Prob 1.6:

Solution:

a, We have:

- P1: Clock rate = 3 GHz, CPI = 1.5
- P2: Clock rate = 2.5 GHz, CPI = 1.0
- P3: Clock rate = 4 GHz, CPI = 2.2

IPS = Clock rate / CPI

IPS_{P1} = 3 Ghz / 1.5 = 2 * 10^9 instruction per sec.

IPS_{P2} = 2.5 Ghz / 1.0 = 2.5 * 10^9 instruction per sec.

IPS_{P3} = 4 Ghz / 2.2 = approximately 1.82 * 10^9 instruction per sec.

⇨ P2 has the highest performance at 2.5 * 10^9 instruction per sec.

b, We have:

Total Cycle = Clock Rate * Execution Time

Given Execution Time = 10 sec.

Total $Cycle_{P1}$ = 3 Ghz * 10 sec = 30 * 10^9 cycles.

Total $Cycle_{P2}$ = 2.5 Ghz * 10 sec = 25 * 10^9 cycles.

Total $Cycle_{P3}$ = 4.5 Ghz * 10 sec = 45 * 10^9 cycles.

Instructions = Total Cycle / CPI

$Instructions_{P1}$ = 30 * 10^9 cycles / 1.5 = 20 * 10^9 instructions.

$Instructions_{P2}$ = 25 * 10^9 cycles / 1.0 = 25 * 10^9 instructions.

$Instructions_{P43}$ = 45 * 10^9 cycles / 2.2 = approximately 18.2 * 10^9 instructions.

c, Because we reduce the execution time by 30% so the new execution time is:

$T_{New} = T_{old} * (1 – 0.3) = 7$ sec.

The original CPI increases by 20%, so the new CPI will be:

$CPI_{New} = CPI_{old} * 1.2$.

Suppose we apply to P1:

$CPI_{P1\ New} = 1.5 * 1.2 = 1.8$

We have the formula:

$T_{New} = (CPI_{New} * Instructions) / Clock\ Rate_{New}$

- ⇨ $Clock\ Rate_{new} = (CPI_{New} * Instructions) / T_{New} = (1.8 * 20 * 10^9) / 7$ = approximately 5.14 Ghz

Prob 1.7:

We have:

- **P1**: Clock rate = 2.5 GHz
  - CPI (Class A) = 1
  - CPI (Class B) = 2
  - CPI (Class C) = 3
  - CPI (Class D) = 3
- **P2**: Clock rate = 3 GHz
  - CPI (Class A) = 2
  - CPI (Class B) = 2
  - CPI (Class C) = 2
  - CPI (Class D) = 2

The instruction mix for the program is:

- 10% of instructions from Class A
- 20% from Class B
- 50% from Class C
- 20% from Class D

Total instruction count = $1.0 * 10^6$ instructions.

a, We have the formula for global CPI is:

$CPI_{Global} = \sum(\text{Fraction of Instructions}) * (\text{CPI for that class})$

- ⇨ $CPI_{Global\ P1}$ = (0.1 * 1) + (0.2 * 2) + (0.5 * 3) + (0.2 * 3) = 2.6
- ⇨ $CPI_{Global\ P2}$ = (0.1 * 2) + (0.2 * 2) + (0.5 * 2) + (0.2 * 2) = 2.0

b, We have the formula:

Total Cycles = CPI_{Global} * Instruction Count

- ⇨ Total $Cycles_{P1}$ = 2.6 * 1.0 * 10^6 = 2.6 * 10^6 cycles.
- ⇨ Total $Cycles_{P2}$ = 2.0 * 1.0 * 10^6 = 2.0 * 10^6 cycles.

To compare between P1 and P2 which one has the better performance, we have the formula:

Execution Time = Total Cycles / Clock Rate

- ⇨ Execution $Time_{P1}$ = (2.6 * 10^6) / (2.5 * 10^9) = 1.04 ms.
- ⇨ Execution $Time_{P2}$ = (2.0 * 10^6) / (3 * 10^9) = 0.6667 ms.

Conclusion, P2 is faster than P1 with 0.6667 ms to 1.04 ms.