Homework 4 solutions for performance problems

2.10

For M1 the peak performance will be achieved with a sequence on instructions of class A, which have a CPI of 1. The peak performance is thus 500 MIPS.
I.e. cycle time = 2 ns, how many instructions with CPI 1 in one sec? à 500 million

For M2, a mixture of A and B instructions, both of which have a CPI of 2, will achieve the peak performance, which is 375 MIPS.
I.e. cycle time= 4/3 ns, each instruction is 2 cycles i.e. 8/3 ns. In one second, do 3/8 billion instructions = 375 million

2.11

CPI for M1 = (1+2+3+4)/4 = 2.5
CPI for M2 = (2+4+2+4)/4 = 3
CPU time for M1 = IC*2.5*2 = 5 IC
CPU time for M2 = IC*3*4/3 = 4 IC

M2 has a smaller execution time and is thus faster by the inverse ratio of the execution time or 5/4 = 1.25.

2.12

M1 would be as fast if the clock rate were 1.25 higher, so 500*1.25 = 625 MHz

2.18

CPI for Mbase = 2.8.
CPI for Mopt = 2.45.

2.19

MIPS for Mbase = 500/2.8 = 179 MIPS
MIPS for Mopt = 600/2.45 = 245 MIPS

2.20

IC*CPI*Cycletime, IC stays the same! Cycletime is inverse of frequency, and we want the ratio of execution times: (IC*2.8/500) / (IC*2.45/600) = 1.37

Another way: since it's the same architecture, we can compare the native MIPS ratings. Mopt is faster by the ratio 245/179 = 1.37.

2.21

This program can be done in one of two ways. Either find the new mix and adjust the frequencies first or find the new (relative) instruction count and divide the CPI by that. We do the first one.

Ratio of number of Mcomp instructions to Mbase = 0.9*0.4+… = 0.89

Pick 1000 instructions

A: 400
B: 250
C: 250
D: 100

After compiler:

A: 400*.9 = 360
B: 250 * .9 = 225
C: 250 * .85 = 212.5
D: 100 * .95 = 95

Calculate the sum: 892.5

New frequencies:
A: 360/892.5 = 40.34
B: 25.2
C: 23.8
D: 10.6

CPI = 2* 0.4034 + 3*0.252 + … = 2.81

2.22

Speedup = IC_{base} *CPI_{base} *Cycle / (IC_{comp} * CPI_{comp}* Cycle) = IC_{base} *CPI_{base} / (IC_{comp} * CPI_{comp}) = 2.8 / (0.89 * 2.81) = 2.8/2.5 = **1.1**
This is because IC for base is larger than IC for comp, because comp has less instructions. How much less? 0.89 = weighted average of IC reductions.

2.41

new time 5+1 = 6
speedup = 10/6 = 5/3

2.42

100 – x + x/5 = 33
x = 5/4 * 66 = 83 sec!