CSE 141 – HOMEWORK 1 (10 PTS): DARK SILICON AND THE TRENDS IN IT INDUSTRY

1. **(1 pt)** Define Moore's Law.

   Moore's law is the expectation for computer power, or more specifically the number of transistors to double around every two years. It is now slowing down because while space is not a problem, and the number of transistors are able to double, we are now having trouble being able to power them without melting the chip.

2. **(1 pt)** Based on Bob Dennard's theory of scaling, what is a transistor?

   A 2D Voltage-Controlled Switch. He stated that as transistors get smaller, their power density remains constant.

3. **(2 pts)** Who originally defined the general-purpose processors' architecture? Please provide an overview of his architecture and make sure to include all the main components. Based on this architecture, how do the program instructions execute?

   Von Neumann. It consists of components that include memory, CPU, and I/O. The memory stores programs and data, and the instructions execute sequentially on the CPU.

4. **(1 pt)** What made computing pervasive?

   Programmability, the ability for wide applications for everyone, and networking.

5. **(2 pts)** If you can parallelize 60% of a program and run it on hexacore microprocessor, how much overall speedup will you achieve compared to purely serial execution?

   Cores = 6

   F = 0.9

   Time baseline = x

   Time multicore = (x * 0.6 / 6) + (0.4 * x) = 0.1x + 0.4x = 0.5x

   Speedup = Time baseline / Time multicore = x / 0.5x = 1 / 0.5 = 2

   2, or twice as fast

6. **(1 pt)** List at least seven possible paths forward after the multicores fail to deliver the traditional performance improvements to which the IT industry has grown accustomed.

1. ***Do nothing***
2. ***Technology Breakthrough***
3. ***Software Bloat Reduction***
4. ***Specialization and Co-design***
5. ***Approximate Computing***
6. ***Biological Computing***
7. ***Quantum Computing***

7. **(2 pts)** Imagine you have developed a specialized hardware that can accelerate 55% of your application with a factor of 1001×, how much overall speedup will you get?

   (.55x * 1001) + (.45x) = 551x speedup

8. **(Bonus 1 pt).** Define approximate computing and what are the four classes of approximate applications?

Approximate computing is giving up perfect computation, for near-perfect accuracy to run faster and more efficiently.

The four classes are:

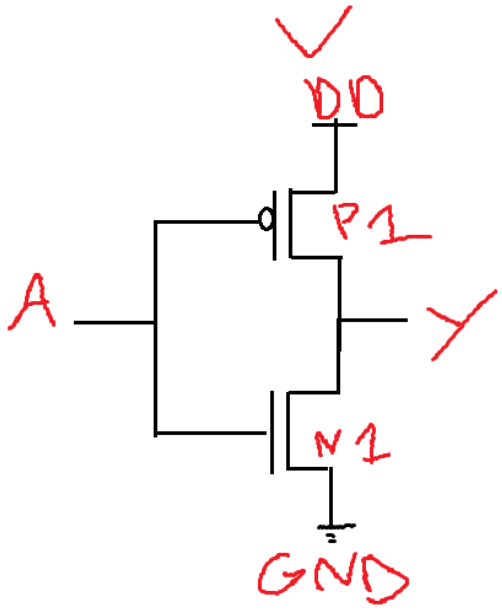
1. ***Programs with analog inputs i.e. sensors***
2. ***Programs with analog outputs***
3. ***Programs with multiple possible answers***
4. ***Convergent programs, i.e. Gradient descent, big data analytics***

9. **(Bonus 0.5 pt).** What is an FPGA?

A field programmable gate array, a processing circuit that is efficient but not as efficient as an ASIC, and not that programmable.

10. **(Bonus 2 pts).** Draw the transistor-level diagram of a NOT and a NAND gate in CMOS technology.

NOT



NAND