Fall, 2023 Week 2 2023.09.

組別:______ 簽名:_____

[group3]

1. Say we have three computers A, B and C, which vary in T_c (cycle time) and CPI (average cycles per instruction), with these values listed in the table below. The three computers are using the same ISA.

Computer	T _c (ps)	CPI	T _c ×CPI	Performance (relative to A)
A	250	3.0		1
В	400	2.0		
С	600	1.2		

Please answer the following questions.

- 1. Calculate the **performance** of each computer **relative to computer A** (round to 2nd decimal place).
- 2. Rank the performance of the computers from best to worst.

Ans:

1.

Computer	T _c (ps)	СЫ	T _c ×CPI	Performance (relative to A)
A	250	3.0	750	1
В	400	2.0	800	750/800 = 0.94
С	600	1.2	720	750/720 = 1.05

2. C > A > B

[group6]

2. Please choose the correct answers.

(a)Response time and throughput use the same measuring unit.

(b)Instruction count and CPI both won't be affected by technology.

(c)By reducing the clock frequency of a processor from 2.5 GHz to 2 GHz, and also reducing its supply

voltage from 1.2 Volt to 0.9 Volt, the dynamic power consumption will be reduced by 50% theoretically.

(d)Using more CPUs in a computer system may not help in reducing the response time.

Ans: (b)(d)

[group11]

What is the full name of CPI? Suppose I have a computer with a performance A, and I want it to be 2A.
 What can I do without modifying the program, ISA and compiler?
 Hint:

$\begin{aligned} \text{Clock Cycles} &= \text{Instruct. Count} \times \text{Cycles per Instruct.} \\ \text{CPU Time} &= \text{Instruct. Count} \times \text{CPI} \times \text{Clock Cycle Time} \\ &= \frac{\text{Instruct. Count} \times \text{CPI}}{\text{Clock Rate}} \end{aligned}$

Ans:

Clock per Instruction

Performance = 1/CPU Time

It is known that the Instruct. Count will not change if the program \sim ISA and compiler is not moved.

CPU Time =	Instruct.	Count	\times CPI \times	Clock	Cycle	Time
	Instruct.	Count	$\times\text{CPI}$			
_	Clo	ck Rat	е			

According to

We know we can halve our CPI or double our clock rate(freq).

[group8]

4. Please fill out the below table and give some brief explanations about your answers. (Put a tick by the item you think which will affect the below performance factors)

	Instruction Count	CPI	Clock Rate
Program			
Compiler			
Instruction Set			
Organization/Hardware			
Technology			

Ans:

	Instruction Count	СРІ	Clock Rate
Program	✓	✓	
Compiler	✓	✓	
Instruction Set	✓	✓	✓
Organization/Hardware		✓	✓
Technology			✓

- 1. The different programs have the distinct numbers of instructions, so the difference of programs will affect instruction count and CPI.
- Different compilers will generate distinct types of instruction when they operate the same instruction.
 Eg. Compiler A generates a multiplicative instruction to deal with 3*2^5. However, Compiler B may only generate a shift instruction to do the multiplication.

Also, the multiplicative instruction takes a few cycles, but the shift instruction only cost 1 cycle. That's the reason why instruction count and CPI will be affected by compiler.

3. The different contents of the instruction sets will generate the distinct instructions. Also, the distinct instructions will cause the dissimilar clock cycle.

E.g. Instruction set A has the multiplicative instruction, however instruction set B doesn't, so it can only use addition and shift to multiply.

And the different instruction leads the dissimilar clock cycles.

That's why instruction set will affect instruction count, CPI and clock rate.

- 4. Distinct structures will lead to the different clock cycles. (RCA or CLA, one cycle, multiple cycles or pipeline) Hence, the different organizations will affect CPI and clock rate.
- The improvement of technology can make the clock cycles take less time. That's why technology can affect the clock rate.

[group2]

5.

Program	Girlfriend Simulator 6900™	GPA Forecast v2.1	
Instruction Class	А	В	
Instruction Counts	6	4	

Computer	MadBook Pro	Microhard Surface	
Clock Frequency	3GHz	2.6GHz	
Instruction Set		x886	
Architecture (ISA)	AKIVIPTI		
Compiler	gcc	g++	
CPI for Class A	1 5	2.5	
Instructions	1.5		
CPI for Class B	2	0.8	
Instructions	3		

If I were to execute both the Girlfriend Simulator 6900[™] and the GPA Forecast v2.1, which computer requires less execution time?

Ans:

Both computers use the same amount of time.

Execution time for MadBook Pro:

Total number of cycles: $6 \cdot 1.5 + 4 \cdot 3 = 21$ cycles Elapsed time: 21/3 = 7ns

Execution time for Microhard Surface: Total number of cycles: $6 \cdot 2.5 + 4 \cdot 0.8 = 18.2$ cycles Elapsed time: 18.2/2.6 = 7ns

[group13]

6. Consider two different implementations, M1 and M2, of the same instruction set. There are three classes of instructions (A, B, and C) in the instruction set. M1 has a clock rate of 80MHz and M2 has a clock rate of 100MHz. The average number of cycles for each instruction class and their frequencies (for a typical program) are shown as the table below. Which of the following statements are correct? (Note: MIPS stands for Million Instructions per second in this problem.)

Instruction	Machine M1	Machine M2	Frequencies	
class	cycles/instuction cycles/instruction		in the	
	class	class	program	
А	1	2	60%	
В	2	3	30%	
С	4	4	10%	

- (a) The average CPI for M1 is 1.6
- (b) The average CPI for M2 is 2.5

(c) M2 has higher MIPS rating than M1

(d) If we change CPI of A for M2 to 1, M2 has higher MIPS rating than M1.

(e) If we increase the clock rate of M1 to 100MHz without affecting the CPI of A, B, and C. The speedup of M1 is 0.8

Ans: abd

[group14]

7. 是非題:

- a. Program execution time decreases when the clock rate increases.
- b. Program execution time increases when the CPI increases.
- c. Program execution time increases when the Instruction count increases.
- d. A speedup of 50 times on 40% of the program will result in an overall speedup of at least 2 times.

Ans:

- (a) False
- (b) True
- (c) True
- (d) False