

CDA 3101 – Summer-C 2007 – Quiz #5 – 20 pts -- KEY --
Please put your NAME, UF-ID[5:8], and CDA3101-Q5 at the top of your paper.

Assume we have a pipelined processor with $N = 5$ segments, running a program P with $M = 1,289$ instructions, where an exception is thrown at Segment #3 on Instructions #284, #397, and #568. Let $F = 0$ cycle be required to flush the pipeline, and let $H = 2$ cycle be required to handle each exception.

Further assume that 20 percent of instructions that do not throw exceptions are branches, and that 10 percent of branch predictions are erroneous. Also, let us predict branches as *branch not taken*, with a branch delay slot that has a probability of 50 percent of being filled with an independent instruction.

1) Calculate the average pipeline CPI without exceptions (10 pts)

$$\begin{aligned}
 N_{\text{CYC}} &= M + \text{fill-cost} + \text{total-branch-penalty} \\
 &= M + N - 1 + f_{\text{BR}} \cdot f_{\text{BE}} \cdot (1 - f_{\text{BDS}}) \cdot \text{branch-cost} \\
 &= 1,289 \text{ cycles} + 4 \text{ cycles} + 1,289 \cdot (0.2 \cdot 0.1 \cdot 0.5 \cdot 1 \text{ cycle}) \\
 &= 1,305.89 \text{ cycles} \sim 1,306 \text{ cycles}
 \end{aligned}$$

$$\text{CPI}_{\text{AVE}} = N_{\text{CYC}} / M = 1,306 / 1,289 = \boxed{1.013}$$

2) Calculate the average pipeline CPI with exceptions and branches (10 pts)

$$\begin{aligned}
 N_{\text{CYC}} &= M + \text{fill-cost} + \text{total-branch-penalty} + \text{total-exception-penalty} \\
 &\text{where } M, \text{ fill-cost, and total-branch-penalty are as in 1), above.}
 \end{aligned}$$

$$\begin{aligned}
 \text{Total-exception-penalty} &= N_{\text{ex}} \cdot (F + H + L) \text{ where } L \text{ is faulting segment} \\
 &= 3 \cdot (0 + 2 + 3) = 15 \text{ cycles}
 \end{aligned}$$

To previous $N_{\text{CYC}} = 1,306$ cycles, we add 15 cycles, to get $N_{\text{CYC}} = 1,321$ cycles.

$$\begin{aligned}
 \text{The new average CPI will be given by } \text{CPI}_{\text{AVE}} &= 1,321 \text{ cycles} / 1,289 \text{ instr} \\
 &= \boxed{1.025}
 \end{aligned}$$