

















# CS 2200 Fall 2006 Test 1

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8. (10 points, 10 min)

A given program takes 1000 instructions to execute with an average CPI of 3 and a clock cycle time of 2 ns. An architect is considering two options.

(a) She can reduce the average CPI of instructions by 25% while increasing the clock cycle time by 10%; or (b) She can reduce the clock cycle time by 20% while increasing the average CPI of instructions by 15%.

(a) You are the manager deciding which option to pursue. Give the reasoning behind your decision.

Let  $E_0$ ,  $E_1$ ,  $E_2$ , denote the execution times with base machine, first option and second option respectively.

$$E_0 = 1000 * 3 * 2 \text{ ns}$$

$$E_1 = 1000 * (3 * 0.75) * 2 \text{ (1.1) ns} = 0.825 E_0$$

$$E_2 = 1000 * (3 * 1.15) * 2 \text{ (0.8) ns} = 0.920 E_0$$

Option 1 is better since it results in lesser execution time than 2.

(b) What is the improvement in execution time of the option you chose compared to the original design?

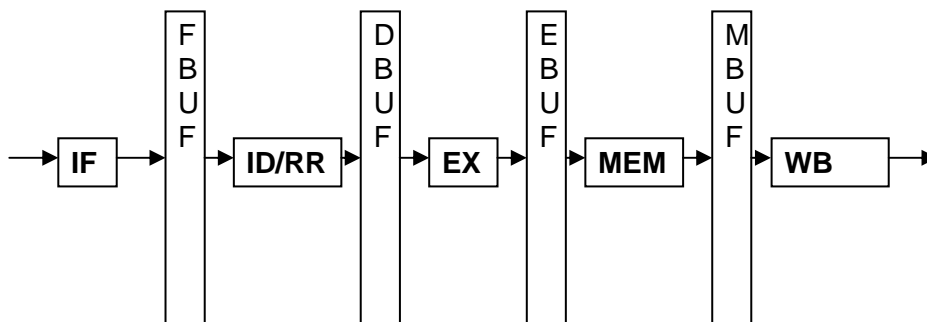
$$\begin{aligned} \text{Improvement of option 1 relative to base} &= \frac{E_0 - E_1}{E_0} \\ &= \frac{E_0 - 0.825 E_0}{E_0} \\ &= 0.175 \end{aligned}$$

17.5 % improvement

## Pipelining

9. (15 points, 10 mins)

For the LC-2200 instruction set we are considering a pipelined processor design using a 5-stage pipeline as shown below



Assume the instruction going through the pipeline is

ADD Rx, Ry, Rz;    Rx <- Ry + Rz

