

ES215: Semester II [2021-2022]
Assignment 4

Due Date: 19-04-2022 (11:59 pm)

100 points

Note: Make appropriate assumptions when required. But, state all the assumptions made and ensure that they do not contradict what has been given in the problem statement. Please type up the solutions and submit them in PDF format. The source files/github link have to be submitted. Please upload all the assignments in Google Classroom. Late assignments will not be graded. Please follow the honor code. Any violations will have severe repercussions.

1. Suppose we have a 5 stage pipeline with each stage taking one cycle. Find the speed up if we have: (**Total: 25 points**)

- a. 30% RAW dependency and 20% branch dependency.
- b. 40% branch dependency.

Also find the speed up if we used a branch predictor with 80% accuracy.

2. Assume that 20% of the instructions executed on a computer are branch instructions. We use delayed branching with one delay slot. Estimate the CPI, if the compiler is able to fill 85% of the delay slots. Assume that the base CPI is 1.5. In the base case, we do not use any delay slot. Instead we stall the pipeline for the total number of delay slots. (**Total: 25 points**)

3. You have implemented a simple Matrix Multiplication program for a given NxN matrix in Assignment#1 using three loops. You might have noticed that the result is independent of how you position the three loops. Hence, we can interchange the positions of loops that can produce different programs to execute matrix multiplication. But what about performance? Does it remain the same or change? What is the impact? And what option(s) provide the best result and why?

Implement Matrix Multiplication program for a given NxN matrix (integer data type) in any of your preferred Languages from the Bucket 1, where N is iterated through the set of values 128, 256, and 512. N can either be hardcoded or specified as input. (**Total: 50 points**)

Bucket1: C, C++, Go (compulsory)

Bucket2: Python, Java. (optional)

For each program out of the total possible 6 combinations:

- a. Compute the execution time for the meat portion of the program for all the possible combinations of loop interchange.
- b. Plot the execution times for each of the iterations. And compare the performance (Program execution times) of the program for a given value of N. –Illustrate your observations.

Grace question: (Total: 1 Grace point)

4. Repeat the above question, using any one of the languages from Bucket 2. Infer and reason if any observations differ?