2. Consider three different processors P1, P2, and P3 executing the same instruction set. P1 has a 3GHz clock rate and a CPI of 1.5. P2 has a 2.5GHz clock rate and a CPI of 1.0. P3 has a 4.0GHz clock rate and has a CPI of 2.2.

(a) [6 points] Which processor has the highest performance expressed in instructions per second? = IPS

CPU_{time} = instruction count × CPI · clock rate / clock rate

clock rate · CPU_{time} = instruction count × CPI / CPI

clock rate · CPU_{time} / CPI = IC

clock rate / CPI · CPU_{time} / 1 = IC

instructions / CPU time = clock rate / CPI

P_2 has the highest performance in instructions per second.

1 GHz = 10^9 Hz

$IPS_1 = \frac{3\text{ GHz}}{1.5} = 2 \times 10^9$

$IPS_2 = \frac{2.5\text{ GHz}}{1} = 2.5 \times 10^9$

$IPS_3 = 4\text{ GHz} / 2.2 = 1.82 \times 10^9$

(b) [6 points] If the processors each execute a program in 10 seconds, find the number of cycles and the number of instructions.

CPU time = 10s, 1 GHz = 10^9 Hz

From Problem A = Know that instructions = IPS × CPU time,

clock cycles = CPU time × clock rate

slides →

Processor 1: instructions$_1$ = $2 \times 10^9 \times 10 = 2 \times 10^{10}$

clock cycles$_1$ = $10 \times 3\text{ GHz} = 10 \times 3 \times 10^9 = 3 \times 10^{10}$

Processor 2: instructions$_2$ = $2.5 \times 10^9 \times 10 = 2.5 \times 10^{10}$

clock cycles$_2$ = $10 \times 2.5\text{ GHz} = 10 \times 2.5 \times 10^9 = 2.5 \times 10^{10}$

Processor 3: instructions$_3$ = $1.82 \times 10^9 \times 10 = 1.82 \times 10^{10}$

clock cycles$_3$ = $10 \times 4\text{ GHz} = 10 \times 4 \times 10^9 = 4 \times 10^{10}$