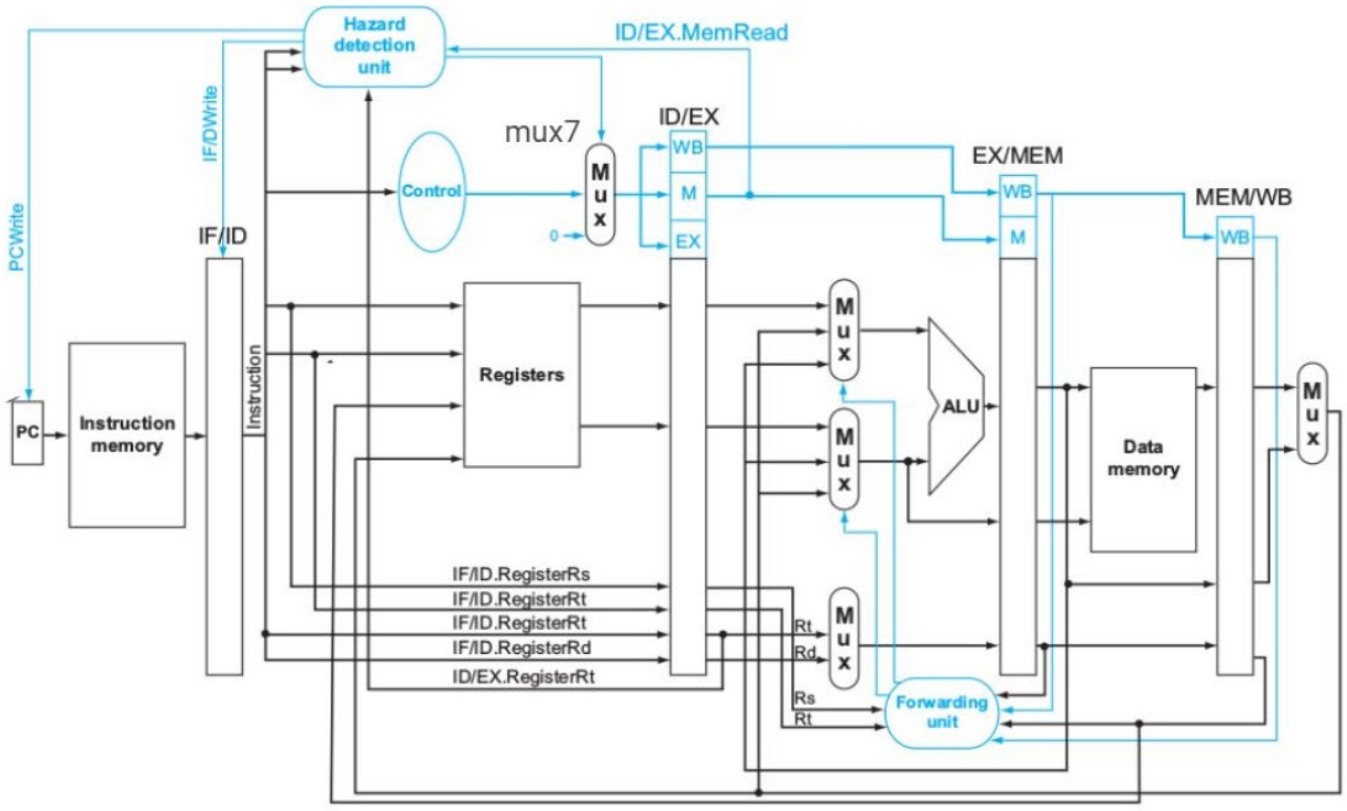
Datapath without forwarding unit and hazard detection unit :



Datapath with Forwarding Unit and Hazard Detection Unit :



Controller:

R-type

Load

Store

Branch

Addi

Jump

Jal

jr

Stli

```
case (opcode)
    6'b000000 : {reg_dst, reg_write, alu_op} = {2'b01, 1'b1, 2'b10};

    6'b100011 : {alu_src, mem_to_reg, reg_write, mem_read} = {1'b1, 2'b01, 1'b1, 1'b1};

    6'b101011 : {alu_src, mem_write} = 2'b11;

    6'b000100 : {pc_src, IFflush} = {1'b0, operands_equal, operands_equal};

    6'b001001: {reg_write, alu_src} = 2'b11;

    6'b000010: {pc_src, IFflush} = {2'b10, 1'b1};

    6'b000011: {reg_dst, mem_to_reg, pc_src} = {2'b10, 2'b10, 2'b10};

    6'b000110: {pc_src} = {2'b11};

    6'b001010: {alu_src, reg_dst, reg_write, alu_op, mem_to_reg} = {1'b1, 2'b00, 1'b1, 2'b11, 2'b00};
endcase
```

Alu controller:

