Birzeit University
Electrical and Computer Engineering Department
Computer Architecture - ENCS 437
Quiz# 1

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Q1: You are going to enhance a machine and there are two types of possible improvements: either (i) make multiply instructions run 4 times faster, or (ii) make memory access instructions run two times faster than before. You repeatedly run a program that takes 100 seconds to execute (on the original machine) and find that of this time 25% is used for multiplication, 50% for memory access instructions, and 25% for other tasks.

1. What will the speedup be if you improve both multiplication and memory access?

part2 ← 10

$$Speedup = \frac{\sum f_i CPI_i \times CT_{old}}{\sum f_i CPI_i \times CT_{new}} = \frac{1}{0.25 \times \frac{MUL}{4} + \frac{0.5 \times Mem}{2}}$$

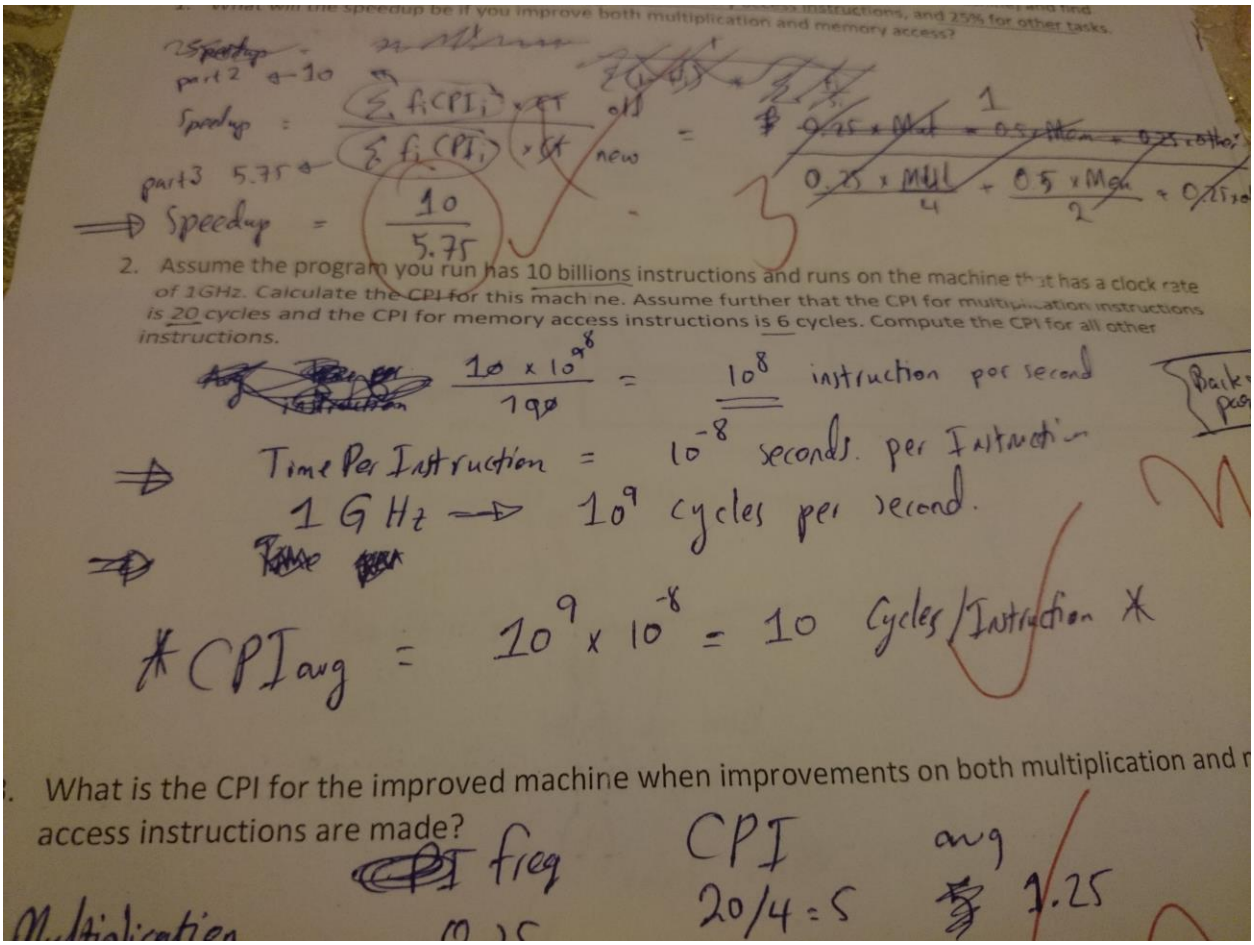
part3 5.75 ←

$$\Rightarrow Speedup = \frac{10}{5.75}$$

2. Assume the program you run has 10 billions instructions and runs on the machine that has a cloc of 1GHz. Calculate the CPI for this machine. Assume further that the CPI for multiplication instru is 20 cycles and the CPI for memory access instructions is 6 cycles. Compute the CPI for all othe instructions.

