Faculty of Media Engineering and Technology
Dept. of Computer Science and Engineering
Dr. Milad Ghantous

CSEN 702: Microprocessors
Winter 2023

Practice assignment 7

Consider the following code:

```
MUL  R3,  R1,  R2
ADD  R5,  R3,  R4
ADD  R7,  R2,  R6
ADD  R10,  R8,  R9
MUL  R11,  R7,  R10
ADD  R5,  R5,  R11
```

Assume multiplication takes 6 cycles and addition takes 4 cycles, to execute. Both units are pipelined.

a) Consider the regular pipeline with forwarding. Compute the number of cycles needed to execute this code. Show the steps by filling the table.

b) Re-execute this code using Tomasulo using 3 add reservation stations and 2 multiply reservation stations (Assume tomasulo is used for integer instructions) and compute the number of cycles needed. (Show all the steps and consider R1, R2, R4, R6, R8, R9 are available initially)
Also, if two instructions finish in the same cycle, discuss your opinion on who publishes on CDB first.

Solution

A)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26
MUL																										
ADD																										
ADD																										
ADD																										
MUL																										
ADD																										

TOTAL=

B) Applying Tomasulo algorithm

Cycle # _____

	Issue	Execute	Write result
MUL R3, R1, R2			
ADD R5, R3, R4			
ADD R7, R2, R6			
ADD R10, R8, R9			
MUL R11, R7, R10			
ADD R5, R5, R11			

	op	Vj	Vk	Qj	Qk	busy
A1						
A2						
A3						

	op	Vj	Vk	Qj	Qk	busy
M1						
M2						

	Qi	Reg value	NOTES
R1			
R2			
R3			
R4			
R5			
R6			
R7			
R8			
R9			
R10			
R11			

Cycle # ____

	Issue	Execute	Write result
MUL R3, R1, R2			
ADD R5, R3, R4			
ADD R7, R2, R6			
ADD R10, R8, R9			
MUL R11, R7, R10			
ADD R5, R5, R11			

	op	Vj	Vk	Qj	Qk	busy
A1						
A2						
A3						

	op	Vj	Vk	Qj	Qk	busy
M1						
M2						

	Qi	Reg value	NOTES
R1			
R2			
R3			
R4			
R5			
R6			
R7			
R8			
R9			
R10			
R11			

Cycle # _____

	Issue	Execute	Write result
MUL R3, R1, R2			
ADD R5, R3, R4			
ADD R7, R2, R6			
ADD R10, R8, R9			
MUL R11, R7, R10			
ADD R5, R5, R11			

	op	Vj	Vk	Qj	Qk	busy
A1						
A2						
A3						

	op	Vj	Vk	Qj	Qk	busy
M1						
M2						

	Qi	Reg value	NOTES
R1			
R2			
R3			
R4			
R5			
R6			
R7			
R8			
R9			
R10			
R11			

Cycle # ____

	Issue	Execute	Write result
MUL R3, R1, R2			
ADD R5, R3, R4			
ADD R7, R2, R6			
ADD R10, R8, R9			
MUL R11, R7, R10			
ADD R5, R5, R11			

	op	Vj	Vk	Qj	Qk	busy
A1						
A2						
A3						

	op	Vj	Vk	Qj	Qk	busy
M1						
M2						

	Qi	Reg value	NOTES
R1			
R2			
R3			
R4			
R5			
R6			
R7			
R8			
R9			
R10			
R11			

Cycle # ____

	Issue	Execute	Write result
MUL R3, R1, R2			
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ADD R7, R2, R6			
ADD R10, R8, R9			
MUL R11, R7, R10			
ADD R5, R5, R11			

	op	Vj	Vk	Qj	Qk	busy
A1						
A2						
A3						

	op	Vj	Vk	Qj	Qk	busy
M1						
M2						

	Qi	Reg value	NOTES
R1			
R2			
R3			
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R5			
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ADD R10, R8, R9			
MUL R11, R7, R10			
ADD R5, R5, R11			

	op	Vj	Vk	Qj	Qk	busy
A1						
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	op	Vj	Vk	Qj	Qk	busy
M1						
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ADD R5, R5, R11			

	op	Vj	Vk	Qj	Qk	busy
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ADD R5, R5, R11			

	op	Vj	Vk	Qj	Qk	busy
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	op	Vj	Vk	Qj	Qk	busy
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