Assignment 1

CMPT 215

Due: July 13^{th}, 2017

Total: 50 marks

Problem 1.

(8 marks) Define and write the equations for the following metrics in terms of instruction count (I), number of clock cycles (C) and clock cycle time (T).

i Frequency

ii CPI

iii MIPS

iv CPU execution time

Solution:

Frequency = $\frac{C}{T}$ or $\frac{1}{T}$

CPI = $\frac{C}{I}$

MIPS = $\frac{I}{T}$ or = $\frac{I}{T \times C}$

CPU$_{time}$ = $I \times T \times \frac{C}{I}$

Computer System Metrics			
Instruction type	CPI	Frequency	Clock cycle(ns)
A	1	20%	0.5
B	2	40%	0.5
C	3	30%	0.5
D	4	10%	0.5

Problem 2.
(6 marks) Calculate the following performance metrics using the given values in the table above and showing all **steps and units**.

i CPI

ii MIPS

iii CPU execution time for 500 instructions

Solution:

i CPI $= 1 \times 0.2 + 2 \times 0.4 + 3 \times 0.3 + 4 \times 0.1 = 2.3$

ii Clock Rate $= \frac{1}{0.5} = 2GHz$ MIPS $= \frac{\text{Clock Rate}}{\text{CPI} \times 10^6} = \frac{2 \times 10^9}{2.3 \times 10^6} = 870$

iii $CPU_{exec} = 500.3 \times 0.5ns = 575ns$

Problem 3.
(4 marks) Suppose it is possible to third (1/3) the number of type C instructions in the table above, what will be the new CPI value?

Solution:
New CPI $= \frac{1 \times 0.2 + 2 \times 0.4 + 3 \times 0.1 \times + 4 \times 0.1}{0.2 + 0.4 + 0.1 + 0.1} = 2.125$

Problem 4.
(4 marks) Describe and write the equation for *Ambdahls law*.

Solution:
Ambdahl's law the performance improvement with a given system improvement is limited by the amount that the improved features are used.
$exec_{new} = \frac{\text{portion affected}}{\text{improvement factor}} + \text{portion unaffected}$

Problem 5.
(10 marks) Convert the following integers into binary and hexadecimal.

i 27

ii 400

iii 88

iv 10

v 99

Solution:

i $27 = 11011,\ 1B$

ii $400 = 110010000,\ 190$

iii $88 = 01011000,\ 58$

iv $10 = 1010,\ A$

v $99 = 1100011,\ 63$

Problem 6.
(5 marks) Convert the following unsigned binary numbers to base 10.

i 1001

ii 101110

iii 111001

iv 01100011

v 01110010

Solution:

i $1001 = 9$

ii $101110 = 46$

iii $111001 = 57$

iv $01100011 = 99$

v $01110010 = 114$

Problem 7.
(3 marks) What is the difference between 1's complement and 2's complement? When are they used and what applications are they used in?

Solution:
1's complement is the **negation** of the **unsigned** binary number. To avoid having two zero values and use an extra binary as a value, 2's complement **adds** 1 to the negation of the unsigned binary number. 2's complement is used in every day computation from calculators to supercomputers; 1's complement is used in **checksums** for error checking in **network packets**.

Problem 8.
(10 marks) Convert the following to 8-bit 1's complement and 2'complement.

i 20

ii 0

iii -100

iv 127

v -127

Solution:

i $20 = 0001\ 0100$

ii $0 = 0000\ 0000$or $11111111,\ 0000\ 0000$

iii $-100 = 1001\ 1011,\ 1001\ 1100$

iv $127 = 0111\ 1111$

v $-127 = 1000\ 0000, 10000001$

Bonus:

Problem 9.
(3 marks) Name the top three fastest machines in the world and mention which benchmark was used to test their performance.

Solution:

1. Sunway Taihulight
2. Tianhe-2
3. Piz Daint

The benchmark used to test the performance of these machines was the LINPACK benchmark.