19.02.2020

Istanbul Technical University
Department of Computer Engineering

BLG 322E – Computer Architecture
Assignment 1

Due Date: 04.03.2020, **Wednesday,** 23:59.

QUESTION:

You will design a pipeline that will execute the operation $3A_i^3$-B_i , where A and B are arrays that consist of 8-bit signed integers represented in two's complement. (For simplicity, assume that all operation results can fit in 32 bits). You are allowed to use only the components that are given below with their timing attributes. You may access 2 different memory addresses simultaneously. You may use more than one of each unit if necessary.

- Memory, access time: 50 ns
- NOT gate, propagation delay: 10 ns
- Adder, propagation delay: 20 ns
- Shifter (combinatorial), propagation delay: 15 ns
- Multiplication circuit propagation delay: 30 ns
- Register, delay: 5 ns

1) Design and draw the optimum pipeline structure in terms of primarily speedup and secondarily implementation cost. Also, take the waiting time for the first result into consideration. (Hint: Independent operations within the same segment can be performed in parallel.)

2) For the given propagation delay and access time information, calculate the speedup for arrays that contain

i) 5 elements,

ii) an infinite number of elements.

Estimate the completion time without pipelining as the total latency of the combinatorial logic circuits on the longest path (without registers).

3) What is the theoretical maximum speed up of your pipeline?

Submission: Use a single sheet of A4 paper to present your solution. Draw the circuit using a computer program or a ruler. Show the connections and I/O symbols of the devices clearly. If your solution is longer than a page, it means you are on the wrong track. You should type your name and student ID at the top of the paper. You must submit your homework through the Ninova system before the due date.

Late submissions are not accepted.

Assignments have to be done individually. If any plagiarism is detected, disciplinary regulations of the University will be applied.

Note: If you have a problem about the homework, you may contact the research assistant of the course (kadir.ozlem@itu.edu.tr).