# Exercise 1

1.

t = 0.9 ns

F = 1/(0.9ns) = 1,11 MHz

2.

AMAT = t\_hit + p\_miss \* t\_miss

AMAT = 0,9 ns + (1-0,94) \* 70 ns = 5,1 ns

3.

We need to take into account how many times the processor executes a load/store instruction. Therefore, we multiply by the percentage.

CPI = CPI\_ideal + percentage\_of\_load/store \* (miss\_rate \* miss penalty)

miss\_penalty (in clock cycles) = miss\_time \* clk freq

miss\_penalty = 70 ns \* 1,11 MHz = 77,7

CPI = 1 + 0,36 \* ( (1-0,94) \* 77,7 ) = 2.68

4.

AMAT = t\_hit\_L1 + p\_miss\_L1 \* t\_miss\_L1

p\_miss\_L2 = miss rate to main memory = 0,1

Calculate the miss time for L1 cache, so when looking into L2, finding the data or looking into L2 and not finding the data.

t\_miss\_L1 = t\_hit\_L2 + p\_miss\_L2 \* t\_miss\_L2

t\_miss\_L1 = 6 ns + 0,1 \* 70 ns = 13 ns

AMAT = 0,9 ns + 0,06 \* 13 ns = 1,68 ns

5.

CPI = CPI\_ideal + p\_miss\_L1 \* (hit\_time\_L2 + p\_miss\_L2 \* hit\_time\_main\_memory) \* F\_clk

CPI = 1 + 0,06 \* (6 ns + 0,1 \* 70 ns) \* 1,11 MHz

CPI = 1.87

6.

Yes, CPI is 2,68 / 1,87 = 1,43 times lower. AMAT is 5,1 / 1,68 = 3,04 times lower. So everything has decreased in time, making it faster.

# Exercise 2

1.

VA = 48 bits

Page size = 8Kb

VA size = Virtual page number size + page offset size

Page offset size = log2(page size) = log2(8KB) = 13 bits

Virtual page number size = VA – page offset = 48 – 13 = 35 bits

Number of virtual pages = 2^(35) = 34,36e9 pages

2.

Physical address size = physical page number size + page offset size

PTE size = Physical page number size + reserved bits size

PTE size = 4 Bytes = 32 bits

Physical page number size = 32 bits - 12 bits = 20 bits

Physical address size = 20 + 13 = 33 bits

Physical addressable space = 2^33 = 8,59e9 pages

3.

Total storage needed in bits = number of PTEs in bits + PTE size in bits

PTE size = 4 bytes = 32 bits = 2^5 bits

(Slide 24 of lecture 10 uses PTE size in bytes, but that is incorrect due to different units right?)

Total storage needed in bits = 35 bits + 32 bits = 67 bits

4.

20 bits are reserved for the physical addresses.

Each page is 8KB

This means that there are 2^20 \* 8KB = 8,4 GB of physical space