Task

In an enhancement of a design of a CPU, the speed of a floating point unit has been increased by 20% and the speed of a fixed point unit has been increased by 10%. What is the overall speed up achieved if the ratio of the number of floating point operations to the number of fixed point operations is 2:3 and the floating point operation used to take twice the time taken by the fixed point operation in the original design?

a) 1.155
b) 1.185
c) 1.255
d) 1.285

Solution

Let the time taken by the fixed point operation in the original is t_{fix}, so time taken by the floating point operation $t_{fl} = 2t_{fix}$.

the ratio of the number of floating point operations to the number of fixed point operations is $N_{fl}: N_{fix} = 2: 3$. And $N = 2 + 3 = 5$.

New speed of a floating point unit is $v *_{fl} = 1.2v_{fl}$.

The same for fixed point unit is $v *_{fix} = 1.1v_{fix}$.

Overall speed in the original design:

$$v_{ov} = \frac{\frac{N_{fl}}{t_{fl}} + \frac{N_{fix}}{t_{fix}}}{N}$$

Overall speed after an enhancement of a design:

$$v *_{ov} = \frac{\frac{N_{fl}}{t_{fl}} \cdot 1.2 + \frac{N_{fix}}{t_{fix}} \cdot 1.1}{N}$$

So overall speed up is $\frac{v_{ov}}{v *_{ov}}$:

$$\frac{v^{*}_{ov}}{v_{ov}} = \frac{\frac{\frac{N_{fl}}{t_{fl}} \cdot 1.2 + \frac{N_{fix}}{t_{fix}} \cdot 1.1}{N}}{\frac{\frac{N_{fl}}{t_{fl}} + \frac{N_{fix}}{t_{fix}}}{N}} = \frac{\frac{N_{fl}}{t_{fl}} \cdot 1.2 + \frac{N_{fix}}{t_{fix}} \cdot 1.1}{\frac{N_{fl}}{t_{fl}} + \frac{N_{fix}}{t_{fix}}} = \frac{\frac{N_{fl}}{2t_{fix}} \cdot 1.2 + \frac{N_{fix}}{t_{fix}} \cdot 1.1}{\frac{N_{fl}}{2t_{fix}} + \frac{N_{fix}}{t_{fix}}}$$

$$= \frac{\frac{2}{2t_{fix}} \cdot 1.2 + \frac{3}{t_{fix}} \cdot 1.1}{\frac{2}{2t_{fix}} + \frac{3}{t_{fix}}} = \frac{1.2 + 3.3}{1 + 3} = \frac{4.5}{4} = 1.125$$

Answer: 1.125