**CPRE 381- Intro to Computer Organization & Implementation**

**HW1**

**Due Date: Sept 8, 2017**

1. Consider a processor running at 1GHz with the following CPI values:

ALU: 1.15; Memory: 1.25; Control: 1.35

Given a program with a loop with a loop body of 200 instructions iterated 1000 times, and the following instruction mix for the program (ALU- 33%; Memory- 35%; Control- 32%), what is the execution time of this program on this processor? **[10 points]**

Execution Time = (200 \* 1000) \* ( (1.15 \* .33) + (1.25 \* .35) + (1.35 \* .32)) \* 1 ns

= 200000 \* ( .3795 + .4375 + .432) \* 1Ghz

= 200000 \* (1.249)

= 249800

1. A programmer found a way to eliminate 20 instructions per loop iteration from the program in Problem 1. Given that 20 eliminated instructions contain 6 ALU instructions, 8 Memory instructions; and 6 Control instructions, what is the CPI of the optimized program? What is the execution time of the optimized program? **[10 points]**

Instructions originally

200 \* .33 = 66 ALU, 200 \* .35 = 70 Memory, 200 \*.32 = 64 Control

New Instructions

66 – 6 = 60 ALU , 70 – 8 = 62 Memory , 64 – 6 = 58 Control

New Fractions : 60/180 = .33 ALU, 62/180 = .34 Memory, 58/180 = .32 Control

CPI = (60/180 \* 1.15) + (62/180 \* 1.25) + (58/180 \* 1.35)

= .3833 + .4306 + .435

= 1.2489

Ex. Time = (180 \* 1000) \* 1.2489 \* 1ns

= 224802 New Execution time

1. The processor designer was able to make ALU 20% faster implying that the new CPI for ALU is 0.8\*old CPI for ALU. What is the execution time of the program in Problem 1 on this improved processor? **[10 points]**

.8 \* (1.15 (old CPI) ) = .92 New CPI

Ex Time = 200000 \* ( (.92 \* .33) + .4375 + .432) \* 1ns

= 200000 \* (.3036 + .4375 + .432)

= 200000 \* 1.1731

= 234620

1. The compiler found a magical way of transforming 20% of the control instructions into an equal number of memory instructions and ALU instructions equal to 25% of extra memory instructions. For every *N* control instructions eliminated (which is 20% of all control instructions), *N* memory instructions and 0.*25\*N* ALU instructions are introduced. What is the new execution time of the program in Problem 1 with this new transformation? **[10 points]**

From Q2, 64 Control \* .20 = 13

N = 13 (rounding up)

N \* .25 = 3 (rounding down)

ALU = 66 + 3 , Memory = 70 + 13, Control = 64 – 13

ALU new = 69, Memory new 83, Control new = 51

New fractions = 69/203 = .3399, 83/203 = .4089, 51/203 = .2512

203000 \* (.3399 \* 1.15 +.4089 \* 1.25 + .2512 \* 1.35) \* 1 ns

= 203000 \* (.3909 + .5111 + .3391) \* 1

= 203000 \* 1.24112

= 251947 execution time

1. Now let us consider an improved transformation. Compiler can convert a control instruction into corresponding 1.1 memory instructions (Some *N* control instructions get converted into *1.1\*N* memory instructions). What fraction of the execution time of Program on Machine in Problem 1 can be enhanced with this transformation? What is the speed-up of this transformation? What is the asymptotic speed-up due to this transformation according to Amdahl’s law? **[10 points]**

The control fraction can be improved.

64 / 64 – N = The speed up of the control

Lets consider N to be 64 or 100% of control instructions are eliminated.

New Execution Time = 200000 \* (1.15 \* .33) + (1.25 \* (70 + 1.1(64)/200) + (1.35 \* (64 - 64)/200)

= 200000\* (.3795 + 1.25(70 + 70.4)/200 + 1.35(0)

= 200000 \* (.3795 + 1.25((140.4)/200))

= 200000 \* (.3795 + .8775)

= 251,400 new

SU = Old/New = 249800/251400 = .994 (so a slow down)