**Assignment 1**

50 points due September 16

Q1. **[5 points] {CPUtime}** Computer A has an overall CPI of 1.3 and can be run at a clock rate of 600MHz. Computer B has a CPI of 2.5 and can be run at a clock rate of 750 Mhz. We have a particular program we wish to run. When compiled for computer A, this program has exactly 100,000 instructions. How many instructions would the program need to have when compiled for Computer B, in order for the two computers to have exactly the same execution time for this program?

**65,000 instructions**

Q2. **[8 points]{CPU time}** The design team for a simple, single-issue processor is choosing between a pipelined or non-pipelined implementation. Here are some design parameters for the two possibilities:

|  |  |  |
| --- | --- | --- |
| Parameter | Pipelined Version | Non-Pipelined Version |
| Clock Rate | 500MHz | 350 MHz |
| CPI for ALU instructions | 1 | 1 |
| CPI for Control instructions | 2 | 1 |
| CPI for Memory instructions | 2.7 | 1 |

(a) For a program with 20% ALU instructions, 10% control instructions and 70% memory instructions, which design will be faster? Give a quantitative CPI average for each case.

Pipeline: 0.004585 seconds  
Non-Piplined: 0.002857 seconds  
Non-piplined is faster

(b) For a program with 80% ALU instructions, 10% control instructions and 10% memory instructions, which design will be faster? Give a quantitative CPI average for each case.

Pipeline: 0.002545 seconds

Non-Piplined: 0.002857 seconds

Pipelined is faster

**Q3)[12 points] (problem 1.5 of HSI book ,5th edition) {CPU time}**

Consider three different processors P1,P2 and P3 executing the same instruction set. P1 has 3GHz clock rate and a CPI of 1.5. P2 has a 2.5Ghz clock rate and a CPI of 1.0. P3 has a 4.0 GHz clock rate and a CPI of 2.2

1. Which processor has the highest performance expresses in instructions per second?

P1: 2e9

P2: 2.5e9

P3: 1.82e9 P2 is the fastest

1. If the processors each execute a program in 10s, find the no. of cycles and the number of instructions.

|  |  |  |
| --- | --- | --- |
|  | **Cycles** | **# of Instructions** |
| **P1** | 3e10 | 2e10 |
| **P2** | 2.5e10 | 2.5e10 |
| **P3** | 4e10 | 1.82e10 |

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

|  |  |
| --- | --- |
| P1 | 5.13Ghz |
| P2 | 4.27 Ghz |
| P3 | 6.84 Ghz |

**Q 4)[8 points] Sum of Execution Times for benchmark suites**

A 4-program benchmark suite has execution times as listed below for 3 different systems. Assume that System-A is the reference machine. How does the performance of system-C compare against that of system-B? Show this comparison for all three metrics (sum of execution times, sum of weighted execution times, and GM of execution times). Report the comparison in terms of performance improvement only for Systems B and C. (use formulae on pg 2 of formula sheet)

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Program** | **A** | **B** | **C** | **D** |
| Exec times on System-A (seconds) | 80 | 100 | 500 | 400 |
| Exec times on System-B (seconds) | 100 | 100 | 500 | 500 |
| Exec times on System-C (seconds) | 120 | 120 | 400 | 400 |

|  |  |  |
| --- | --- | --- |
|  | System B | System C |
| Sum of Execution Times | 1200 | 1040 |
| Weighted Times | 100/8 = 1.25 | 120/8 = 1.5 |
| Geometric Mean | 1200\*1.25 =1500 | 1040\*1.5 = 1560 |

((1200/1400)-1) \* 100 = 15.4% Faster

**Q5)[9 points] Problem 1.10 of HSI book on Chip fabrication (part d not included)**

Assume a 15cm diameter wafer has a cost of 12, contains 84 dies, and has 0.020 defects/cm2. Assume a 20 cm diameter wafer has a cost of 15, contains 100 dies, and has 0.031 defects/ cm2.

1. Find the yield for both wafers.

0.13 and 0.29

1. Find the cost per die for both wafers.

1.098 and 5.1725

1. If the number of dies per wafer is increased by 10%, and the defects per area unit increases by 15%, find the die area and yield.

2227.74

**Q6) [8 points]** **Performance Equation based on IPC/CPI**

My new laptop has a clock speed that is 20% lower than my old laptop. I run the same three binaries on both machines. Each binary runs for roughly the same number of cycles on each machine. The IPCs of the binaries are listed in the table below. What speedup does my new laptop provide? (use formulae on pg 2 of formula sheet)

|  |  |  |  |
| --- | --- | --- | --- |
|  | **Program A** | **B** | **C** |
| IPCs on old laptop | 0.5 | 0.8 | 1.2 |
| IPCs on new laptop | 1.0 | 0.7 | 2.0 |

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18% overall faster