Release Date: 04/13/2020 Due Date: 04/24/2020 – 6:30pm

CSE 141 – Homework 1 (10 pts): Dark Silicon and the Trends in IT Industry

# **(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.**

# **(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.**

# **(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.**

# **(1 pt)** What made computing pervasive?

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

# **(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**

# **(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.

#### **Do nothing**

#### **Technology Breakthrough**

#### **Software Bloat Reduction**

#### **Specialization and Co-design**

#### **Approximate Computing**

#### **Biological Computing**

#### **Quantum Computing**

# **(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

# **(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:**

#### **Programs with analog inputs i.e. sensors**

#### **Programs with analog outputs**

#### **Programs with multiple possible answers**

#### **Convergent programs, i.e. Gradient descent, big data analytics**

# **(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.**

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

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