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CPE-333

Quiz Week 4: Pipelining Problems

1. How many clock cycles to execute the following 5 instructions With Forwarding

Clock:	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
add $x1_w$ $x2_r$ $x0_r$	IF	DEC	ALU	DM fw	WB										
sub $x1_w$ $x2_r$ $x1_r$		IF	DEC	ALU	DM fw	WB									
lw $x3_w$ $0(x1_r)$			IF	DEC	ALU	DM	WB fw								
sw $x4_r$ $0(x3_r)$				IF	DEC	DEC stall	ALU	DM	WB						
add $x1_w$ $x2_r$ $x2_r$					IF	IF	DEC	ALU	DM	WB					

1) The 5 instructions will take 10 clock cycles

2 How many clock cycles to execute the following instructions no forwarding

Clock:	1	2	3	4	5	6	7	8
beq $x1_r$ $x2_r$ label	IF	DEC	ALU	DM				
add $x1_w$ $x2_r$ $x3_r$		IF	DEC	ALU	Flush	Flush		
sub $x1_w$ $x2_r$ $x4_r$			IF	DEC	Flush	Flush		
add $x5_w$ $x6_r$ $x7_r$								
label: exit				IF	DEC	ALU	DM	WB

2) The 5 instructions will take 8 clock cycles

3.a How many clock cycles to execute the following 6 instructions With Forwarding

Clock:	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
addi $x1_w$ $x0_r$ 3	IF	DEC	ALU	DM fw	WB fw										
addi $x2_w$ $x1_r$ 2		IF	DEC	ALU	DM	WB									
lw $x3_w$ $0(x1_r)$			IF	DEC	ALU	DM	WB fw								
add $x2_w$ $x2_r$ $x3_r$				IF	DEC	DEC stall	ALU	DM	WB						
addi $x3_w$ $x1_r$ 1					IF	IF	DEC	ALU	DM	WB					
sw $x0_r$ $0(x7_r)$							IF	DEC	ALU	DM	WB				

3) The 6 instructions will take 11 clock cycles

3.b How many clock cycles to execute the loop without Forwarding, loop executes 100 times

ASSUMING BRANCH PREDICTOR IS PC+4, i.e. wrong 100 times

Clock:	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17		
label: lw $x0_w$ $0(x1_r)$	IF	DEC	ALU	DM	WB														
add $x3_w$ $x2_r$ $x0_r$		IF	DEC stall	DEC stall	DEC	ALU	DM	WB											
sw $x3_r$ $0(x1_r)$			IF	IF	IF	DEC	DEC	DEC	ALU	DM	WB								
addi $x1_w$ $x1_r$ 4						IF	IF	IF	DEC	ALU	DM	WB							
addi $x4_w$ $x4_r$ -1									IF	DEC	ALU	DM	WB						
bnez $x4_r$ label										IF	DEC	DEC	DEC	ALU	DM	WB			
											IF	IF	IF	DEC	ALU	flush	flush		
														IF	DEC	flush	flush		
label:…															IF	DEC	ALU	DM	WB

Each loop executes every 14ccs. Last loop takes extra 2 to finish WB. = 14*100+2

4) Code will execute in 1402 clock cycles.