ICS 152, Problem Set 2

- Please show your work.
- Bottom line answers without proper explanation are worth **zero** points.

1. Each hour,
M1 can execute p2 80 times ((3600-(1600*2))/5
M2 can execute p2 120 times ((3600-(1600*1.5))/10)

a)
M2 is faster

b)
Since the performance is measured by the throughput for p2, M2 is more effective either if the cost of both machines is the same or the cost of M1 is $500 and the cost of M2 is $800.

C() = Cost per unit throughput of p2 = cost / throughput of p2
If M1 cost = M2 cost = 1 => C(M1) = 1/80, C(M2)=1/120
If M1 cost is $500, M2 cost is $800 => C(M1)=500/80, C(M2)=800/120

2. a)
For I1:
CPI(C1) = CPI(C3)=3
CPI(C2) = 3.4

Compiler 1 is faster on I1 by $((1.6/3x10^9)/(3/6x10^9)) = 1.0666$

b)
For I2:
CPI(C1)=CPI(C2)=1.6
CPI(C3)=1.5

Compiler 2 is faster on I2 by $((3.4/6x10^9)/(1.6/3x10^9)) = 1.0625$

c)
Either Compiler 1 or Compiler 3 (both have CPI=3)

d)
Compiler 3 for I2 (CPI=1.5)

e)
I1 and Compiler 1 or I1 and Compiler 3

3. Multiply instructions replaced = difference in cycles (P,P') / difference in CPI (P,P')
Since one multiply instruction is replaced by 2 add instructions

Multiply instructions replaced = $1x10^9 / 2 = 5x10^8$ instructions

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4. Benchmarks try to measure performance for specific applications. Since applications and architectures change with time, it may be possible that previous benchmarks do not correctly stress important parameters in the new architectures or applications.

5. The news release is misleading because it defines performance and performance boost based only on the clock rate.

6. a)
With co-processor:
20 million cycles per second, 10 cycles per instruction => 20/10 = 2 MIPS

Without co-processor:
20 million cycles per second, 6 cycles per instructions => 20/6 = 3.333 MIPS

b)
Suppose the run with the co-processor uses x instructions, whereas the run without the co-processor uses y instructions. By the performance equation:

$$1 = x * 10 * (1 / 20{,}000{,}000)$$
$$\Rightarrow x = 2{,}000{,}000 \text{ instructions}$$

and

$$10 = y * 6 * (1 / 20{,}000{,}000)$$
$$\Rightarrow y = 33{,}333{,}333 \text{ instructions}$$

c)
33,333,333 / 2,000,000 = 16.67

7.

$$Speedup = \frac{performance\ after\ improvement}{performance\ before\ improvement} = \frac{execution\ time\ before\ improvement}{execution\ time\ after\ improvement}$$

a)
speedup = 10 /(5/5+5) = 10/6 = 1.66666

b)
Let x be the execution time affected by the improvement

Speedup = 100 / ((x/5) + (100-x) = 3
x= 83.3333
Then floating point instructions have to account for 83.333% of the initial execution time. In this case 83.333 sec