Homework#1 Solutions

1.2

A. Performance via pipelining
B. Dependability via redundancy
C. Performance via prediction
D. Make the common case fast
E. Hierarchy of memory
F. Performance via parallelism
G. Use abstraction to simplify design

1.7

Instruction Class	P1	P2
A	1	2
B	2	2
C	3	2
D	3	2

We first calculate the instruction count for each class :

$IC(ClassA) = 10\% \times 1.0 \times 10^6 = 1.0 \times 10^5$

$IC(ClassB) = 20\% \times 1.0 \times 10^6 = 2.0 \times 10^5$

$IC(ClassC) = 50\% \times 1.0 \times 10^6 = 5.0 \times 10^5$

$IC(ClassD) = 20\% \times 1.0 \times 10^6 = 2.0 \times 10^5$

To calculate the time for each implementation, we need to multiply the instruction count with CPI and CT.

$ET = IC \times CPI \times CT$

$$CT(P1) = \frac{1}{frequency} = \frac{1}{2.5GHz} = \frac{1}{2.5 \times 10^9} = 4 \times 10^{-10}s$$

$$CT(P2) = \frac{1}{frequency} = \frac{1}{3GHz} = \frac{1}{3 \times 10^9} = 3.3333 \times 10^{-10}s$$

$$ET(P1) = (1.0 \times 10^5 \times 1 + 2.0 \times 10^5 \times 2 + 5.0 \times 10^5 \times 3 + 2.0 \times 10^5 \times 3) \times 4 \times 10^{-10} = 1.04 \times 10^{-3} s$$

$$ET(P2) = (1.0 \times 10^5 \times 2 + 2.0 \times 10^5 \times 2 + 5.0 \times 10^5 \times 2 + 2.0 \times 10^5 \times 2) \times 3.3333 \times 10^{-10} = 6.67 \times 10^{-4} s$$

$$CPI(P1) = \frac{total\ \ cycles}{total\ \ IC} = \frac{ET(P1) \times frequency}{IC(P1)}$$

$$CPI(P2) = \frac{total\ \ cycles}{total\ \ IC} = \frac{ET(P2) \times frequency}{IC(P2)}$$

$$CPI(P1) = \frac{1.04 \times 10^{-3} \times 2.5 \times 10^9}{10^6} = 2.6$$

$$CPI(P2) = \frac{6.67 \times 10^{-4} \times 3.0 \times 10^9}{10^6} = 2.0$$

$$Clock\ \ cycles(P1) = CPI \times IC = 2.6 \times 10^6$$

$$Clock\ \ cycles(P2) = CPI \times IC = 2.0 \times 10^6$$

1.8

A.

$$ET = IC \times CPI \times CT$$

$$CPI = \frac{ET}{CT \times IC}$$

$$CPI(compilerA) = \frac{1.1}{1 \times 10^{-9} \times 1.0 \times 10^9} = 1.1$$

$$CPI(compilerB) = \frac{1.5}{1 \times 10^{-9} \times 1.2 \times 10^9} = 1.25$$

B.

Let’s assume the CT(A)

$$\frac{ET(B)}{ET(A)} = \frac{IC(B) \times CPI(B) \times CT(B)}{IC(A) \times CPI(A) \times CT(A)}$$

$$\frac{ET(B)}{ET(A)} = \frac{1.2 \times 10^9 \times 1.25 \times CT(B)}{1.0 \times 10^9 \times 1.1 \times CT(A)} = 1.36\frac{CT(B)}{CT(A)}$$

Also, we know that ET(B) is equal to ET(A), so we have

$$1.36\frac{CT(B)}{CT(A)} = 1$$

Simplifying this gives us:

$$\frac{CT(B)}{CT(A)} = \frac{1}{1.36}$$

This implies :

$$\frac{frequency(B)}{frequency(A)} = 1.36$$

C.

$$\frac{ET(A)}{ET(new)} = \frac{1.1}{1.1 \times 6 \times 10^{8} \times 10^{-9}} = 1.67$$

$$\frac{ET(B)}{ET(new)} = \frac{1.5}{1.1 \times 6 \times 10^{8} \times 10^{-9}} = 2.27$$