Cairo University **Faculty of Engineering – Credit hour system**
Computer Engineering Department **CMP N 301 – Computer Architecture**

Sheet (1)

1) [1.5] Consider three different processors P1, P2, and P3 executing the same instruction set. P1 has a 3 GHz clock rate and a CPI of 1.5. P2 has a 2.5 GHz clock rate and a CPI of 1.0. P3 has a 4.0 GHz clock rate and has a CPI of 2.2.

a. Which processor has the highest performance expressed in instructions per second?
b. If the processors each execute a program in 10 seconds, fi nd the number of cycles and the number of instructions.
c. We are trying to reduce the execution time by 30% but this leads to an increase of 20% in the CPI. What clock rate should we have to get this time reduction?

2) [1.6] Consider two different implementations of the same instruction set architecture. The instructions can be divided into four classes according to their CPI (class A, B, C, and D). P1 with a clock rate of 2.5 GHz and CPIs of 1, 2, 3, and 3, and P2 with a clock rate of 3 GHz and CPIs of 2, 2, 2, and 2.

Given a program with a dynamic instruction count of 1.0E6 instructions divided into classes as follows: 10% class A, 20% class B, 50% class C, and 20% class D,
which implementation is faster?

a. What is the global CPI for each implementation?
b. Find the clock cycles required in both cases.

3) [1.7] Compilers can have a profound impact on the performance of an application. Assume that for a program, compiler A results in a dynamic instruction count of 1.0E9 and has an execution time of 1.1 s, while compiler B results in a dynamic instruction count of 1.2E9 and an execution time of 1.5 s.

a. Find the average CPI for each program given that the processor has a clock cycle time of 1 ns.
b. Assume the compiled programs run on two diff erent processors. If the execution times on the two processors are the same, how much faster is the clock of the processor running compiler A's code versus the clock of the processor running compiler B's code?
c. A new compiler is developed that uses only 6.0E8 instructions and has an average CPI of 1.1. What is the speedup of using this new compiler versus using compiler A or B on the original processor?

4) [1.13] Another pitfall cited in Section 1.10 is expecting to improve the overall performance of a computer by improving only one aspect of the computer. Consider a computer running a program that requires 250 s, with 70 s spent executing FP instructions, 85 s executed L/S instructions, and 40 s spent executing branch instructions.

a. By how much is the total time reduced if the time for FP operations is reduced by 20%?
b. By how much is the time for INT operations reduced if the total time is reduced by 20%?
c. Can the total time can be reduced by 20% by reducing only the time for branch instructions?

5) [1.14] Assume a program requires the execution of 50 × 106 FP instructions,110 × 106 INT instructions, 80 × 106 L/S instructions, and 16 × 106 branch instructions. Th e CPI for each type of instruction is 1, 1, 4, and 2, respectively.
Assume that the processor has a 2 GHz clock rate.

a. By how much must we improve the CPI of FP instructions if we want the program to run two times faster?
b. By how much must we improve the CPI of L/S instructions if we want the program to run two times faster?
c. By how much is the execution time of the program improved if the CPI of INT and FP instructions is reduced by 40% and the CPI of L/S and Branch is reduced by 30%?