$$\frac{10 \times 10^8}{100} = 10^8 \text{ instruction per second}$$

10^{-8} seconds per Instruction



what will the speedup be if you improve both multiplication and memory access instructions, and 25% for other tasks.

part2 = 10

Speedup = $\frac{\sum f_i (CPI_i) \times CT_{old}}{\sum f_i (CPI_i) \times CT_{new}}$ = $\frac{1}{\frac{0.25 \times MUL}{4} + \frac{0.5 \times Mem}{2} + 0.25 \times 1}$

part3 5.75

⇒ Speedup = $\frac{10}{5.75}$

2. Assume the program you run has 10 billions instructions and runs on the machine that has a clock rate of 1GHz. Calculate the CPI for this machine. Assume further that the CPI for multiplication instructions is 20 cycles and the CPI for memory access instructions is 6 cycles. Compute the CPI for all other instructions.

$\frac{10 \times 10^9}{10} = 10^8$ instruction per second

⇒ Time Per Instruction = 10^{-8} seconds per Instruction

1 GHz ⇒ 10^9 cycles per second.

⇒

*CPI avg = $10^9 \times 10^{-8} = 10$ Cycles/Instruction *

3. What is the CPI for the improved machine when improvements on both multiplication and memory access instructions are made?

freq CPI avg

Multiplication 0.25 20/4 = 5 1.25

$\frac{10 \times 10}{1\text{ns}} = \frac{10^8}{}$ instruction per second

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⇒ Time Per Instruction = 10^{-8} seconds per Instruction

⇒ 1 GHz → 10^9 cycles per second.

$*CPI_{avg} = 10^9 \times 10^{-8} = 10$ Cycles/Instruction *

3. What is the CPI for the improved machine when improvements on both multiplication and memory access instructions are made?

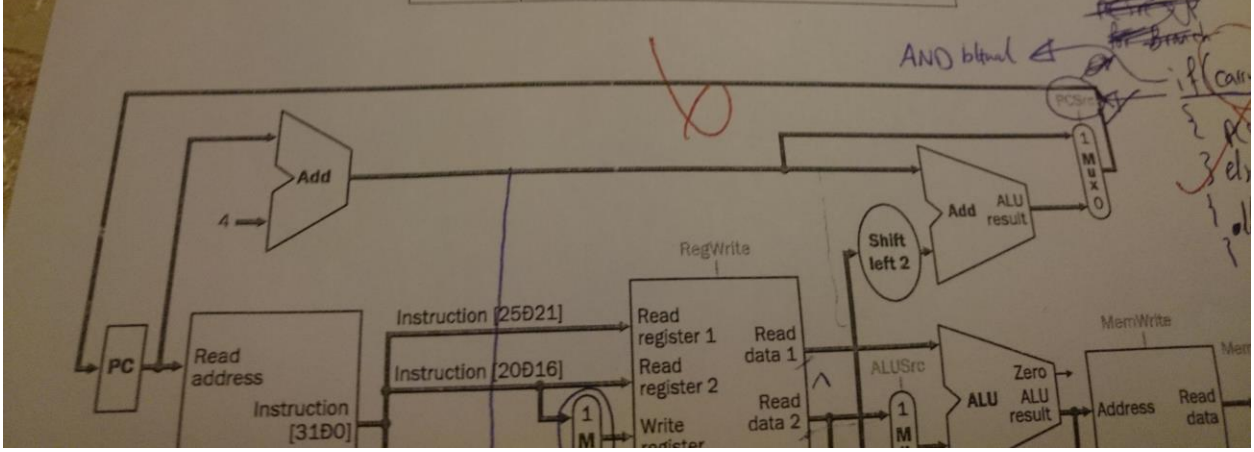
	freq	CPI	avg
Multiplication	0.25	20/4 = 5	1.25
Memory	0.5	6/2 = 3	1.5
other	0.25	12	3

