Section 9: Complex Pipelining

CS 152
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Problem 1: Iron Law
When we introduced the Iron Law earlier in the course, we used CPI (cycles per instruction). Rewrite it using IPC (instructions per cycle). What does this shift indicate? Is there an advantage to using CPI?

Problem 2: Resource Scaling
Given a simple single issue in-order pipeline, you decide to add a second pipeline and make it dual issue (and fetch). By how much does just the hazard detection and forwarding logic increase?

Problem 3: Branch Predictor Necessity
In this problem we will continually modify and improve a processor, and see how important branch prediction is. Assume that branches occur once every 10 cycles. For all of these questions, respond with the CPI component for the branch penalty if there is no branch prediction, if it is 50% accurate, and if it is 90% accurate. You may assume that are no non-branch hazards.

a) Simple in-order single issue pipeline with a branch delay slot of 3 cycles

b) We decrease the clock rate by making the pipeline deeper so now the branch delay slot is 5 cycles

c) We make our system dual issue (& fetch)

d) We deepen our pipeline again so now our branch penalty is 12 cycles

e) We we widen our CPU so now it is quad issue (& fetch)