**Homework 1**

**1.1) A 2.5 GHz clock frequency corresponds to what clock cycle time (in picoseconds)?**

 400 ps

**1.2) What are the two main architectural components of a CPU?**

**Datapath** – brawn – performs operations (arithmetic) on data

**Control** – brain – sequences datapath, memory, and I/O, according to instructions

**1.3) If 25% of the instructions take 1 cycle to execute, 35% take 2 cycles, 30% take 3 cycles, and 10% take 4 cycles, what is the average CPI?**

CPI = (1\*25 + 2\*35 + 3\*30 + 4\*10)/100 = **2.25**

**1.4) If 90% of a program’s execution time can be accelerated by a factor of 9 using a new processor, how much faster will the entire program run on the new processor?**

1s + 9s/9 = 1s + 1s = 2s

speedup is 10s/2s = 5 times faster

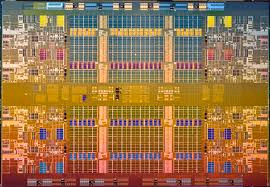
**1.5) If processor performance doubles every two years, how much faster will processors be in ten years?**

32 times (2 after 2 years, 4 after 4 years, 8 after 6 years, 16 after 8 years, 32 after 10 years)

**1.6) If you concatenate a 6000-instruction sequence with an CPI of 2 and a 4000-instruction sequence with an CPI of 4, what is the CPI of the resulting 10,000-instruction sequence?**

(4000\*4+6000\*2)/10000 = **2.8 CPI**

**1.7) Looking at the die photos of several recent microprocessors, we noticed two distinct regions. What are the regular (non-fuzzy) regions?**



In this image the main, center (unfuzzy parts) are the **memory**.

**1.8) Why did the decades-long increase in processor frequency stop a few years ago?**

Because of the **power wall** – we can’t reduce voltage further and we cant remove more heat so processors would fry out due to large quantities of heat produced by the increase in the # of transistors. Therefore the processor frequency stopped increasing.

**1.9) Go to ark.intel.com and find out for a Xeon X5690 the number of cores per chip, the number of threads per core, the normal CPU clock frequency, the (L3) cache size, the lithography feature size, the TDP power consumption, and the voltage range.**

**Cores per chip** – 6

**Threads per core** – 2

**Normal CPU clock frequency** – 3.46 GHz

**L3 cache size** – 12 MB

**Lithography feature size** – 32 nm

**TDP power consumption** – 130 W

**Voltage range** – .750V - 1.350V

**1.10) These days, how do microprocessor manufacturers typically use additional transistors that become available with every new chip generation?**

1. Keep instructions from having to leave the chip to complete (go to RAM), and
2. Increase pipelining – keep the line full or avoid having to go to RAM by predicting dependcy outcomes.
3. They can also be used to widen your data path (64-bit processors instead of 32-bit processors)