

113 計算機組織 Homework 1 (Due date: 2024/09/24)

You must write down / type the calculations, or you won't get the scores.

請用手寫於 A4 紙上,並掃描上傳至北科 I 學園 plus、請勿抄襲,抄襲者與被抄襲者分數除 2

1. (15%) Consider three different processors P1, P2, and P3 executing the same instruction set. P1 has a 3.2 GHz clock rate and a CPI of 1.6. P2 has a 1.5 GHz clock rate and a CPI of 1 and P3 has a 4.2 GHz clock rate and has a CPI of 2.1.

(a)(2%) Which processor has the highest performance expressed in instructions per second?

(b) (12%) If the processors each execute a program in 10 seconds, find the number of cycles and the number of instructions.

(c) (2%) We are trying to reduce the execution time by 20% but this leads to an increase of 30% in the CPI. What clock rate should we have to get this time reduction?

2. (10%) Consider two different implementations of the same instruction set architecture. The instructions can be divided into three classes according to their CPI (class A, B, and C). P1 with a clock rate of 1.8 GHz and CPIs of 5, 3, and 3, and P2 with a clock rate of 1.2 GHz and CPIs of 3, 2, and 3. Given a program with a dynamic instruction count of 1×10^6 instructions divided into classes as follows: 30% class A, 30% class B, and 40% class C, please answer the following questions.

(a)(5%) Which implementation is faster? (P1 or P2)

(b)(5%) Find the clock cycles required in both cases.

3. (15%) The MIT processor, released in 2023, had a clock rate of 3.8 GHz and voltage of 1.4 V. Assume that, on average, it consumed 20 W of static power and 70 W of dynamic power. The Core i9 Bridge, released in 2024, had a clock rate of 3.7 GHz and voltage of 1.1 V. Assume that, on average, it consumed 40 W of static power and 60 W of dynamic power W.

Reference formula:

$$(1) \text{ Capacitive loads} = \frac{\text{Dynamic Power}}{\text{Voltage}^2 * \text{Clock Rate}}$$

$$(2) \text{ total dissipated power} = \text{static power} + \text{dynamic power}$$

$$(3) \text{ static power} = \text{voltage} * I$$

(a) (6%) For each processor, find the average capacitive loads.

(b) (4%) Find the percentage of the total dissipated power comprised by static power and the ratio of static power to dynamic power for each technology.

(c) (10%) If the total dissipated power is to be reduced by 20%, how much should the voltage be reduced to maintain the same leakage current? Note: power is defined as the product of voltage and current.

4. (15%) Consider a computer running a program that requires 700 seconds, with 150 seconds spent executing FP instructions, 250 seconds executing INT operations, 100 seconds executing L/S instructions, and 200 seconds spent executing branch instructions.

- (a) (3%) By how much is the total time reduced if the time for INT operations is reduced by 25%?
- (b) (3%) By how much is the time for L/S operations reduced if the total time is reduced by 10%?
- (c) (3%) Can the total time can be reduced by 30% by reducing only the time for branch instructions?

5.(10%) Case 1, Machine M with complier X

Instruction class	CPI	Instruction count
A	3	2500
B	4	1800
C	2	2300
D	6	900

Case 2, Machine M with complier Y

Instruction class	CPI	Instruction count
A	3	2200
B	4	2000
C	2	2300
D	6	1000

- (a) (5%) Which case has better effects?
- (b) (5%) How slow the clock rate should be to make the process has 0.4s difference?
- 6. (10%)** A designer wants to improve the overall performance of a given machine with respect to a target benchmark suite and is considering an enhancement X that applies to 35% of the original dynamically- executed instructions, and speeds each of them up by a factor of 2. The designer's manager has some concerns about the complexity and the cost effectiveness of X and suggests that the designer should consider an alternative enhancement Y. Enhancement Y, if applied only to some (yet unknown) fraction of the original dynamically-executed instructions, would make them only 60% faster. Determine what percentage of all dynamically-executed instructions should be optimized using enhancement Y in order to achieve the same overall speedup as obtained using enhancement X.
- 7. (10%)** For a calculator, which one of these two following changes will be more efficient?
- (a) Accelerate multiplication operation for 6 times, and this operation occupies 45% of the whole execution time.
- (b) Accelerate other operations for 4 times, and these operations occupy 55% of the whole execution time.
- (Assume the costs of these two changes are the same and they are mutually exclusive.)
- 8. (5%)** Throughput and Response Time: Do the following changes to a computer system **increase throughput, decrease response time, or both?**

- (a) Replacing the processor in a computer with a faster version
 - (b) Adding additional processors to a system that uses multiple processors for separate tasks—for example, searching the web
- 9. (10%) Please use the CPU benchmarks, such as AnTutu, NovaBench, CPU-Z, for evaluate the performance of your mobile phone or computer, and please provide the specification and performance you obtained, and give your findings.**