RESEARCH AND READING ASSIGNMENT

1) [12] [Max 1 page] Read and briefly summarize the paper titled *"A New Golden Age for Computer Architecture"* and answer the following questions:

   a) What are the reasons of switching from CISC to RISC?

   b) In which situation VLIW will fail and in which will still be available?

   c) What are the main current challenges for processor architecture?

   d) List the approaches improving program performance in hardware technology.

2) [12] [Max 1 page] Determine the rate of increase in transistor counts and clock frequencies in the 70's, 80's, 90's, 00's, and this decade. Also, create a plot of the number of transistors versus technology feature size using an MS Excel spreadsheet. (Hint: You can visit the Intel on-line microprocessor museum.)

EXERCISES

1) [12] Table below shows relevant chip statistics that influence the cost of several processors. Explore the effect of different possible design decisions for the Processor A and answer the below questions.

Chip	Die size (mm^2)	Estimated defect rate (per cm^2)	N	Manufacturing size (nm)	Transistors (billions)
Processor A	180	0.03	12	10	7.5
Processor B	120	0.04	14	7	7.5
Processor C	200	0.04	14	7	12

   a) What is the yield for Processor A?

   b) What might be the reasons that Processor A has a lower defect rate than the others?

2) [12] One challenge for architects is that the design created today will require several years of implementation, verification, and testing before appearing on the market. This means that the architect must project what the technology will be like several years in advance. Sometimes, this is difficult to do. The increase in performance once mirrored this trend. Had performance continued to climb at the same rate as in the 1990s, approximately what performance would chips have over the VAX-11/780 in 2025?

3) [10] A new 22-core processor, runs four applications on this system, but the resource requirements are not equal. Assume the system and application characteristics as listed. Given that application A requires 41% of the resources, if we statically assign it 41% of the cores, what is the overall speedup if A is run parallelized but everything else is run serially.

Application	A	B	C	D
% Parallelizable	50	80	60	90

4) [12] One critical factor in powering a server farm is cooling. If heat is not removed from the computer efficiently, the fans will blow hot air back onto the computer, not cold air. Observe the effect of different design decisions on the necessary cooling, and thus the price, of a system. A cooling door for a rack costs $4,000 and dissipates 14 KW (into the room; additional cost is required to get it out of the room). How many servers with a Processor P2, 1 GB 240-pin DRAM, and a single 7,200 rpm hard drive can you cool with one cooling door? Use the table below for your power calculations.

Component Type	Product	Performance	Power
Processor	P1	1.2 GHz	72-79 W peak
	P2	2 GHz	48.9 – 66 W
DRAM	MEM1	184-pin	3.7 W
	MEM2	240-pin	2.3 W
Hard disk drive	HDD1	5400 rpm	7.9 W read/seek, 2.9 W idle
	HDD2	7200 rpm	7.9 W read/seek, 4.0 W idle

CASE STUDIES

A) You have the following characteristics, as shown in the table below, on your company's processor for a certain benchmark, which runs at 600 MHz:

Instruction Type	Frequency (%)	Cycles
Arithmetic and logical	30	3
Load and Store	25	2
Branches	40	3
Floating Point (FP)	5	8

You are asked to consider a cheaper, lower-performance version of this processor, by removing some of the FP hardware to reduce the die size. The wafer has a diameter of 10 cm, costs $3,000, and has a defect rate of 2/(cm^2). This wafer has a 80% yield. The current chip has a die size of 12 mm^2. The new chip becomes 10 mm^2, and FP instructions will now take 12 cycles to execute.

a) [10] What are the old and new CPI (Cycles Per Instructions) and MIPS (Million Instructions Per Second) ratings running this benchmark?

b) [10] What would be the theoretical limit of the best possible overall speedup that we could ever get by only improving the FP unit, and what would be the CPI and MIPS ratings of this new processor?

c) [Bonus, 10] What are the old and new die yields? What are the old and new costs per (working) processor? Please comment on the overall effect of the proposed hardware change on the cost and the performance of the processor. (N = 4)

B) [10] Your company produces a mobile device. To extend the battery life in the newer version of the device, you are asked to elaborate on the idea to simply reduce the processor clock speed by 25% and make no other changes. Stating your assumptions, describe whether this is a good idea or a bad idea, and why? Make sure to address both power and energy.