CS2400-003 6pm-7:50pm Spring 2020
Christopher Welch

Homework 01 **Submit the answers in Moodle as a word document or pdf**

1. The eight great ideas in computer architecture are similar to ideas from other fields. Match the eight ideas from computer architecture, "Design for Moore's Law", "Make the Common Case Fast", "Use Abstraction to Simplify Design", "Performance via Parallelism", "Performance via Pipelining", "Performance via Prediction", "Hierarchy of Memories", and "Dependability via Redundancy" to the following ideas from other fields: **(8 points)**

a. Assembly lines in automobile manufacturing
-Performance via Pipelining

b. Suspension bridge cables
-Performance via Parallelism

c. Aircraft and marine navigation systems that incorporate wind information
-Performance via Prediction

d. Express elevators in buildings
-Make the Common Case Fast

e. Library reserve desk
-Hierarchy of Memories

f. Increasing the gate area on a CMOS transistor to decrease its switching time
-Dependability via Redundancy

g. Adding electromagnetic aircraft catapults (which are electrically powered as opposed to current steam-powered models), allowed by the increased power generation offered by the new reactor technology
-Design for Moore's Law

h. Building self-driving cars whose control systems partially rely on existing sensor systems already installed into the base vehicle, such as lane departure systems and smart cruise control systems
-Use Abstraction to Simplify Design

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2. Consider two different implementations of the same instruction set architecture. The instructions can be divided into four classes according to their CPI (class A, B, C, and D). P1 with a clock rate of 2.5 GHz and CPIs of 1, 2, 3, and 3, and P2 with a clock rate of 3 GHz and CPIs of 2, 2, 2, and 2.

Given a program with a dynamic instruction count of 1.0E6 instructions divided into classes as follows: 10% class A, 20% class B, 50% class C, and 20% class D, which is faster: P1 or P2? **(2 points)**

Class	A	B	C	D	Clock Rate
P1 CPI	1	2	3	3	2.5 GHz
P2 CPI	2	2	2	2	3 GHz
Instruction Count = 1×10^6	10%	20%	50%	20%	

$(0.1*10^6)(1) / (2.5 * 10^9) = 4 \times 10^{-5}$ s
$(0.2*10^6)(2) / (2.5 * 10^9) = 1.6 \times 10^{-4}$ s
$(0.5*10^6)(3) / (2.5 * 10^9) = 6 \times 10^{-4}$ s
$(0.2*10^6)(3) / (2.5 * 10^9) = 2.4 \times 10^{-4}$ s
P1: Total Time = 1.04×10^{-3} s
$(0.1*10^6)(2) / (3 * 10^9) = 6.67 \times 10^{-5}$ s
$(0.2*10^6)(2) / (3 * 10^9) = 1.33 \times 10^{-4}$ s
$(0.5*10^6)(2) / (3 * 10^9) = 3.33 \times 10^{-4}$ s
$(0.2*10^6)(2) / (3 * 10^9) = 1.33 \times 10^{-4}$ s
P2: Total Time = 6.657×10^{-4} s

P2 is the Fastest.

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a. What is the average CPI for each implementation? **(2 points)**
Global CPI = (CPU-Time x Clock Rate)/IC
P1 = $((1.04 \times 10^{-3}) \times (2.5 \times 10^9)) / 10^6 =$ **2.6 CPI Avg.**
P1 = $((6.66 \times 10^{-4}) \times (3 \times 10^9)) / 10^6 =$ **2.0 CPI Avg.**

b. Find the clock cycles required in both cases. **(2 points)**
Clock Cycles required = Avg. CPI * Instruction Count
P1 = $2.6 * (1 * 10^6) =$ **$2.6 * 10^6$**
P2 = $2.0 * (1 * 10^6) =$ **$2.0 * 10^6$**

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3. Consider a computer running a program that requires 250 s, with 70 s spent executing FP instructions, 85 s executed L/S instructions, and 40 s spent executing branch instructions.

3.1 By how much is the total time reduced if the time for FP operations is reduced by 20%? **(2 points)**

250 – (0.2 x 70 s) = 236
236 / 250 = 94.4%
100% - 94.4% = **5.6% Reduced**

3.2 By how much is the time for INT operations reduced if the total time is reduced by 20%? **(2 points)**

250 * 0.8 = 200 s
200 − 70 − 85 – 40 = 5 s Optimized Int Time
250 − 70 − 85 – 40 = 55 s Regular Int Time
5 / 55 = 9%
100% - 9% = **91% reduced**

3.3 Can the total time can be reduced by 20% by reducing only the time for branch instructions? **(2 points)**

55 + 70 + 85 = 210
210 / 255 = 0.82
100% - 82% = 18% Decrease
No, the total time cannot be reduced by 20% by reducing only the time for branch instructions.