QUIZ 1 - QUIZ 1

Computer Architecture (New York University)

ECE 6913, Computing Systems Architecture

Spring 2021 NYU ECE

Please fill in your name: _____

Quiz 1, March 5th 2021

Maximum time: 140 minutes : 11 **AM - 1:20 PM** [+ 10 minutes to assemble PDF and upload]

Open Book, Open Notes,

Calculators allowed.

Must show your work in steps – to get any credit

This is NOT a group project You may NOT discuss, share your Quiz solutions with anyone else.

You must stay logged in to Zoom throughout the Quiz, with Camera on

Instructor available online if you have questions on the Quiz, during the Quiz – enter question in Zoom chat box at any time during Quiz

This Test has 6 problems. Please attempt all of them. Please show **all work**. Please write **legibly**

1. Please be sure to have 5-10 sheets of white or ruled paper & a Pencil, Eraser
2. Write down your solutions on 8.5 x 11 sheets of white paper, single sided with your name printed in top right corner of each sheet and with **Page Number and Problem number identified clearly on each sheet**
3. **Stop working on your Quiz at 1:20 PM** – you have 10 minutes to scan/take pictures of each sheet and upload them as completed PDF assignment to NYU Classes – you may use any of several smartphone apps to integrate your scans/pictures of sheets into a PDF file
4. Take pictures of each sheet and **upload** the PDF of all sheets after checking you have all sheets in the right order **by 1:30 PM latest.**
5. You may use iPAD to write down your solutions directly rather than on paper
6. Portal **will close at 1:30 PM** not allowing upload of your quiz after this time

Problem 1.

In this exercise, assume that we are considering enhancing a machine by adding vector hardware to it. When a computation is run in vector mode on the vector hardware, it is `12 times faster than the normal mode of execution`. We call the percentage of time that could be spent using vector mode the *percentage of vectorization.* Vectors are discussed in Chapter 4, but you don't need to know anything about how they work to answer this question!

a. *Approximately plot the speedup as a percentage of the computation performed in vector mode by identifying a few data points on the plot. Label the y-axis "Net speedup" and label the x-axis "Percent vectorization."*
b. *What percentage of vectorization is needed to achieve a speedup of 1.5?*
c. *What percentage of the computation run time is spent in vector mode if a speedup of 1.5 is achieved?*
d. *What percentage of vectorization is needed to achieve one-third the maximum speedup attainable from using vector mode?*

Problem 2.

a. *Find a short sequence of RISC-V instructions that extracts* `bits 23` *down to* `8` *from register* `x7` *and uses the bitwise inverted value of this field to replace* `bits 29` *down to* `14` *in register* `x8` *without changing any of the bits of registers* `x7` *or any of the other bits in* `x8`

b.

Problem 3.

This problem explores energy efficiency and its relationship with performance. The parts of this problem assume the following energy consumption for activity in Instruction memory, Registers, and Data memory. You can assume that the other components of the datapath consume a negligible amount of energy. ("Register Read" and "Register Write" refer to the register file only.)

I-Mem	1 Register Read	Register Write	D-Mem Read	D-Mem Write
140pJ	70pJ	60pJ	140pJ	120pJ

Assume that components in the datapath have the following latencies. You can assume that the other components of the datapath have negligible latencies.

I-Mem	Control	Register Read or Write	ALU	D-Mem Read or Write
200 ps	150 ps	90 ps	90 ps	250 ps

a. *How much energy is spent to execute a* ***sub*** *instruction in a single-cycle design and in the five-stage pipelined design*

b. *How much energy is spent to execute a* ***sw*** *instruction in a single-cycle design*

c. *How much energy is spent to execute a* ***beq*** *instruction in a single-cycle design*

Problem 4.

a. *Write a sequence of 2* `RISC V` *instructions that would accomplish loading register* `x10` *with the* `32b` *constant* `0x0BADFEED`

b. Provide the instruction type and assembly language instruction for the following binary value:

$00000000000100001000000010110011_2$

Problem 5.

You have a system that contains a special processor for doing floating-point operations. You have determined that 50% of your computations can use the floating-point processor. The speedup of the floating-point processor is 15.

a. What is the overall speedup achieved using he floating point processor

b. What is the overall speedup achieved when 75% of the computations use the floating-point processor?

c. What fraction of the computations should be able to use the floating-point processor in order to achieve an overall speedup of 2.25?