CSCI 206 Homework #3

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Exercise 4.1

4.1.1

	RegWrite	MemRead	ALU Mux	MemWrite	ALU Op	Reg Mux	Branch
a	1	0	0 (reg)	0	Add	1 (ALU)	0
b	0	1	1 (Imm)	0	Add	0 (D-mem)	0

4.1.2

a. PC, PC add, Instruction Memory, Registers, ALU

b. PC, PC add, Instruction Memory, Registers, ALU, Data Memory

4.1.3

a. Resources produce unused output: Branch add

Resources produce no output: Data Memory

b. Resources produce unused output: one of the Register output, Branch add

Resources produce no output: n/a

4.1.4

a. I-Mem, Regs, Mux, ALU, Mux

b. I-Mem, Regs, Mux, ALU, Mux

4.1.5

a. I-Mem, Regs, Mux, ALU, D-Men, Mux

b. I-Mem, Regs, Mux, ALU, D-Men, Mux

4.1.6

a. I-Mem, Regs, Mux, ALU, Mux

b. I-Mem, Regs, Mux, ALU, Mux

Exercise 4.2

4.2.1

a. I-Mem, two read ports and one write port of Regs.

b. I-Mem, Regs, ALU mux, Regs Mux

4.2.2

a. Another read port in Regs, and another input port for ALU.

b. ALU can do shift

4.2.3

a. Another ALU Mux control bit

b. ALU shift control signal.

4.2.4

The critical path: I-Mem, Regs, Mux, ALU, D-Mem, Mux

without: 400+200+30+120+350+30 = 1130ps

a. with: 400+200+30+120+350+30 = 1130ps (add unit does not affect the critical path)

b. with: 400+(200+100)+30+120+350+30 = 1230ps

4.3.5

a. speedup = 1130/1130 = 1

b. speedup = 1130/(0.95*1230) = 0.97

4.3.6

cost-without: 1000+30*2+10*3+100+200+2000+500 = 3890

a. cost-with: 100+50*2+10*3+100+200+2000+500 = 3930

Cost ratio = 3930/3890 = 1.01

Cost/performance = 1.01/1 = 1.01

b. cost-with: 3890+200 = 4090

cost ratio = 4090/3890 = 1.05

cost/performance = 1.05/0.97 = 1.08

Exercise 4.16

4.16.1

a. IF/ID: Instruction and PC + 4;

ID/EX: Control bits for EX, MEM, and WB, PC +4, data from two registers, extended immediate 32 bits, and the destination register address;

EX/MEM: Control bits for MEM and WB, PC + 4 + Offset, ALU result and ALU zero output, data from the second register, the destination register address;

MEM/WB: Control bits for WB, the read data from memory, and ALU result, and the destination register address.

b. The same as a.

4.16.2

a. lw $1, 40($6) 010011 00110 00001 0000000000101000 (op rs rt immediate)

need to be read: $6

actually read: $1, $6

b. add $5, $5, $5 op rs rt rd shamt funt

need to be read: $5

actually read: $5 twice

4.16.3

a. EX: calculate the memory address: 40 + $6

MEM: load value form the memory

b. EX: calculate $5 + $5

MEM: nothing

4.16.4

a.

2: add	$5, $5, $8	WB				
2: add	$6, $6, $8	**MEM**	WB			
2: sw	$1, 20($50)	EX	MEM	**WB**		
2: beq	$1, $0, Loop	ID	EX	MEM	**WB**	
3: lw	$1, 40($6)	IF	ID	EX	MEM	WB
3: add	$5, $5, $8		IF	ID	EX	**MEM**
3: add	$6, $6, $8			IF	ID	EX
3: sw	$1, 20($50)				IF	ID
3: beq	$1, $0, Loop					IF

b.

2: sw	$0, 0($1)	**WB**	
2: sw	$0, 4($1)	MEM	**WB**

2: add	$2, $2, $4	EX	MEM	WB		
2: beq	$2, $0, Loop	ID	EX	MEM	**WB**	
3: add	$1, $2, $3	IF	ID	EX	MEM	WB
3: sw	$0, 0($1)		IF	ID	EX	MEM
3: sw	$0, 4($1)			IF	ID	EX
3: add	$2, $2, $4				IF	ID
3: beq	$2, $0, Loop					IF

4.16.5

a. resources that are not doing useful work are marked as bold in 4.16.4 session.

1/5 = 20%

b. 2/5 = 40%

4.16.6

a. The beq instruction and PC +4

b. The same as a.