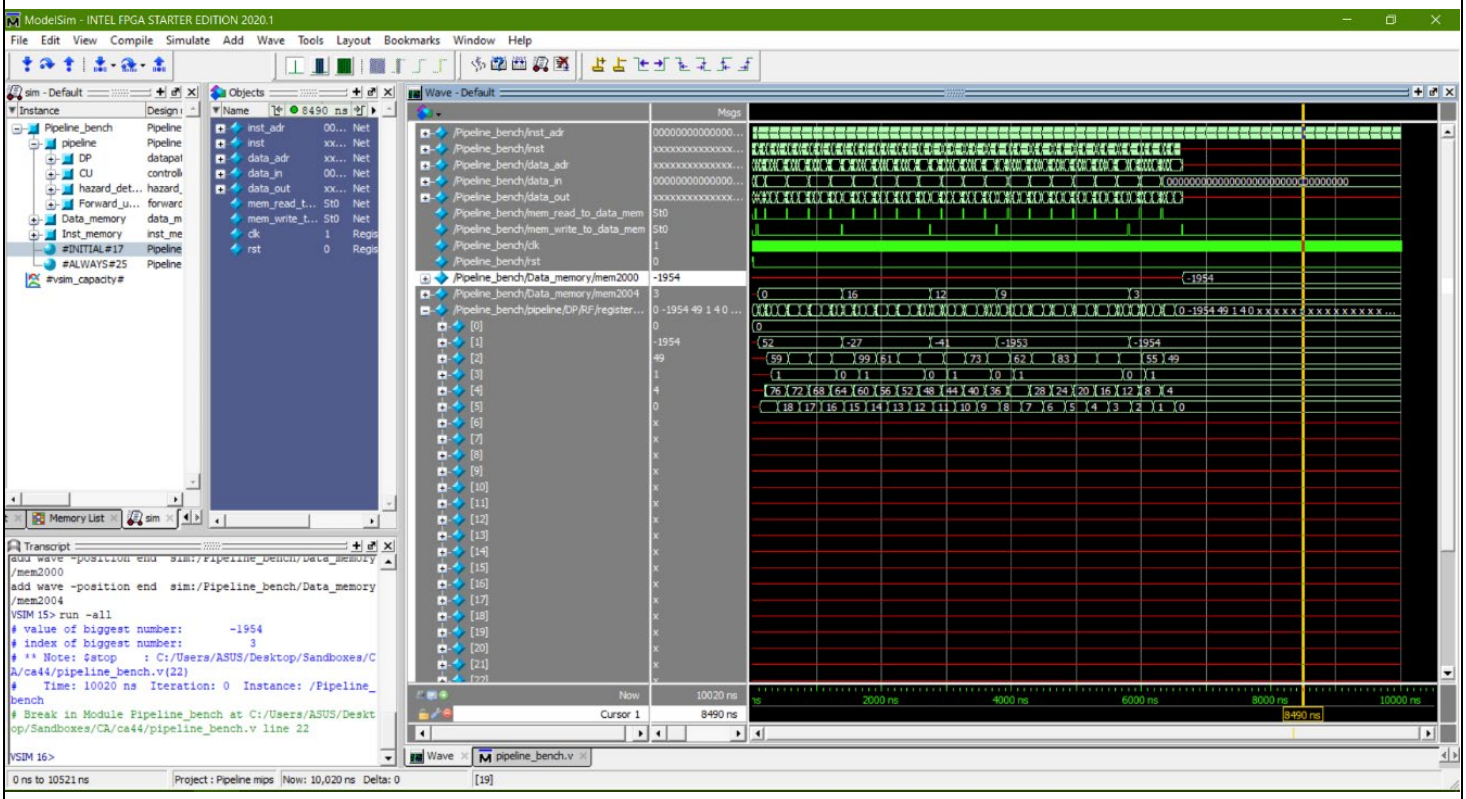
Alu op	Func	Operation	
00	Xxxxxx	010	+
01	Xxxxxx	110	-
11	xxxxxx	111	Stli
10	100000	010	+
	100011	110	-
	100100	000	&
	100101	001	|
	101010	111	sti

کد تست برنامه:

```
A = mem[1000]
Mem[2004] = 0
For(i=19; i!=0; i--)
    C= i+i
    C = C+C
    B = mem[1000+C]
    If( B <A)
        A = B
Mem[2004] = i
Mem[2000] = A
```

0	Ld R1, R0, 1000	100011 00000 00001 0000001111101000
1	SW R0, R0, 2004	101011 00000 00000 0000011111010100
2	ADDI R5, R0, 19	001001 00000 00101 0000000000010011
3	NOP	00000000000000000000000000000000
4	NOP	00000000000000000000000000000000
5	NOP	00000000000000000000000000000000
6	Beq R5, R0, 25	000100 00101 00000 0000000000011001
7	Add R4, R5, R5	000000 00101 00101 0010000000100000
8	Add R4, R4, R4	000000 00100 00100 0010000000100000
9	Ld R2, R4, 1000	100011 00100 00010 0000001111101000
10	NOP	00000000000000000000000000000000
11	NOP	00000000000000000000000000000000
12	NOP	00000000000000000000000000000000
13	Stl R3, R2, R1	000000 00001 00010 0001100000101010
14	NOP	00000000000000000000000000000000
15	NOP	00000000000000000000000000000000

16	NOP	00000000000000000000000000000000
17	Beq R3, R0, 1	000100 00011 00000 0000000000000001
18	1Jump 2	000010 00000000000000000000010101
19	Add R1, R2, R0	000000 00010 00000 00001 00000 100000
20	Sw R5, R0, 2004	101011 00000 00101 0000011111010100
21	Addi R5, R5, -1	001001 00101 00101 1111111111111111
22	NOP	00000000000000000000000000000000
23	NOP	00000000000000000000000000000000
24	NOP	00000000000000000000000000000000
25	Jump 5	000010 00000000000000000000000101
26	Sw R1, R0, 2000	101011 00000 00001 0000011111010000
…	…	…



شکل موج خروجی در جریان تست برنامه