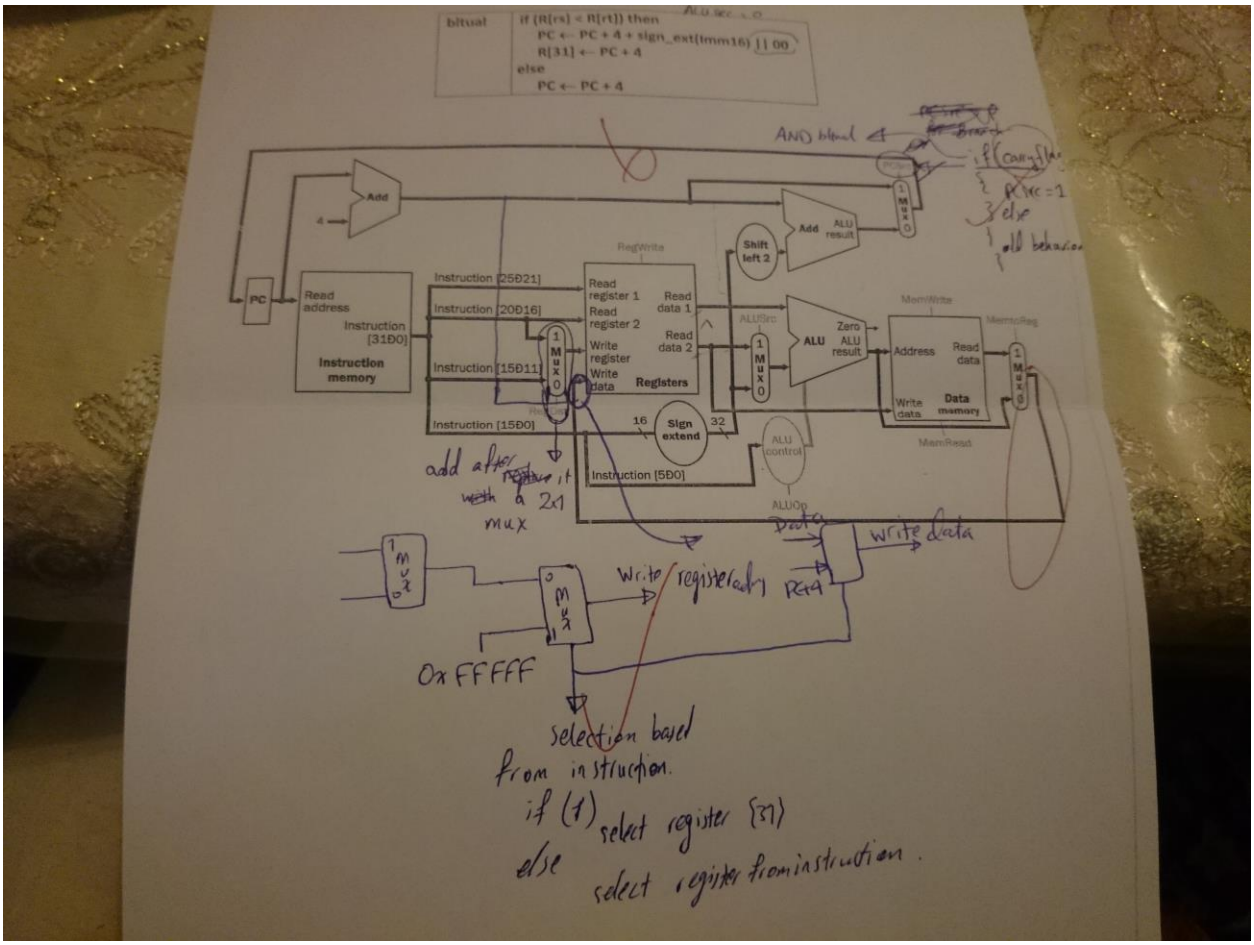
$CPI_{avg\ new} = 5.75$

Q1: Extend the single-cycle data-path shown below to support the following instruction. Add to the datapath any necessary functional unites and control signals.

ALUSrc = 0

bltual	if (R[rs] < R[rt]) then
	PC ← PC + 4 + sign_ext(Imm16) || 00
	R[31] ← PC + 4
	else
	PC ← PC + 4




bltual
if (R[rs] < R[rt]) then
PC ← PC + 4 + sign_ext(Imm16) || 00
R[31] ← PC + 4
else
PC ← PC + 4
AND bltual
Add
4
PC
Read address
Instruction [31Ð0]
Instruction memory
Instruction [25Ð21]
Instruction [20Ð16]
Instruction [15Ð11]
Instruction [15Ð0]
RegWrite
Read register 1
Read register 2
Write register
Write data
Read data 1
Read data 2
Registers
Shift left 2
Add
ALU result
ALUSrc
ALU
Zero
ALU result
MemWrite
MemtoReg
Address
Read data
Write data
Data memory
MemRead
16
Sign extend
32
ALU control
Instruction [5Ð0]
ALUOp
add after with a 2x1 mux
Write register
Read
Write data
0x FFFF
selection based from instruction.
if (1) select register [31]
else select register from instruction.