

## CS 161 – Design and Architecture of Computer Systems Spring 2019 – Quiz 2

NAME (First, Last) \_\_\_\_\_

1. Consider a 5-stage MIPS pipeline with the following assumptions:

- 10000 instruction program with the following instruction breakdown:
  - R-type: 50% (Add)
  - LW: 20%
  - SW: 10%
  - BEQ: 20%
- Assume full-forwarding support with all forwarding paths available.
- Branches are resolved in the memory stage (are executed in the execute stage).
- Predict “always not-taken” for branches. Assume we flush on a misprediction.
- 40% of branches are actually taken.
- 20% of R-type instructions are followed immediately by a dependent instruction.
- 15% of loads are followed immediately by a dependent instruction.

a. Calculate the CPI.

CPI = ideal CPI (1) + stalls for data dependences ( $0.2 * 0.15 * 1$ ) + stalls for control dependences ( $0.2 * 0.4 * 2$ ) = 1.19

Notes:

1- You don't need to know the number of instructions in order to calculate the CPI. 2- We don't have stall for the dependent instructions that come after R-type instructions (because we assumed full-forwarding support).

b. Suppose we enhance the processor with a dynamic branch predictor with 80% accuracy. What is the new CPI?

CPI = ideal CPI (1) + stalls for data dependences ( $0.2 * 0.15 * 1$ ) + stalls for control dependences ( $0.2 * 0.2 * 2$ ) = 1.11