CS425: Computer Systems Architecture

Homework Problem Set 1
Assignment Date: Wednesday 04/11/2026
Due Date: Friday 13/11/2026 23:59:59

Instructions: Solve all problems, create a .pdf file and upload it to your designated gitlab repo. Check the delivery information at the end of this document.

Problem 1 (35 points)

Assume that you run four applications (X, Y, Z, W) on a 20-core processor system, given the application characteristics provided in the table below:

Application	X	Y	Z	W
% resources need	40	25	20	15
% parallelizable	50	80	60	90

i. Calculate and plot on a graph the speedup achieved when running each application in isolation on 2, 4, 8, 12, 16, 20 cores compared to running it serially. Show your calculations, the formulas you used, and comment on the results.
ii. Application X needs 40% of the resources, so we assign it 40% of the cores. Find the overall speedup if X runs in parallel but remaining applications run serially. State your assumptions, show your calculations, the formulas you used, and comment on the results.
iii. Propose a core allocation strategy that minimizes completion time when all applications run in parallel. State your assumptions, show your calculations, the formulas you used, and comment on the results.

Problem 2 (35 points)

The servers used by the major cloud providers provide adequate compute capacity to sustain the highest load demand. However, these servers operate at only 40% of their peak while the power comsumption does not scale linearly with the load. One solution would be to turn off the servers, but the problem would be long restart times in response to larger load demands. You propose a new system that does quick restart while waiting in "Active Idle" state.

Go to the SPECpower_ssj2008 website and select a system with Intel Xeon or AMD EPYC processors with published results from Q2'2026. Indicate your specific system selection and present in tables the numbers that you will use (consult the html page of the selected system). Answer the following questions and make sure that you clearly state your assumptions, show your calculations, the formulas you used, and comment on the results.

i. Calculate the power savings in case of turning off 50% of the servers.
ii. Calculate the power savings when 50% of the servers are in the "quick restart" state.
iii. Calculate the power savings if the voltage is reduced by 30% and frequency is reduced by 40%.
iv. Calculate the power savings if 25% of the servers are in the "quick restart" state and 25% of them are completely off.

Problem 3 (30 points)

Apart from scalability and throughput, availability is a key consideration when designing servers.

i. Your institution has a processor chip which exhibits a Failure In Time of 10000. What is the Mean Time To Failure for this system?

ii. If engineers need one days to fix and get the system running again, find the system's availability.

iii. The institution wants to build a supercomputer with 4096 nodes using these chips, and assigned to you the MTTF estimation of the following two scenarios:

- **a.** To cut down costs, the institution will deploy unreliable computer units to set up the supercomputer, meaning that if one fails, they all fail.
- **b.** The institution will use reliable computer units to build the supercomputer. In this case, the system will experience catastrophic failure only if 64 units fail.

Note: Consider the worst case scenario of simultaneous failures.

Which scenario would you recommend if the extra upfront cost of the second scenario is 2x compared to the first one? State your assumptions, show your calculations, the formulas you used, and comment on the results.

Delivery Information:

For this homework, we have created personal git repositories on the Department's gitlab server for each student enrolled in the course. Your personal repository is in the form:

https://gitlab.csd.uoc.gr/hy425_2026f/hw1_submits/hw1-csdXYZWA

Get a clone of your repository with `git clone` using your username (csdXYZWA@csd.uoc.gr). Access is only available via the University network and the VPN. *(Do not fork the repo – Work directly on the cloned git repo)*.

Commit and push a PDF with the solutions.

Indicative git commands:

- git status (see the changes)
- git config user.email csdXYZW@csd.uoc.gr
- git config user.name "Name Surname"
- git add csdXYZW_hw1.pdf
- git commit -m "hw1 delivery" (commit and message)
- git push (use your username and password)

Make sure that the push was successfully done and that your files have been uploaded on the gitlab repo

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Note: AI-generated content is **not permitted** for this exercise. AI tools may only be used to proofread your final draft.

- Disclosure Required: If you use an AI tool for proofreading, add an AI Disclosure Note at the end of your submission stating which tool was used and how (e.g., "XYZ used for grammar checks …").
